Operating Instructions for

EP1957

TwinSAFE EtherCAT Box with 8 fail-safe inputs and 4 fail-safe outputs

Version: 1.1.0
Date: 2018-11-05

BECKHOFF

Table of contents

1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

It is essential that the following notes and explanations are followed when installing and commissioning these components.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Origin of the document

This documentation was originally written in German. All other languages are derived from the German original.

Currentness

Please check whether you are using the current and valid version of this document. The current version can be downloaded from the Beckhoff homepage at http://www.beckhoff.com/english/download/twinsafe.htm. In case of doubt, please contact Technical Support [▶ 50].

Product features

Only the product features specified in the current user documentation are valid. Further information given on the product pages of the Beckhoff homepage, in emails or in other publications is not authoritative.

Disclaimer

The documentation has been prepared with care. The products described are subject to cyclical revision. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. We reserve the right to revise and change the documentation at any time and without prior announcement. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, DE102004044764, DE102007017835 with corresponding applications or registrations in various other countries.

The TwinCAT Technology is covered, including but not limited to the following patent applications and patents: EP0851348, US6167425 with corresponding applications or registrations in various other countries.

EtherCAT® and Safety over EtherCAT® are registered trademarks and patented technologies, licensed by Beckhoff Automation GmbH, Germany.

Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH & Co. KG apply.

1.2 Safety instructions

1.2.1 Delivery state

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

1.2.2 Operator's obligation to exercise diligence

The operator must ensure that

- the TwinSAFE products are only used as intended (see chapter Product description);
- the TwinSAFE products are only operated in sound condition and in working order.
- the TwinSAFE products are operated only by suitably qualified and authorized personnel.
- the personnel is instructed regularly about relevant occupational safety and environmental protection aspects, and is familiar with the operating instructions and in particular the safety instructions contained herein.
- the operating instructions are in good condition and complete, and always available for reference at the location where the TwinSAFE products are used.
- none of the safety and warning notes attached to the TwinSAFE products are removed, and all notes remain legible.

1.2.3 Description of safety symbols

In these operating instructions the following instructions are used.
These instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to the environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.1.0	• Project design limits added
1.0.0	• First release • Dimensioning updated • Certificate added
0.5.0	• Dimensions of the EP1957 updated in the text
0.4.0	• Revision following review
0.3.0	• Diagrams updated • Description of *Module Fault Link active* parameter added.
0.2.0	• Parameter descriptions expanded • Technical data updated • EN 81-20, EN 81-22 and EN 81-50 notes added
0.0.1	• First draft

1.4 Version history of the TwinSAFE product

This version history lists the software and hardware version numbers. A description of the changes compared to the previous version is also given.

Updated hardware and software

TwinSAFE products are subject to a cyclical revision. We reserve the right to revise and change the TwinSAFE products at any time and without prior notice.
No claims for changes to products already delivered can be asserted from these hardware and/or software changes.

A description of how a firmware (software) update can be performed can be found in chapter Firmware update of TwinSAFE products [▶ 46].

Date	Software version	Hardware version	Modifications
31.07.2018	01	00	First release

2 System description

2.1 EtherCAT Box Modules

The EtherCAT system has been extended with EtherCAT Box modules with protection class IP67. Through the integrated EtherCAT interface the modules can be connected directly to an EtherCAT network without an additional Coupler Box. The high-performance of EtherCAT is thus maintained into each module.

The extremely low dimensions of only 126 x 30 x 26.5 mm are identical to those of the Fieldbus Box extension modules. They are thus particularly suitable for use where space is at a premium. The small mass of the EtherCAT modules facilitates applications with mobile I/O interface (e.g. on a robot arm). The EtherCAT connection is established via screened M8 connectors.

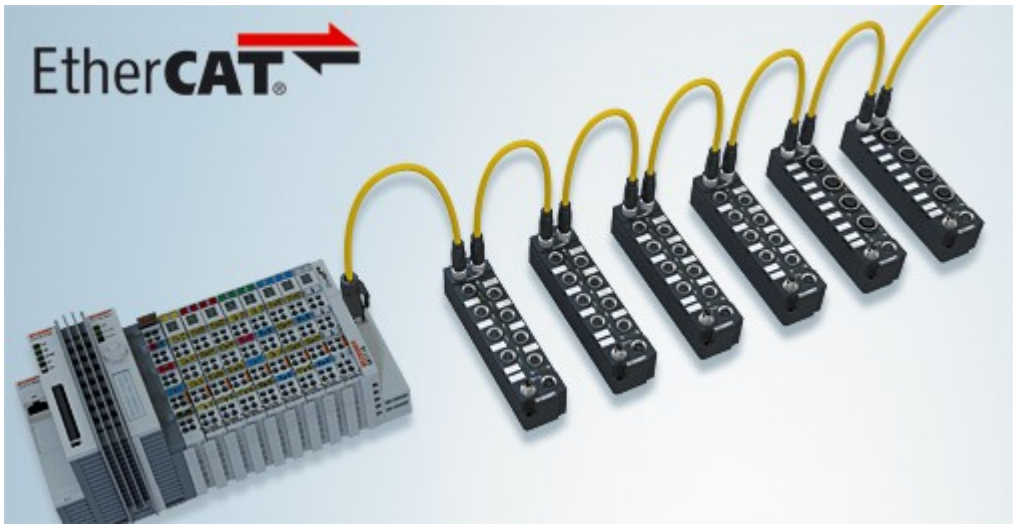


Fig. 1: EtherCAT Box modules extend the EtherCAT system with IP67 protection

The robust design of the EtherCAT Box modules enables them to be used directly at the machine. Control cabinets and terminal boxes are now no longer required. The modules are fully sealed and therefore ideally prepared for wet, dirty or dusty conditions.

Pre-assembled cables significantly simplify EtherCAT and signal wiring. Very few wiring errors are made, so that commissioning is optimized. In addition to pre-assembled EtherCAT, power and sensor cables, field-configurable connectors and cables are available for maximum flexibility. Depending on the application, the sensors and actuators are connected through M8 or M12 connectors.

Basic EtherCAT documentation

You will find a detailed description of the EtherCAT system in the Basic System Documentation for EtherCAT, which is available for download from our website (www.beckhoff.de) under *Downloads*.

3 Product description

3.1 EP1957

The EP1957 is an EtherCAT Box with digital inputs for 24 V_{DC} sensors or for potential-free contacts, with digital outputs for 24 V_{DC} actuators. The EtherCAT Box has 8 fail-safe inputs and 4 fail-safe outputs.

With two-channel connection the EP1957 meets the requirements of EN 61508-1:2010 SIL 3 and EN ISO 13849-1:2015 (Cat 4, PL e), see chapter Safe inputs and outputs [▶ 14].

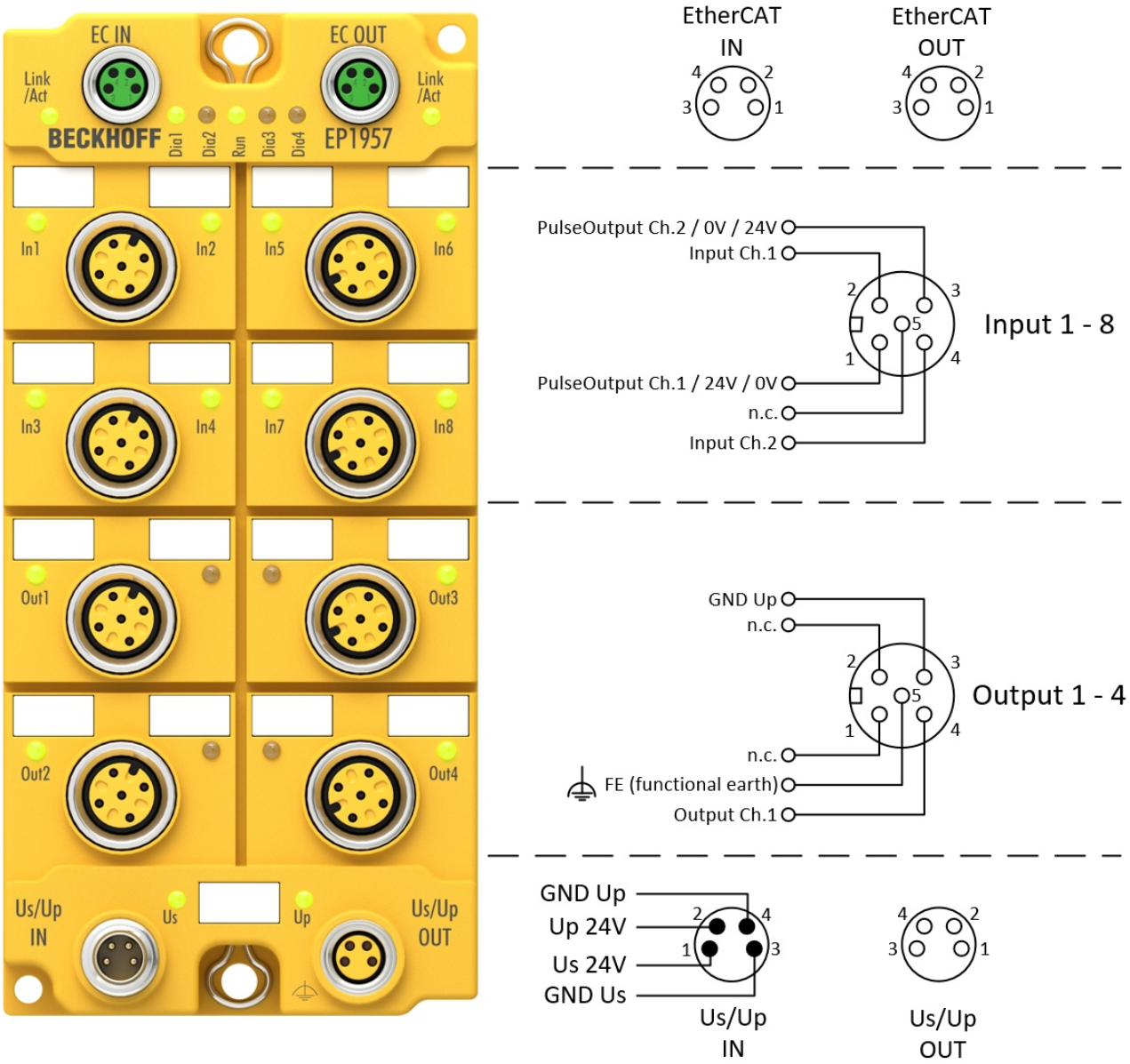


Fig. 2: EP1957 - connection diagram

The control voltage U_S supplies the module electronics.
The clock outputs / sensor supply voltage (parameterizable) and the safe outputs are supplied from the field voltage U_P.

The TwinSAFE EtherCAT Box has the typical design of an EtherCAT Box with 60mm width.

3.2 Intended use

⚠ WARNING

Caution - Risk of injury!

TwinSAFE components may only be used for the purposes described below!

The TwinSAFE EtherCAT Box expands the application range of the Beckhoff system with functions that enable it to be used for machine safety applications. The TwinSAFE Boxes are designed for machine safety functions and directly associated industrial automation tasks. They are therefore only approved for applications with a defined fail-safe state. This safe state is the wattless state. Fail-safety according to the relevant standards is required.

The TwinSAFE EtherCAT Box allows the connection of:

24 V_{DC} sensors such as

- emergency stop push buttons, pull cord switches, position switches, two-hand switches, safety mats, light curtains, light barriers, laser scanners etc.
- Safe sensors, which use a 24V_{DC} supply and send safe OSSD signals.

24 V_{DC} actuators such as

- Contactors, protective door switches with tumblers, valves etc.

⚠ WARNING

The fail-safe principle!

The basic rule for a safety system such as TwinSAFE is that failure of a part, a system component or the overall system must never lead to a dangerous condition. The safe state is always the switched off and wattless state.

⚠ WARNING

System limits

The TÜV SÜD certificate applies to this TwinSAFE component, the function blocks available in it, the documentation and the engineering tool. *TwinCAT 3.1* and the *TwinSAFE Loader* are permitted as engineering tools. Any deviations from these procedures or tools, particularly externally generated xml files for TwinSAFE import or externally generated automatic project creation procedures, are not covered by the certificate.

⚠ WARNING

Power supply from SELV/PELV power supply unit!

The TwinSAFE components must be supplied with 24 V_{DC} by an SELV/PELV power supply unit with an output voltage limit U_{max} of 36 V_{DC}. Failure to observe this can result in a loss of safety.

⚠ WARNING

Commissioning test

Before the EP1957 can be used for the safety task, the user must carry out a commissioning test so that sensor and actuator wiring errors can be ruled out.

⚠ CAUTION

Follow the machinery directive!

The TwinSAFE components may only be used in machines as defined in the machinery directive.

⚠ CAUTION

Ensure traceability!

The buyer has to ensure the traceability of the device via the serial number.

⚠ CAUTION

Note on approval according to EN 81-20, EN 81-22 and EN 81-50

- The TwinSAFE components may only be used in machines that have been designed and installed in accordance with the requirements of the EN 60204-1 standard.
- Provide a surge filter for the supply voltage of the TwinSAFE components against overvoltages. (Reduction to overvoltage category II)
- EN 81 requires that in the case of devices with internal temperature monitoring, a stop must be reached in the event of an overtemperature. In this case, passengers must be able to disembark (see EN 81-20 chapter 5.10.4.3, for example). To ensure this, application measures are necessary. The internal terminal temperature of the TwinSAFE components can be read out by the user. There is a direct switch-off at the maximum permissible temperature of the respective TwinSAFE component (see chapter Temperature measurement).
  The user must select a temperature threshold below the maximum temperature such that a stop can be reached in all cases before the maximum temperature is reached. Information on the optimum terminal configuration can be found under Notes on the arrangement of TwinSAFE components and under Example configuration for temperature measurement.
- For the use of the TwinSAFE components according to EN 81-22 and EN 81-50, the conditions described in the manuals for achieving category 4 according to EN ISO 13849-1:2015 **must be** observed.
- The use of TwinSAFE components is limited to indoor applications.
- Basic protection against direct contact must be provided, either by fulfilling protection class IP2X or by installing the TwinSAFE components in a control cabinet which corresponds at least to protection class IP54 according to EN 60529.
- The ambient conditions regarding temperature, humidity, heat dissipation, EMC and vibrations, as specified in the operating instructions under technical data, must be observed.
- The operating conditions in potentially explosive atmospheres (ATEX) are specified in the operating instructions.
- The safe state (triggering) of the application must be the de-energized state. The safe state of the TwinSAFE components is always the de-energized, switched-off state, and this cannot be changed.
- The service life specified in the operating instructions must be observed.
- If the TwinSAFE component is operated outside the permissible temperature range, it changes to "Global Shutdown" state.
- The TwinSAFE components must be installed in a control cabinet with protection class IP54 according to EN 60529, so that the requirement for contamination level 3 according to EN 60664-1 can be reduced to level 2.
- The TwinSAFE components must be supplied by a SELV/PELV power supply unit with a maximum voltage of U_{max} <= 36 V_{DC}.

3.3 Technical data

Product designation	EP1957-0022
Fieldbus	EtherCAT
Number of inputs	8
Number of outputs	4
Input and output connections	M12
Status display	12 (one green LED per input/output) + 5 diagnostic LEDs + 2 LEDs for Us/Up + 2 LEDs for EtherCAT link/act
Reaction time (Read input/write to E-bus)	typically: 4 ms (in default setting without local TwinSAFE Logic), maximally: see error reaction time
Watchdog time	adjustable from 2 ms to 60 s
Fault response time	≤ watchdog time
Cable length between sensor and EtherCAT Box	Unshielded: 100 m max. (at 0.75 or 1 mm²)
	Shielded: 100 m max. (at 0.75 or 1 mm²)
Output current of the clock outputs (parameter *Input Power Mode*: Diag test pulse)	typically 10 mA
Output current sensor supply (parameter *Input Power Mode*: power mode A/B)	max. 250 mA
Max. output current clock outputs / sensor supply in the event of an error	max. 3 A (the duration depends on the overtemperature-related shut-down of the output driver)
Safe outputs	max. 0.5 A per channel Diagnostic thresholds: > 4.7 V -> high signal is detected < 1.0 V -> low signal is detected
Input process image	7 byte
Output process image	7 byte
Supply voltage for the EP1957	24 V_{DC} (–15% / +20%)
Power consumption U_S (connected with 8 potential-free contacts and 4 outputs)	12 channels occupied: typically 120 mA 0 channels occupied: typically 100 mA (provide 4 A fuse)
Current consumption U_P (connected with 8 potential-free contacts and 4 actuators, without load currents)	12 channels occupied: approx. 60 mA 0 channels occupied: approx. 20 mA (provide 4 A fuse)
Power dissipation of the EtherCAT Box	typically 4.7 watts
Electrical isolation (between the channels)	no
Electrical isolation (between the channels and EtherCAT)	yes
Insulation voltage (between the channels and EtherCAT, under common operating conditions)	insulation tested with 500 V_{DC}
Dimensions (W x H x D)	60 (+0.5) mm x 126 (+0.5) mm x 26.5 mm
Housing material	PBT+PET (Valox 855)
Sealing compound	polyurethane
Weight	app. 315 g
Permissible ambient temperature (operation)	-25 °C to +60 °C
Permissible ambient temperature (transport/storage)	-40°C to +85°C
Permissible air pressure (operation/storage/transport)	750 hPa to 1100 hPa (this corresponds to an altitude of approx. -690 m to 2450 m above sea level, assuming an international standard atmosphere)
Inadmissible operating conditions	TwinSAFE EtherCAT boxes must not be used under the following conditions: • under the influence of ionizing radiation (exceeding the natural background radiation) • in corrosive environments
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
Shocks	15 g with pulse duration 11 ms in all three axes
Protection class (when screwed together)	IP67 (according to EN 60529)
correct installation position	variable
Approvals	CE, TÜV SÜD

3.4 Safety parameters

Characteristic numbers	EP1957-0022
Lifetime [a]	20
Proof test interval [a]	not required[1]
PFH_D	6.50E-09
PFD	8.30E-05
$MTTF_D$	high
DC	high
Performance level	PL e
Category	4
HFT	1
Element classification[2]	Type B

1. Special proof tests throughout the service life of the EtherCAT Box are not required.
2. Classification according to EN 61508-2:2010 (see chapters 7.4.4.1.2 and 7.4.4.1.3)

The EP1957 EtherCAT Box can be used for safety-related applications according to IEC 61508:2010 up to SIL3 and EN ISO 13849-1:2015 up to PL e (Cat 4).

Further information on calculating or estimating the $MTTF_D$ value from the PFH_D value can be found in the TwinSAFE application manual or in EN ISO 13849-1:2015, Table K.1.

In terms of safety-related parameters, the Safety-over-EtherCAT communication is already considered with 1% of SIL3 according to the protocol specification.

3.5 Safe inputs and outputs

The safe input modules and corresponding clock outputs have a two-channel design. This has the advantage that a two-channel safe sensor with an M12 connection can be used, and a fault such as cross-circuit or external feed results in shutdown of the whole module.

The safe output modules have a single-channel design.

⚠ DANGER

Clocked signals inside a sheathed cable

If clocked signals (clock outputs for the safe inputs and safe outputs) of different modules are used within a sheathed cable, a fault in one module, such as cross-circuit or external feed, must lead to the disconnection of all these modules. This is achieved by setting the *Module Fault Link active* parameter for all modules involved. This parameter is set to TRUE by default. The parameter acts separately for the input and output modules.

⚠ DANGER

Safe inputs in Cat.4 / PL e

If two safe input channels are to be used in a category 4 structure without an M12 plug connector, please make sure to combine even and odd channel numbers.

3.6 Dimensions

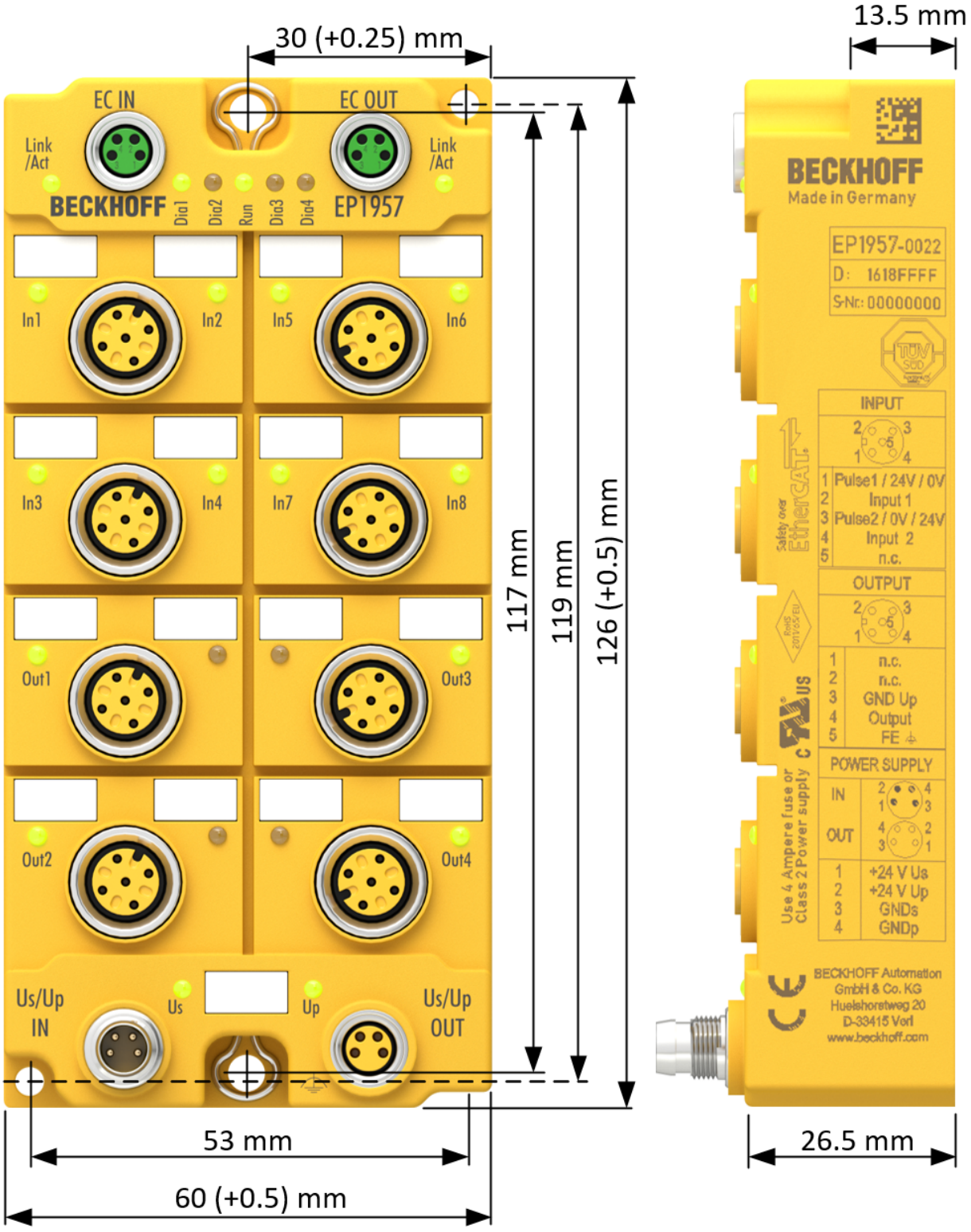


Fig. 3: EP1957 - dimensions

The EP1957 module has the following dimensions:
Width: 60 (+0.5) mm
Height: 126 (+0.5) mm
Depth: 26.5 mm

When fully wired, the connected cables increase the total depth of the module.

4 Operation

4.1 Environmental conditions

Please ensure that the TwinSAFE Boxes are only transported, stored and operated under the specified conditions (see technical data)!

⚠ WARNING

Risk of injury!

The TwinSAFE EtherCAT boxes must not be used under the following conditions.

- under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation)
- in corrosive environments

NOTE

Electromagnetic compatibility

The TwinSAFE components comply with the current standards on electromagnetic compatibility with regard to spurious radiation and immunity to interference in particular.
However, in cases where devices such as mobile phones, radio equipment, transmitters or high-frequency systems that exceed the interference emissions limits specified in the standards are operated near TwinSAFE components, the function of the TwinSAFE components may be impaired.

4.2 Installation

4.2.1 Fixing

Protect connectors against soiling!

Protect all connections from contamination during installation and operation of the modules! Protection class IP67 is only guaranteed if all cables and plug connectors are connected, and unused connections are protected with the appropriate cover plugs!
Connector sets see catalog.

- Modules with narrow housing are installed with two M3 screws.
- Modules with wide housing are installed with two M3 screws in the mounting holes in the corners or two M4 screws in the central mounting holes (see also chapter Power connection and grounding [▶ 19]).
- The bolts must be longer than 15 mm. The fastening holes in the modules have no thread.
- Note when mounting that the overall height is increased further by the fieldbus connections.

Mounting rail ZS5300-0001

The mounting rail ZS5300-0001 (500 mm x 129 mm) allows time-saving configuration of the modules.

The rail is made of 1.5 mm thick stainless steel (V2A) and features ready-made M3 threads. The rail has 5.3 mm slots for mounting on the machine with M5 screws.

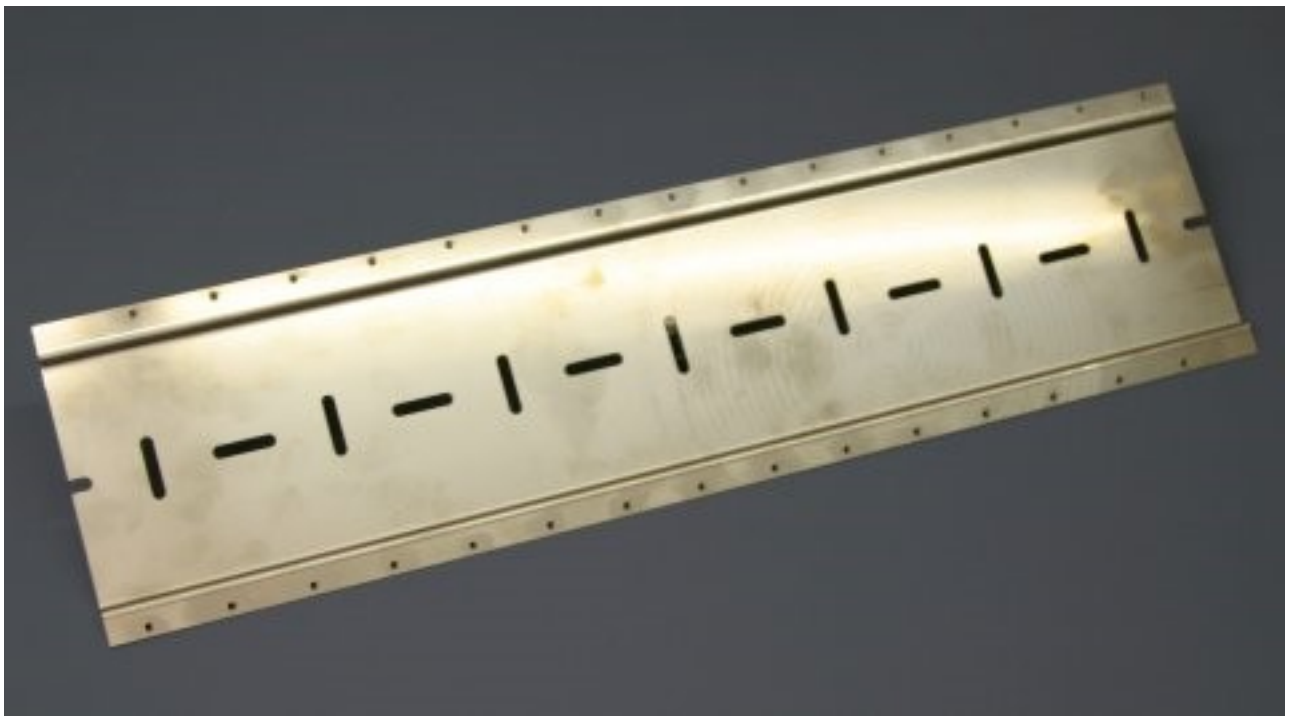


Fig. 4: Mounting rail ZS5300-0001

The mounting rail is 500 mm long and enables the installation of 15 narrow modules, with a distance of 2 mm between them. It can be shortened as required for your particular application.

Mounting Rail ZS5300-0011

The mounting rail ZS5300-0011 (500 mm x 129 mm) has in addition to the M3 treads also pre-made M4 treads to fix 60 mm wide modules via their middle holes.

Up to 14 narrow or 7 wide modules may be mixed mounted.

4.2.2 Connection

4.2.2.1 Tightening torque for connectors

The plug connectors should be tightened with the recommended torque.

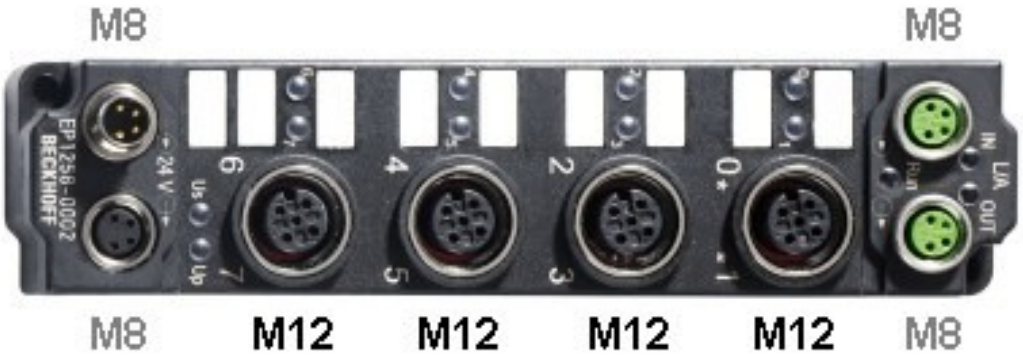


Fig. 5: EtherCAT Box with M8 and M12 connectors

Type	Connection	Nm	ft-lb
M8	Power supply, EtherCAT	0,4	0,3
M12	Input signals	0,6	0,44

Torque wrench

Fig. 6: Torque wrench ZB8801

Ensure the proper torque is used

Use torque wrenches available from Beckhoff to tighten the plug connectors (see accessories)!

4.2.2.2 EtherCAT connection

The EtherCAT Box (EPxxxx) has two M8 connectors marked **green** for the incoming and outgoing EtherCAT connection.

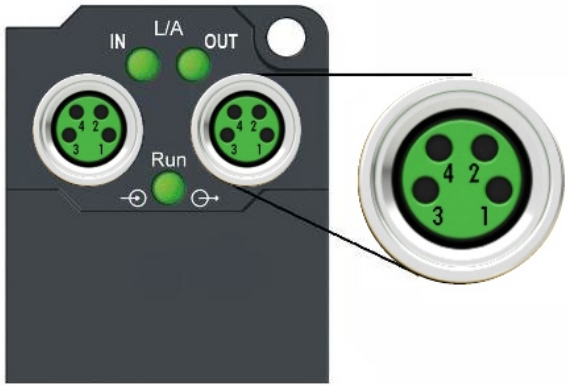


Fig. 7: EtherCAT connection 30 mm housing M8

Connection

There are various different standards for the assignment and colors of connectors and cables for EtherCAT.

EtherCAT		Connector	Cable		Standard
Signal	**Description**	**M8**	**ZB9010, ZB9020, ZK1090-6292**	**ZB903x, ZK1090-31xx**	**TIA-568B**
Tx +	Transmit Data+	Pin 1	yellow[1]	orange/white[2]	white/orange
Tx -	Transmit Data-	Pin 4	orange[1]	orange[2]	orange
Rx +	Transmit Data-	Pin 2	white[1]	blue/white[2]	white/green
Rx -	Receive Data-	Pin 3	blue[1]	blue[2]	green
Shield	Shield	Housing	Shield	Shield	Shield

[1)] Core colors according to EN 61918

[2)] Core colors

4.2.2.3 EtherCAT cables

For connecting EtherCAT devices only Ethernet cables that meet the requirements of at least **category 5 (CAT5) according to EN 50173 or ISO/IEC 11801** should be used.

Wiring recommendations

Detailed recommendations for EtherCAT wiring can be found in the documentation "Design recommendations for EtherCAT/Ethernet infrastructure", which is available for download from www.Beckhoff.de.

EtherCAT uses four cable wires for signal transmission. Due to automatic cable detection (auto-crossing) symmetric (1:1) or cross-over cables can be used between EtherCAT devices from BECKHOFF.

4.2.2.4 Power connection and grounding

This chapter provides basic information about the power supply and grounding of the EP1957 TwinSAFE EtherCAT Box. In particular, please note that the *General information on connecting the functional ground* only serves as an example.

Supply voltages (power connection)

The supply and distribution of the supply voltages takes place via the connections:

- **Us/Up IN** for feeding in the supply voltages
- **Us/Up OUT** for distribution of the supply voltages.

Both connections have an M8 thread and can be found on the left (Us/Up IN) and right (Us/Up OUT) side of the TwinSAFE EtherCAT Box (see diagram: *EP1957 - power connection*).

Information: An overview of pin assignment for the two connections can be found later in this chapter.

General information for connecting the functional ground

The grounding lugs of the EP1957 are internally connected to the safe outputs (pin 5 of the M12 connections).

To provide functional grounding  , if possible the connection should:

- have a large surface
- have low impedance and
- be permanent.

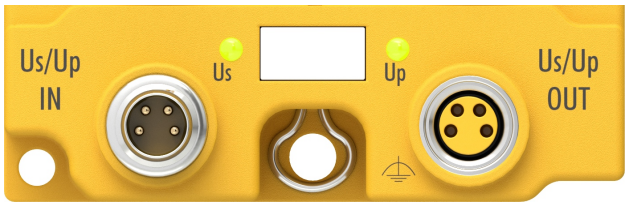
In order to establish a permanent connection, all operating states of the machine, such as vibrations, must be taken into account.

The connection can be established using the following two methods:

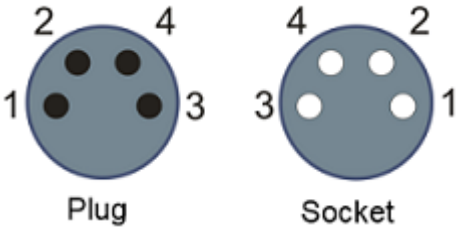
1. via a screw connection from the TwinSAFE-EtherCAT Box to the machine bed
2. through a ring terminal (hole dia. 4.3 mm) with cable connection to the functional ground

A grounding lug is available at the upper and lower mounting points (hole dia. 5 mm for M4 thread) on the housing.

NOTE	
	**Connecting the functional ground** The functional ground connection should have low impedance and a large surface.



EP1957 - power connection



M8 - pin assignment

Contact	Voltage
1	Control voltage Us, +24 V_{DC}
2	Peripheral voltage Up, +24 V_{DC}
3	GND Us
4	GND Up
⏚	Connecting the functional ground

The contacts of the M8 plug connectors can conduct a maximum current of 4 A.

Two LEDs indicate the status of the supply voltages.

NOTE

Do not confuse the power port with EtherCAT port!

Never connect the power cables (M8, 24 V_{DC}) to the green-marked EtherCAT sockets of the EtherCAT Box Modules. This can cause the destruction of the modules!

Control voltage Us

The fieldbus and the processor logic are supplied from the 24 V_{DC} control voltage Us. The control voltage is electrically isolated from the fieldbus circuitry.

Peripheral voltage Up

The peripheral voltage Up supplies the digital clock outputs, the safe inputs and the safe outputs.

Redirection of the supply voltages

The power IN and OUT connections are bridged in the module. Hence, the supply voltages Us and Up can be passed from EtherCAT Box to EtherCAT Box in a simple manner.

⚠ CAUTION

Note the maximum current!

For the distribution of the supply voltages Us and Up, please note that the maximum permitted current of 4 A for the respective contacts of the M8 plug connector should not be exceeded, even in the event of a fault, e.g. short circuit!

4.2.2.5 Signal connection for inputs

The EP1957 has 8 safe inputs.

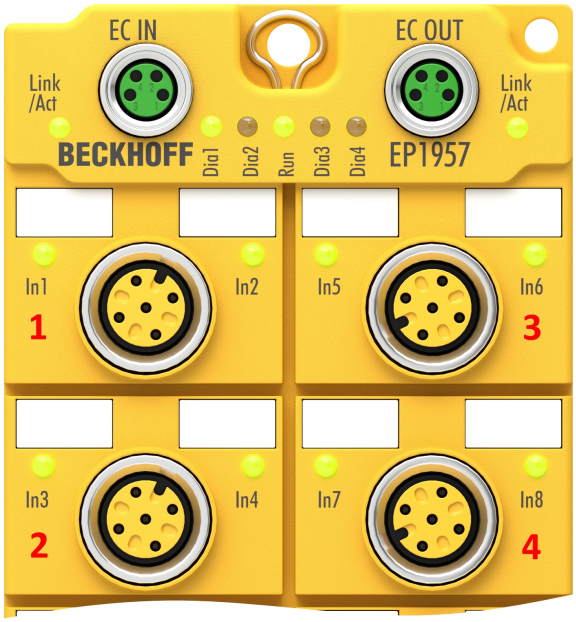


Fig. 8: EP1957 - safe inputs 1 to 8

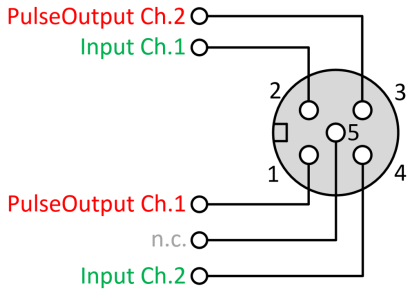


Fig. 9: PinOut default setting

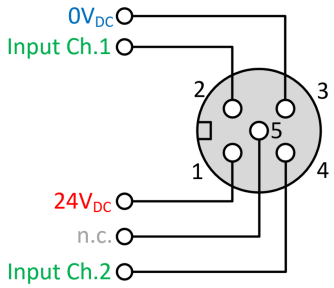


Fig. 10: PinOut alternative 1 (parameter input power mode = power mode A)

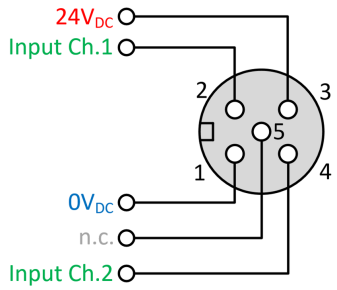


Fig. 11: PinOut alternative 2 (parameter input power mode = power mode B)

M12 connection (numbered in red)	Contact	Chan-nel	Signal	Alternative 1: Parameter Power mode A	Alternative 2: Parameter Power mode B
1	1	1	Pulse output 1	24 V_{DC} Sensor supply	0 V_{DC} Sensor supply
	2		Input 1	Input 1	Input 1
	3	2	Pulse output 2	0 V_{DC} Sensor supply	24 V_{DC} Sensor supply
	4		Input 2	Input 2	Input 2
	5	-	not connected	not connected	not connected
2	1	3	Pulse output 3	24 V_{DC} Sensor supply	0 V_{DC} Sensor supply
	2		Input 3	Input 3	Input 3
	3	4	Pulse output 4	0 V_{DC} Sensor supply	24 V_{DC} Sensor supply
	4		Input 4	Input 4	Input 4
	5	-	not connected	not connected	not connected
3	1	5	Pulse output 5	24 V_{DC} Sensor supply	0 V_{DC} Sensor supply
	2		Input 5	Input 5	Input 5
	3	6	Pulse output 6	0 V_{DC} Sensor supply	24 V_{DC} Sensor supply
	4		Input 6	Input 6	Input 6
	5	-	not connected	not connected	not connected
4	1	7	Pulse output 7	24 V_{DC} Sensor supply	0 V_{DC} Sensor supply
	2		Input 7	Input 7	Input 7
	3	8	Pulse output 8	0 V_{DC} Sensor supply	24 V_{DC} Sensor supply
	4		Input 8	Input 8	Input 8
	5	-	not connected	not connected	not connected

Sensor supply

For the sensor supply, please ensure that the maximum current input does not exceed 250 mA and the parameter *Diag TestPulse active* is set to FALSE.

⚠ CAUTION

Configurable inputs

The inputs 1 to 8 can be occupied as you want with normally closed contacts or normally open contacts. The corresponding evaluation takes place in the safety controller.
Alternatively, a safe sensor can be supplied with 24 V_{DC}, instead of the clock outputs for potential-free contacts. The polarity of pins 1 and 3 can be parameterized. Detection of cross-circuits or external feeds must take place via the connected safe sensor.

Functional ground

Pin 5 of the M12 connections is not connected to the functional ground, since an SELV/PELV power supply unit is specified for the EtherCAT Box.

4.2.2.6 Characteristic curve of the inputs

The characteristic curve of the inputs is similar to type 3 according to EN 61131-2.

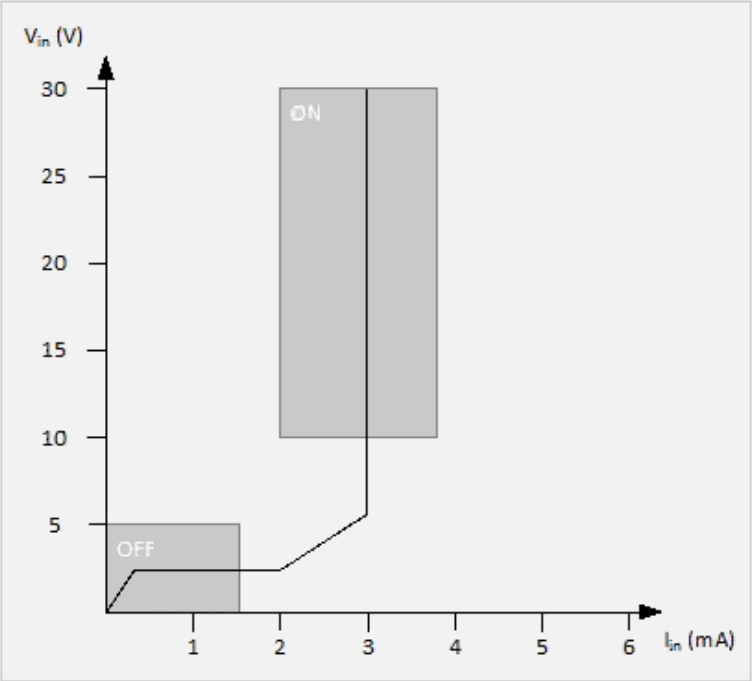


Fig. 12: Characteristic curve of the inputs

4.2.2.7 Signal connection for outputs

The EP1957 has 4 safe outputs, each with a maximum output current of 0.5 A.

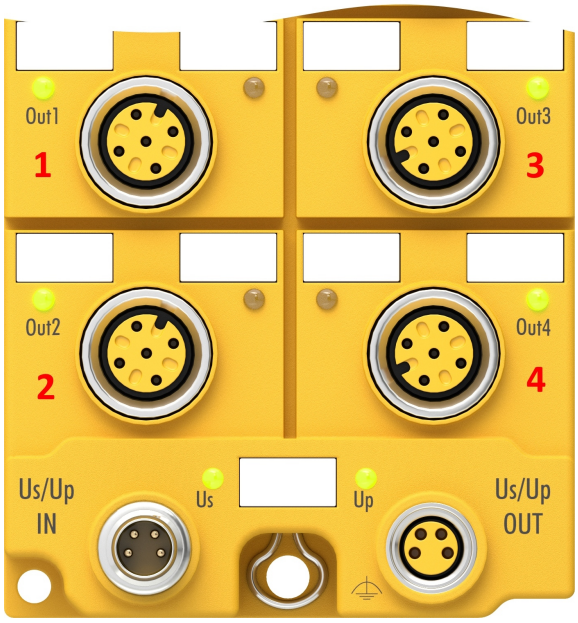


Fig. 13: EP1957 - safe outputs 1 to 4

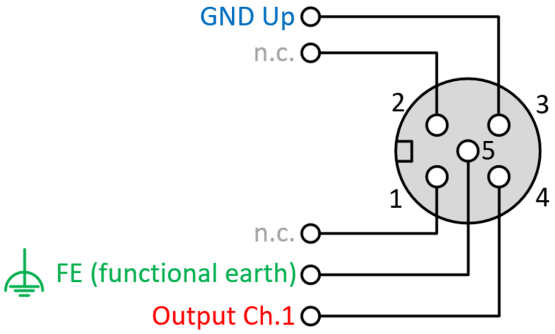


Fig. 14: PinOut safe output

M12 connection (numbered in red)	Contact	Channel	Signal
1	1	-	not connected
	2		not connected
	3	1	GND Up
	4		Output 1
	5	-	Functional ground FE
2	1	-	not connected
	2		not connected
	3	2	GND Up
	4		Output 2
	5	-	Functional ground FE
3	1	-	not connected
	2		not connected
	3	3	GND Up
	4		Output 3
	5	-	Functional ground FE
4	1	-	not connected
	2		not connected
	3	4	GND Up
	4		Output 4
	5	-	Functional ground FE

Functional ground

The functional ground on pin 5 of the M12 connections of the outputs is internally connected to the grounding lugs of the EtherCAT Box.

4.2.2.8 Overvoltage protection

If protection against overvoltage is necessary in your system, provide a surge filter for the power supply to the EtherCAT Box.

4.2.3 Temperature measurement

The temperature measurement of the EP boxes consists of a single box which is wired with corresponding supply and communication lines. The inputs and/or outputs of the EP Box are switched on for the test.

NOTE

External heat sources / radiant heat / impaired convection

The maximum permissible ambient temperature of 60°C was tested with the example configuration described above. Impaired convection or an unfavorable location near heat sources may result in overheating of the TwinSAFE components.

The key parameter is always the maximum permitted internally measured temperature of 110°C, above which the TwinSAFE components switch to safe state and report an error. The internal temperature can be read from the TwinSAFE components via CoE.

4.2.4 Signal cables

Permitted cable length

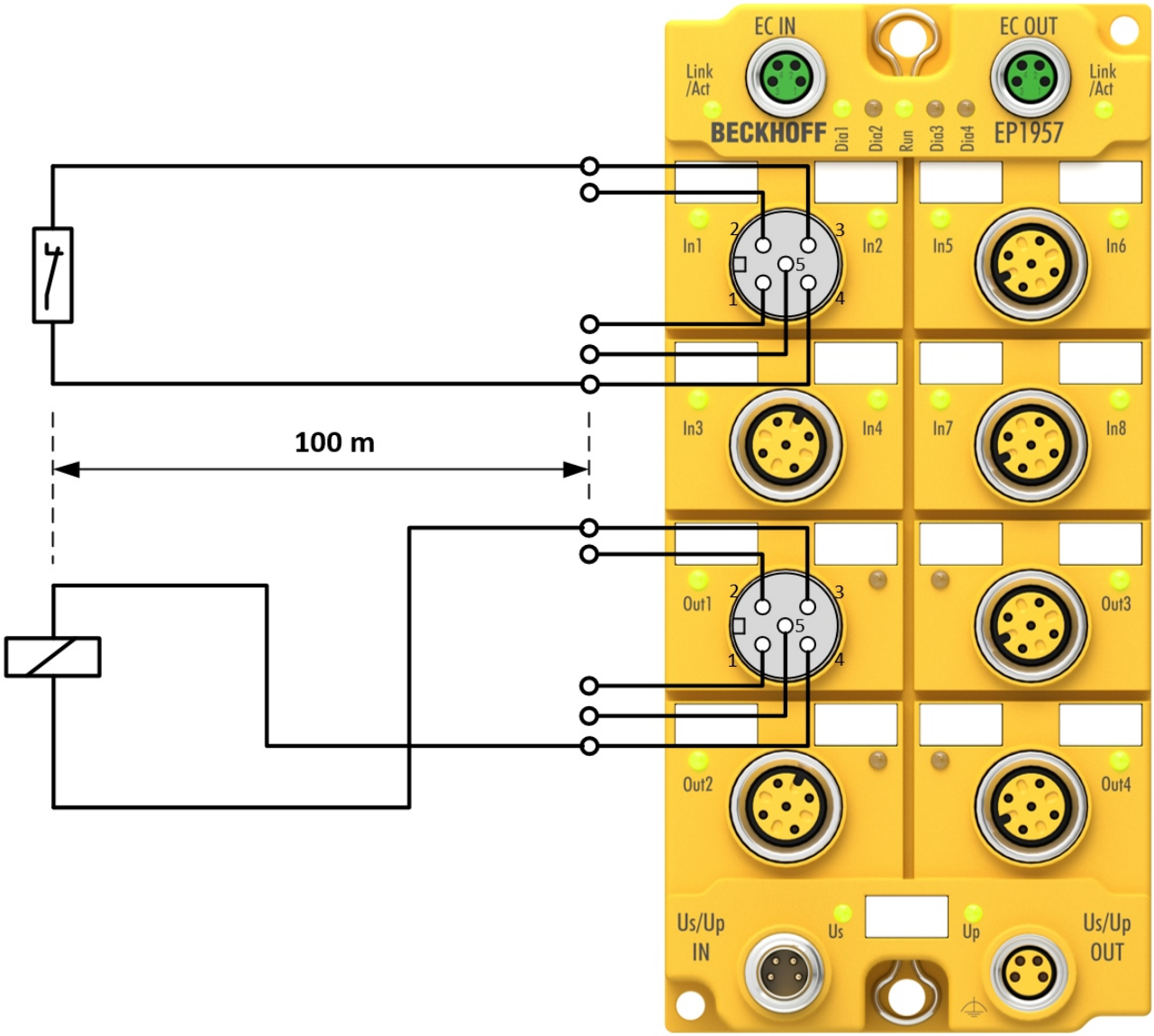


Fig. 15: EP1957 - signal cables

When connecting a single switching contact via a dedicated continuous cable (or via a non-metallic sheathed cable), the maximum permitted cable length is 100 m if a sensor test is active.

The use of contact points, connectors or additional switching contacts in the cabling reduces the maximum propagation.

Cable routing

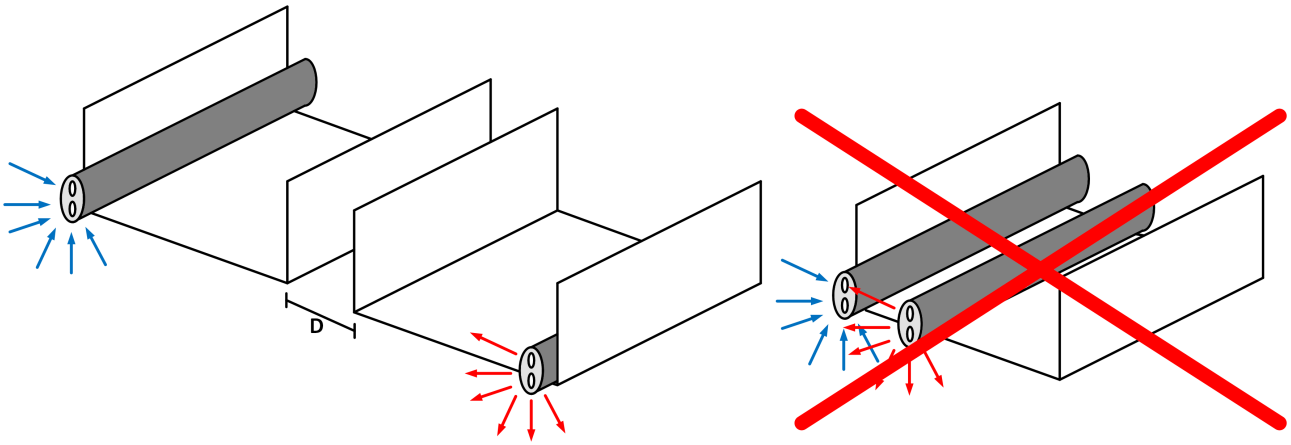


Fig. 16: Cable routing

NOTE

Route the signal cable separately

The signal cable must be routed separately from potential sources of interference, such as motor supply cables, 230 V_{AC} power cables etc.!
Interference caused by cables routed in parallel can influence the signal form of the test pulses and thus cause diagnostic messages (e.g. sensor errors or OpenLoad errors).
D: Distance between the cable ducts should be as large as possible
blue arrows: signal line
red arrows: potential source of interference

The common routing of signals together with other clocked signals in a common cable also reduces the maximum propagation, since crosstalk of the signals can occur over long cable lengths and cause diagnostic messages.

4.3 Configuration of the EP1957 in TwinCAT

4.3.1 Adding an EtherCAT device

See TwinCAT automation software documentation.

4.3.2 Adding an EP1957

An EP1957 is added in exactly the same way as any other Beckhoff EtherCAT Box. Open the *TwinSAFE Fieldbus Boxes* item in the list and select the EL1957.

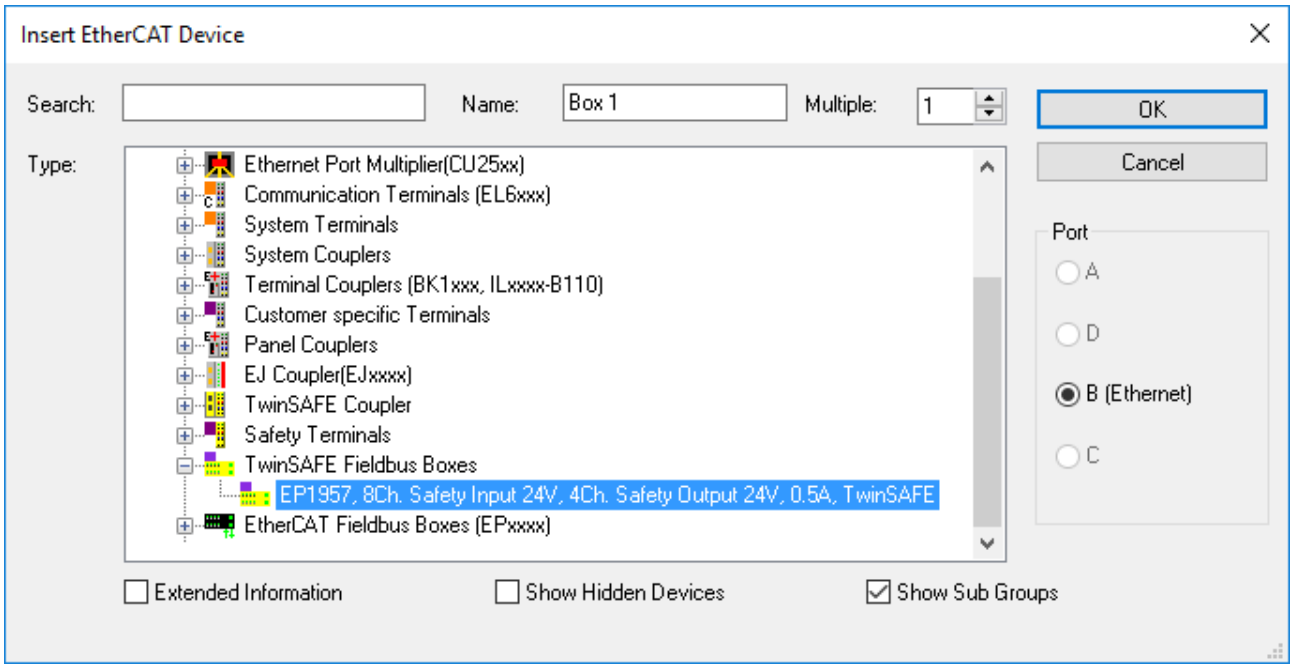


Fig. 17: Adding an EP1957

4.3.3 Using the integrated TwinSAFE Logic functions

On delivery, the EP1957 behaves like a safe TwinSAFE I/O slave, which can be used as an alias device within a TwinSAFE Logic, e.g. EL6910.

Alternatively, the local logic function of the EP1957 can be used. To this end please create a TwinSAFE project in the Safety Editor and select the EP1957 as the target system. Further information on creating a project can be found in the EL6910 documentation and the description of the function blocks under http://www.beckhoff.de/german/download/twinsafe.htm.

In order to be able to use the EP1957 again as a safe TwinSAFE I/O slave, please delete the logic, the mapping and the parameter data on the EtherCAT Box and switch the voltage off and on again.

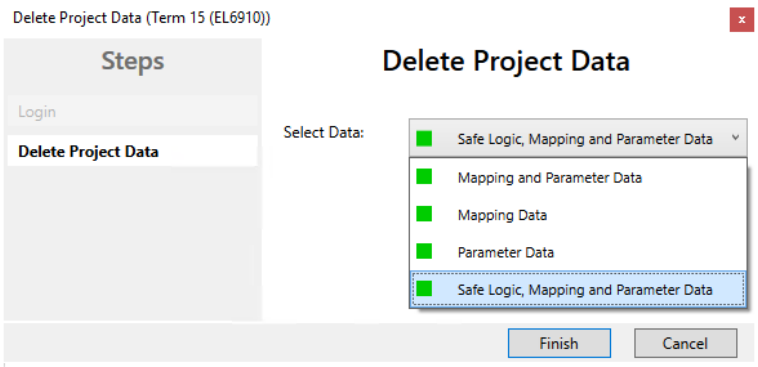


Fig. 18: EP1957 - Delete project data

4.3.4 Project design limits of EP1957

Project design limits

The maximum project design size for EP1957 is determined by the available memory. This is managed dynamically. The values specified in the following table are therefore only guide values and may differ from the actual values, depending on the safety project.

NOTE

Execution time of the logic function

The execution time of the logic program - with identical logic program - will typically be longer compared to the EL6910, since the safe I/O signals must be processed additionally. This also has a corresponding effect on the processing of the I/O signals, since with increasing project size these can only be evaluated with a lower frequency.

Process image size	max. 1486 byte per data direction (maximum memory size 0x1E00 for 3 buffers, ie with the same size of input and output process data, a maximum size of 1280 bytes per data direction is possible. Only straight start addresses are possible, so fill bytes must be taken into account)
TwinSAFE connections	128 max. (up to 255 CRCs in total; 1 CRC is required for a TwinSAFE connection with 1 or 2 byte safe data.)
Safe data per TwinSAFE connection	maximum 126 byte (telegram length 255 byte)
TwinSAFE blocks	maximum 512 (when using ESTOP function blocks with complete input and output mapping, other function blocks can lead to a smaller maximum number)
TwinSAFE groups	128 max.
TwinSAFE user	40 max.
Standard PLC inputs	dynamic (memory-dependent), max. 1483 byte
Standard PLC outputs	dynamic (memory-dependent), max. 1483 byte

NOTE

Project development

TwinCAT 3.1 Build 4022.25 or newer is required to use the internal logic functions. If the EP1957 is used as TwinSAFE slave with the default project, at least an EL6910, EK1960 or newer logic component is required as TwinSAFE master.

4.3.5 Address settings on the TwinSAFE EtherCAT Box

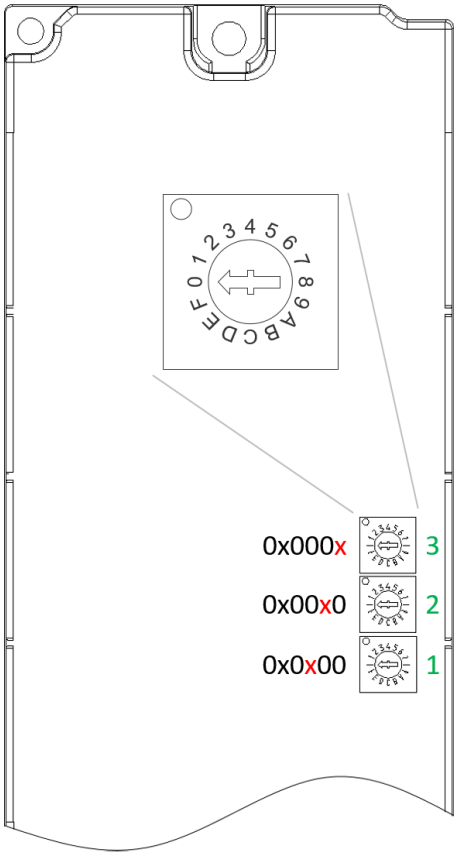


Fig. 19: EP1957 - Rotary switch on the underside

The TwinSAFE address of the Box must be set using the three rotary switches on the underside of the TwinSAFE-EP Box. TwinSAFE addresses between 1 and 4095 are available.

Rotary switch			Address
1 (bottom)	2 (center)	3 (top)	
0	0	1	**1**
0	0	2	**2**
0	0	3	**3**
…	…	…	**…**
0	0	F	**15**
0	1	0	**16**
0	1	1	**17**
…	…	…	**…**
0	F	F	**255**
1	0	0	**256**
1	0	1	**257**
…	…	…	**…**
F	F	F	**4095**

⚠ WARNING

TwinSAFE address

Each TwinSAFE address must be unique within a network!
The address 0 is not a valid address.

4.3.6 Alias devices

The communication between the safety logic and the I/O level is realized via an alias level. At this alias level (subnode *Alias Devices*) corresponding alias devices are created for all safe inputs and outputs, and also for standard signal types. For the safe inputs and outputs, this can be done automatically via the I/O configuration.

The connection- and device-specific parameters are set via the alias devices.

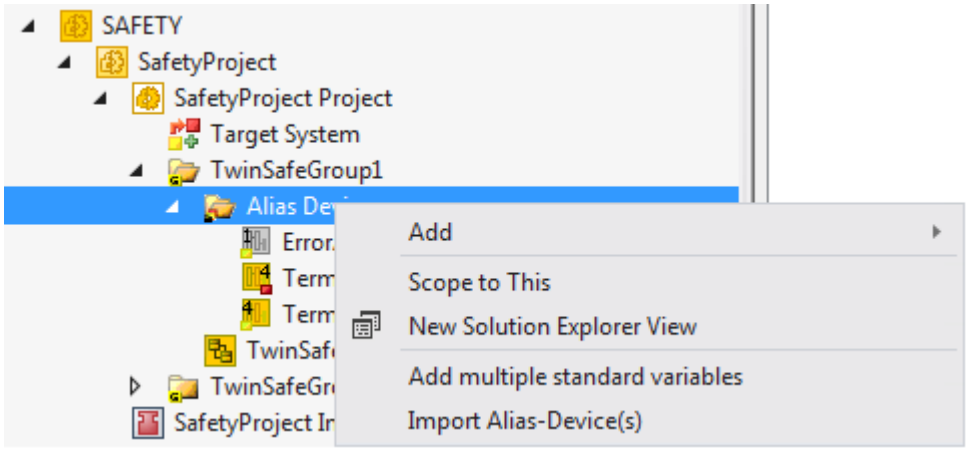


Fig. 20: Starting the automatic import from the I/O configuration

If the automatic import is started from the I/O configuration, a selection dialog opens, in which the individual terminals to be imported can be selected.

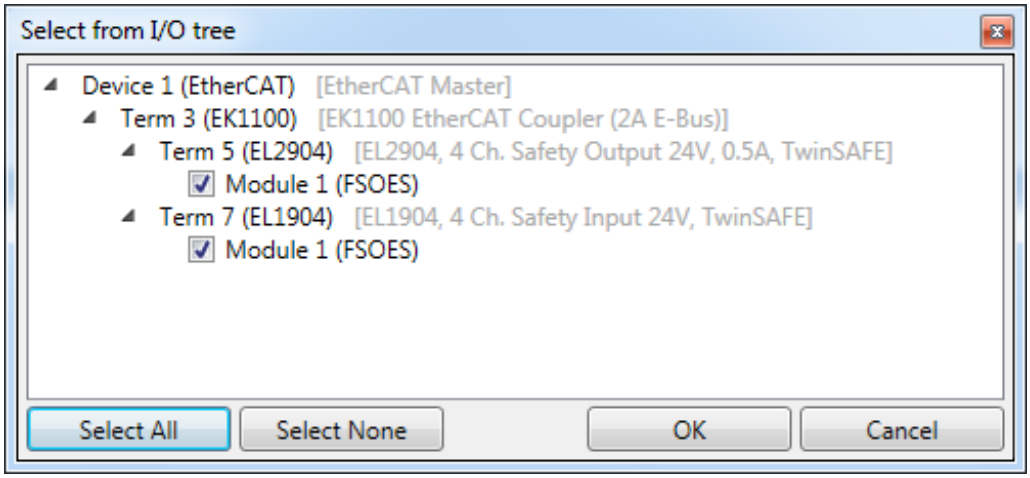


Fig. 21: Selection from the I/O tree

The alias devices are created in the safety project when the dialog is closed via OK.

Alternatively, the user can create the alias devices individually. To this end select *Add* and *New item* from the context menu, followed by the required device.

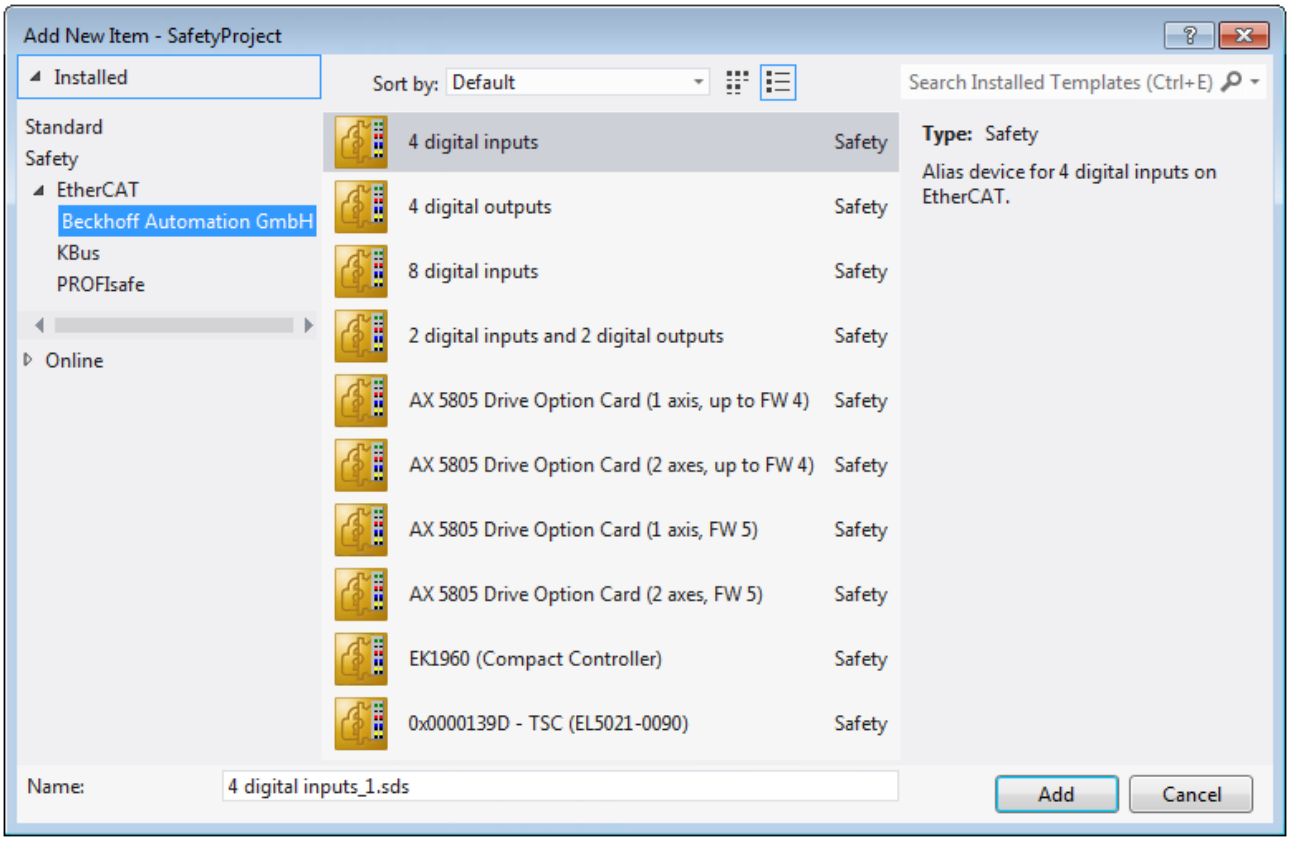


Fig. 22: Creating alias devices by the user

4.3.7 EP1957 parameters

After creating the alias device, it can be parameterized according to the user specifications. The FSoE address is set under the *Linking* tab, and the link to the physical device is created.

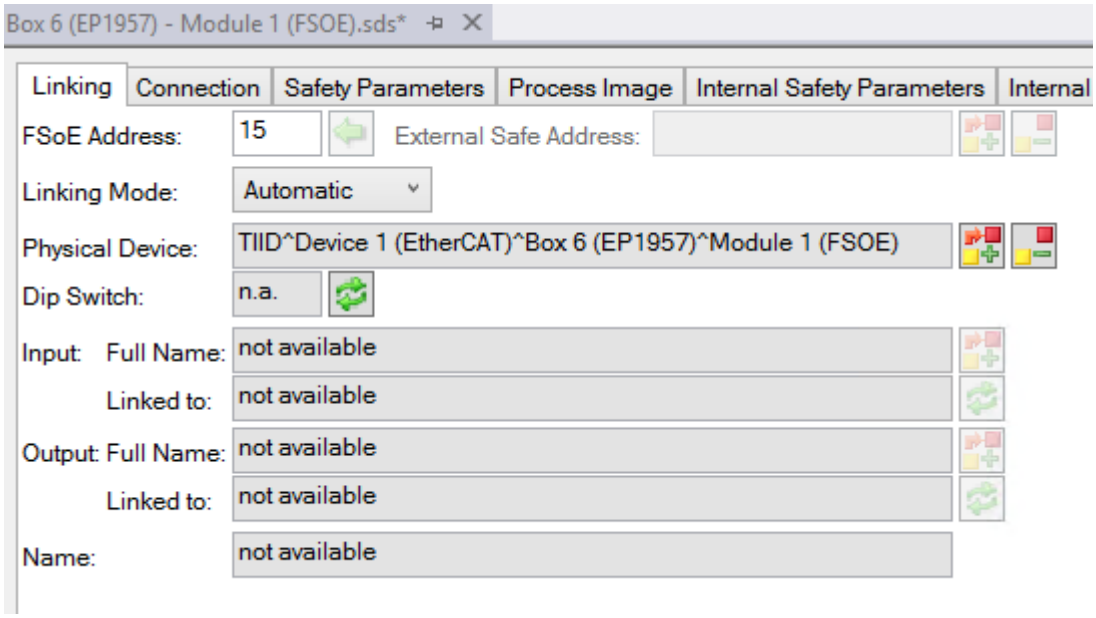


Fig. 23: EP1957 - *Linking* tab

Name	Description
FSoE address	Parameterized FSoE address (to be set by the user)
External safe address	currently not supported
Linking mode	• Automatic (automatic linking to the physical device) • Manual (manual linking, e.g. to network variables) • Local (signals are used in the local logic)
Physical device	Link to the TwinSAFE component within the TwinCAT solution
DIP switch	DIP or rotary switch address read from the TwinSAFE component
Input: Full name	In manual mode: Display of the variables below the TwinSAFE Logic, e.g. EL6910
Input: Linked to:	In manual mode: Display of the linked variables
Output: Full name	In manual mode: Display of the variables below the TwinSAFE Logic, e.g. EL6910
Output: Linked to	In manual mode: Display of the linked variables
Name	In manual mode: Name of the TwinSAFE message below the TwinSAFE Logic and for the info data

Under the *Connection* tab you can make further settings, e.g. the mapping of the info data or the behavior in case of a module error.

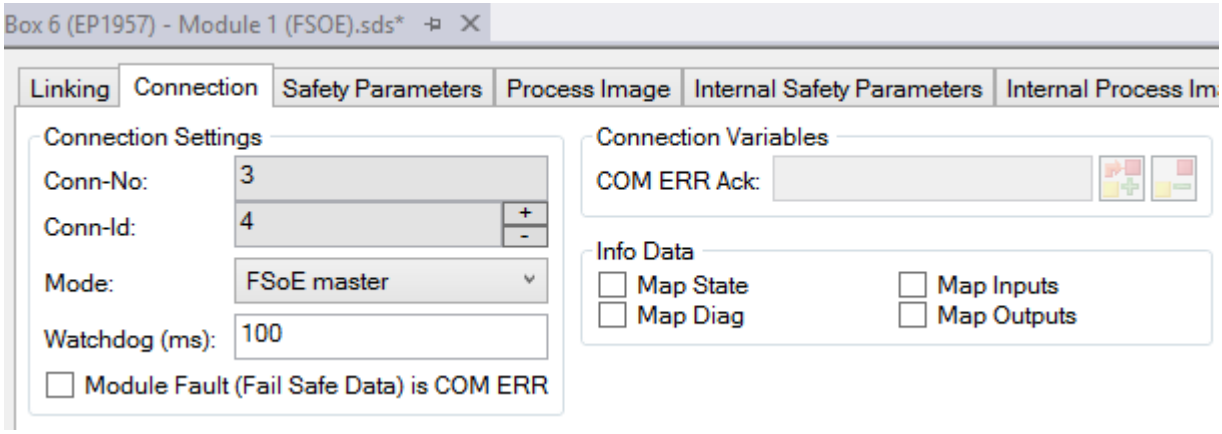
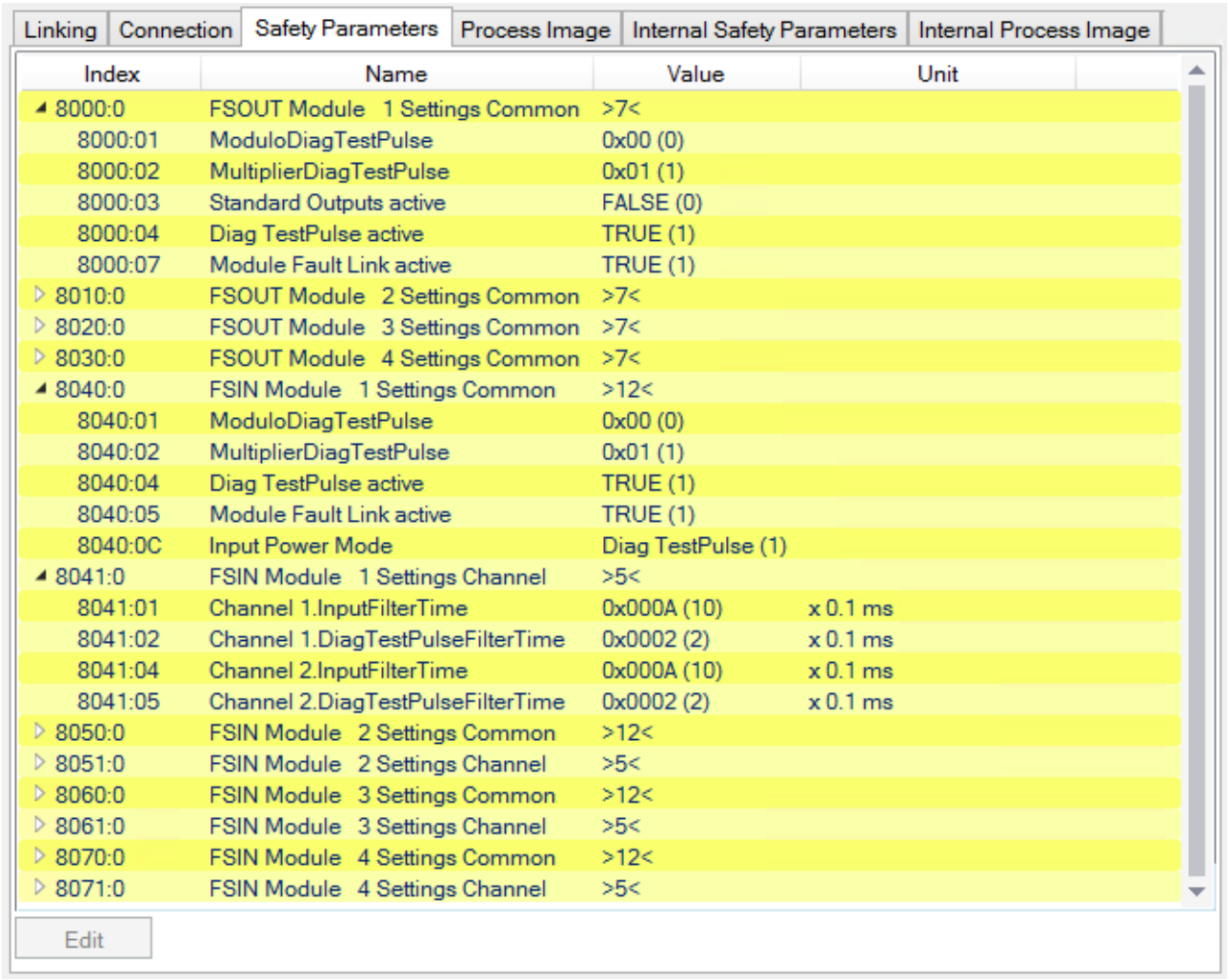


Fig. 24: EP1957 - *Connection* tab

Name	Description
Conn. no.	Connection number (issued by the system)
Conn. Id	Connection ID: Pre-allocated by system, can be changed by the user. The connection ID must be unique within the TwinCAT project.
Mode	• FSoE master (the logic is the master for this alias device) • FSoE slave (the logic is a slave for this alias device)
Watchdog	Setting the watchdog time in ms for this connection. This setting directly affects the fault response time.
Module Fault is ComError	If the checkbox is checked, module error also triggers a ComError, which switches the TwinSAFE group where the connection was created to the error state.
Com ERR Ack	For each connection, an additional error acknowledge can be configured. In this case, the connection must also be acknowledged, in addition to the Err Ack for the respective group.
Map state	The connection state is placed in the cyclic process data.
Map diag	The connection diagnostics is placed in the cyclic process data.
Map inputs	The safe input information of the connection is placed in the cyclic process data.
Map outputs	The safe output information of the connection is placed in the cyclic process data.

The *Safety Parameters* tab contains the parameters of the EL1957 to be set. The outputs are parameterized via the objects 0x8000 etc. The inputs are configured via the objects 0x8040 etc.



Index	Name	Value	Unit
8000:0	FSOUT Module 1 Settings Common	>7<	
8000:01	ModuloDiagTestPulse	0x00 (0)	
8000:02	MultiplierDiagTestPulse	0x01 (1)	
8000:03	Standard Outputs active	FALSE (0)	
8000:04	Diag TestPulse active	TRUE (1)	
8000:07	Module Fault Link active	TRUE (1)	
8010:0	FSOUT Module 2 Settings Common	>7<	
8020:0	FSOUT Module 3 Settings Common	>7<	
8030:0	FSOUT Module 4 Settings Common	>7<	
8040:0	FSIN Module 1 Settings Common	>12<	
8040:01	ModuloDiagTestPulse	0x00 (0)	
8040:02	MultiplierDiagTestPulse	0x01 (1)	
8040:04	Diag TestPulse active	TRUE (1)	
8040:05	Module Fault Link active	TRUE (1)	
8040:0C	Input Power Mode	Diag TestPulse (1)	
8041:0	FSIN Module 1 Settings Channel	>5<	
8041:01	Channel 1.InputFilterTime	0x000A (10)	x 0.1 ms
8041:02	Channel 1.DiagTestPulseFilterTime	0x0002 (2)	x 0.1 ms
8041:04	Channel 2.InputFilterTime	0x000A (10)	x 0.1 ms
8041:05	Channel 2.DiagTestPulseFilterTime	0x0002 (2)	x 0.1 ms
8050:0	FSIN Module 2 Settings Common	>12<	
8051:0	FSIN Module 2 Settings Channel	>5<	
8060:0	FSIN Module 3 Settings Common	>12<	
8061:0	FSIN Module 3 Settings Channel	>5<	
8070:0	FSIN Module 4 Settings Common	>12<	
8071:0	FSIN Module 4 Settings Channel	>5<	

Fig. 25: EP1957 - *Safety Parameters* tab

Index	Name	Default value/ unit	Description
8000:01	ModuloDiagTestPulse (FSOUT module 1)	0x00 / integer	Modulo value for the frequency of generating a test pulse. 0 -> every time 1 -> every 2nd time ...
8000:02	MultiplierDiagTestPulse (FSOUT module 1)	0x01 / integer	Length of the test pulse in multiples of 400 µs
8000:03	Standard outputs active (FSOUT module 1)	FALSE / Boolean	Activation of the logical AND operator of the safe and standard outputs of the module
8000:04	Diag test pulse active (FSOUT module 1)	TRUE / Boolean	Activation of test pulses for the corresponding output module
8000:07	Module Fault Link active	TRUE / Boolean	If a module error occurs in this module, a module error is also set for all other output modules of this TwinSAFE component for which this parameter is also set to TRUE.
8010:01-04	Parameters for FSOUT module 2	see module 1	see module 1
8020:01-04	Parameters for FSOUT module 3	see module 1	see module 1
8030:01-04	Parameters for FSOUT module 4	see module 1	see module 1
8040:01	ModuloDiagTestPulse (FSIN module 1)	0x00 / integer	Modulo value for the frequency of generating a test pulse. 0 -> every time 1 -> every 2nd time ...
8040:02	MultiplierDiagTestPulse (FSIN module 1)	0x01 / integer	Length of the test pulse in multiples of 400 µs
8040:04	Diag test pulse active (FSIN module 1)	TRUE / Boolean	Activation of test pulses for the corresponding input module
8040:05	Module Fault Link active	TRUE / Boolean	If a module error occurs in this module, a module error is also set for all other input modules of this TwinSAFE component for which this parameter is also set to TRUE.
8040:0C	Input power mode (FSIN module 1)	Diag test pulse / ENUM	• Diag test pulse • Power mode A (*Diag TestPulse active* must be FALSE) • Power mode B (*Diag TestPulse active* must be FALSE) see chapter Signal connection for inputs [▶ 21]
8041:01	Channel1.InputFilterTime	0x000A / 0.1 ms	Input filter of the safe input. Following this time the internal input signal changes to the applied signal state. Internal test pulses can have a length of up to 2 ms.
8041:02	Channel1.DiagTestPulse-FilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal
8041:04	Channel2.InputFilterTime	0x000A / 0.1 ms	Input filter of the safe input. Following this time the internal input signal changes to the applied signal state. Internal test pulses can have a length of up to 2 ms.
8041:05	Channel2.DiagTestPulse-FilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal
8050:01-0C	Parameters for FSIN module 2	see module 1	see module 1
8051:01-05	Parameters for FSIN module 2	see module 1	see module 1
8060:01-0C	Parameters for FSIN module 3	see module 1	see module 1
8061:01-05	Parameters for FSIN module 3	see module 1	see module 1
8070:01-0C	Parameters for FSIN module 4	see module 1	see module 1
8071:01-05	Parameters for FSIN module 4	see module 1	see module 1

4.3.8 Process image of the EP1957

The process image of EP1957 consists of 7 bytes of input data and 7 bytes of output data. Each of these 7-byte telegrams contains 2 bytes of safe data.

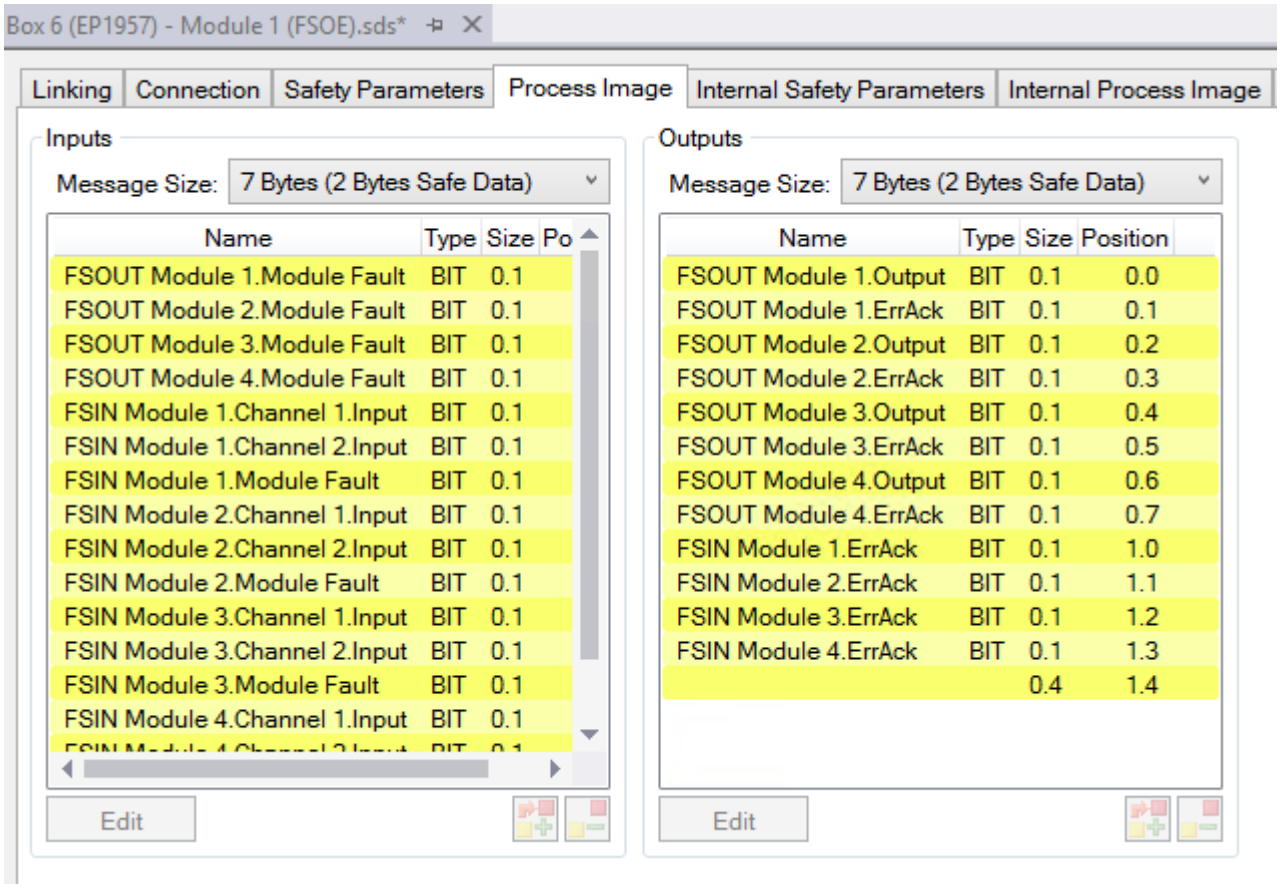


Fig. 26: EP1957 - process image

The assignment of the individual signals in the safe data is listed in the following table.

Name	Process image	Bit position	Description
FSOUT module 1. module fault	IN	0.0	Module error information for safe output 1
FSOUT module 2. module fault	IN	0.1	Module error information for safe output 2
FSOUT module 3. module fault	IN	0.2	Module error information for safe output 3
FSOUT module 4. module fault	IN	0.3	Module error information for safe output 4
FSIN Module1.Channel1.Input	IN	0.4	Safe input channel 1
FSIN Module1.Channel2.Input	IN	0.5	Safe input channel 2
FSIN Module1.Module Fault	IN	0.6	Module error information for safe input module 1
FSIN Module2.Channel1.Input	IN	0.7	Safe input channel 3
FSIN Module2.Channel2.Input	IN	1.0	Safe input channel 4
FSIN Module2.Module Fault	IN	1.1	Module error information for safe input module 2
FSIN Module3.Channel1.Input	IN	1.2	Safe input channel 5
FSIN Module3.Channel2.Input	IN	1.3	Safe input channel 6
FSIN Module3.Module Fault	IN	1.4	Module error information for safe input module 3
FSIN Module4.Channel1.Input	IN	1.5	Safe input channel 7
FSIN Module4.Channel2.Input	IN	1.6	Safe input channel 8
FSIN Module4.Module Fault	IN	1.7	Module error information for safe input module 4
FSOUT Module1.Output	OUT	0.0	Safe output 1
FSOUT Module1.ErrAck	OUT	0.1	Error acknowledge for safe output module 1
FSOUT Module2.Output	OUT	0.2	Safe output 2
FSOUT Module2.ErrAck	OUT	0.3	Error acknowledge for safe output module 2
FSOUT Module3.Output	OUT	0.4	Safe output 3
FSOUT Module3.ErrAck	OUT	0.5	Error acknowledge for safe output module 3
FSOUT Module4.Output	OUT	0.6	Safe output 4
FSOUT Module4.ErrAck	OUT	0.7	Error acknowledge for safe output module 4
FSIN Module1.ErrAck	OUT	1.0	Error acknowledge for safe input module 1
FSIN Module2.ErrAck	OUT	1.1	Error acknowledge for safe input module 2
FSIN Module3.ErrAck	OUT	1.2	Error acknowledge for safe input module 3
FSIN Module4.ErrAck	OUT	1.3	Error acknowledge for safe input module 4

4.4 TwinSAFE reaction times

The TwinSAFE terminals form a modular safety system that exchanges safety-oriented data via the Safety-over-EtherCAT protocol. This chapter is intended to help you determine the system's reaction time from the change of signal at the sensor to the reaction at the actuator.

Typical reaction time

The typical reaction time is the time that is required to transmit information from the sensor to the actuator, if the overall system is working without error in normal operation.

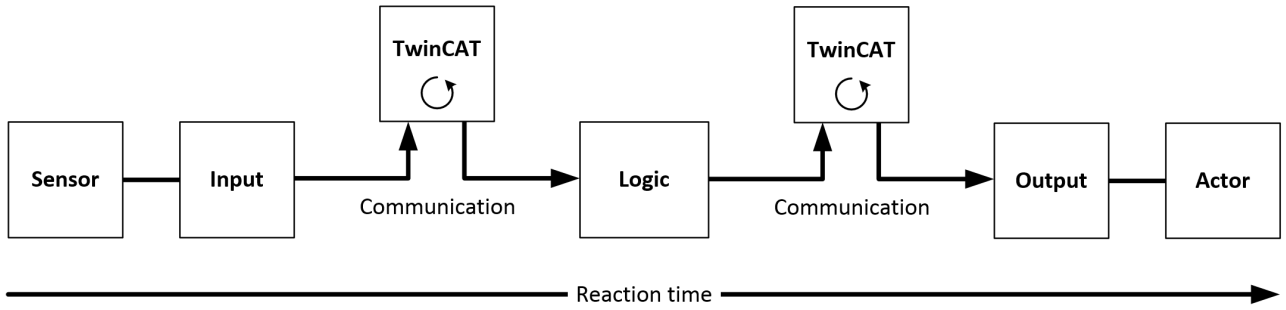


Fig. 27: Typical reaction time

Definition	Description
RTSensor	Reaction time of the sensor until the signal is provided at the interface. Typically supplied by the sensor manufacturer.
RTInput	Reaction time of the safe input, such as EL1904 or EP1908. This time can be found in the technical data. In the case of the EL1904 it is 4 ms.
RTComm	Reaction time of the communication This is typically 3x 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).
RTLogic	Reaction time of the logic terminal. This is the cycle time of the logic terminal and typically ranges from 500 µs to 10 ms for the EL6900, depending on the size of the safety project. The actual cycle time can be read from the terminal.
RTOutput	Reaction time of the output terminal. This typically lies within the range of 2 to 3 ms.
RTActor	Reaction time of the actuator. This information is typically supplied by the actuator manufacturer
WDComm	Watchdog time of the communication

This results in the following equation for the typical reaction time:

$$ReactionTime_{typ} = RT_{Sensor} + RT_{Input} + 3 * RT_{Comm} + RT_{Logic} + 3 * RT_{Comm} + RT_{output} + RT_{Actor}$$

with, for example

$$ReactionTime_{typ} = 5ms + 4ms + 3 * 1ms + 10ms + 3 * 1ms + 3ms + 20ms = 48ms$$

Worst-case reaction time

The worst case reaction time is the maximum time required to switch off the actuator in the case of an error.

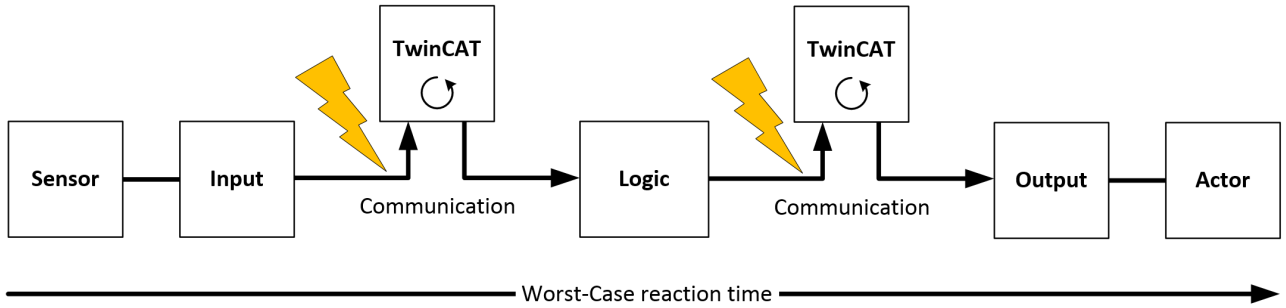


Fig. 28: Worst-case reaction time

This assumes that a signal change occurs at the sensor and is transmitted to the input. A communication error occurs at precisely the moment when the signal is to be transferred to the communication interface. This is detected by the logic following the watchdog time of the communication link. This information should then be transferred to the output, but a further communication error occurs here. This error is detected at the output following the expiry of the watchdog time and leads to the switch-off.

This results in the following equation for the worst-case reaction:

$$ReactionTime_{max} = WD_{Comm} + WD_{Comm} + RT_{Actor}$$

with, for example

$$ReactionTime_{max} = 2 * 15ms + 20ms = 50ms$$

4.5 Diagnosis

4.5.1 EtherCAT- Fieldbus LEDs

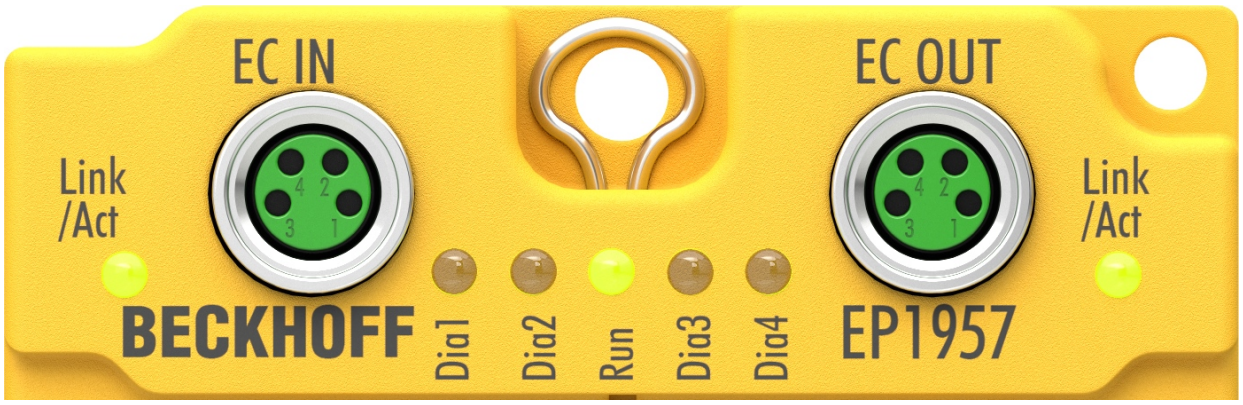


Fig. 29: EtherCAT- Fieldbus LEDs

LED displays

LED	Display	Meaning
IN Link/Act	off	no connection to the preceding EtherCAT module
	lit	LINK: connection to the preceding EtherCAT module
	flashes	ACT: communication with the preceding EtherCAT module
OUT Link/Act	off	no connection to the following EtherCAT module
	lit	LINK: connection to the following EtherCAT module
	flashes	ACT: Communication with the following EtherCAT module
Run	off	Status of the EtherCAT module is Init
	flashes quickly	Status of the EtherCAT module is pre-operational
	flashes slowly	Status of the EtherCAT module is safe-operational
	lit	Status of the EtherCAT module is operational

4.5.2 Status LEDs

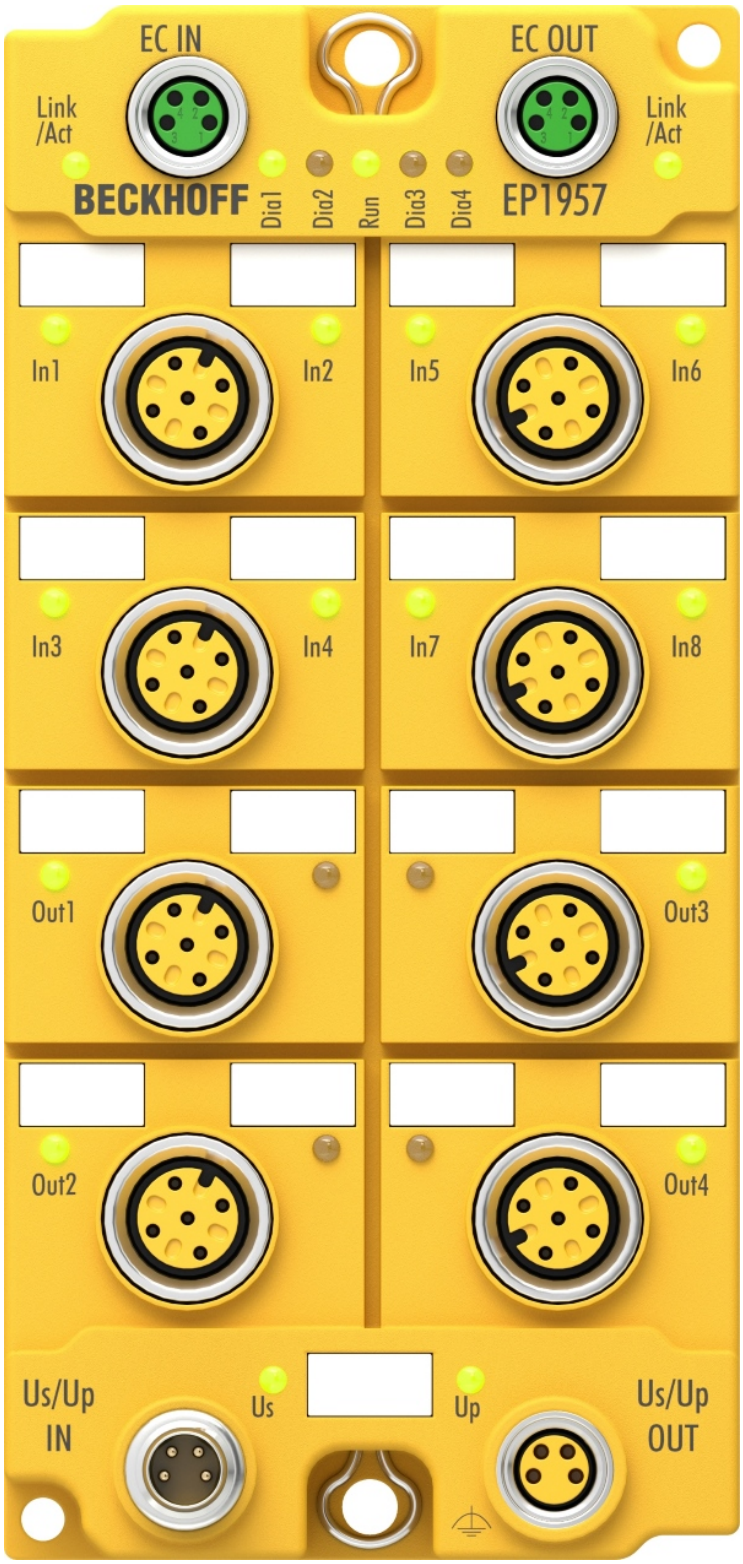


Fig. 30: EP1957 - status LEDs

LED	Display	Meaning
In 1	on	Input 1 is connected and logical 1
	off	Input 1 is not connected and logical 0
In 2	on	Input 2 is connected and logical 1
	off	Input 2 is not connected and logical 0
In 3	on	Input 3 is connected and logical 1
	off	Input 3 is not connected and logical 0
In 4	on	Input 4 is connected and logical 1
	off	Input 4 is not connected and logical 0
In 5	on	Input 5 is connected and logical 1
	off	Input 5 is not connected and logical 0
In 6	on	Input 6 is connected and logical 1
	off	Input 6 is not connected and logical 0
In 7	on	Input 7 is connected and logical 1
	off	Input 7 is not connected and logical 0
In 8	on	Input 8 is connected and logical 1
	off	Input 8 is not connected and logical 0
Out 1	on	Output 1 is connected
	off	Output 1 is not connected
Out 2	on	Output 2 is connected
	off	Output 2 is not connected
Out 3	on	Output 3 is connected
	off	Output 3 is not connected
Out 4	on	Output 4 is connected
	off	Output 4 is not connected
Us	on	Control voltage Us is available
	off	Control voltage Us is not available
Up	on	Control voltage Us is available
	off	Control voltage Up is not available

4.5.3 Diagnostic LEDs

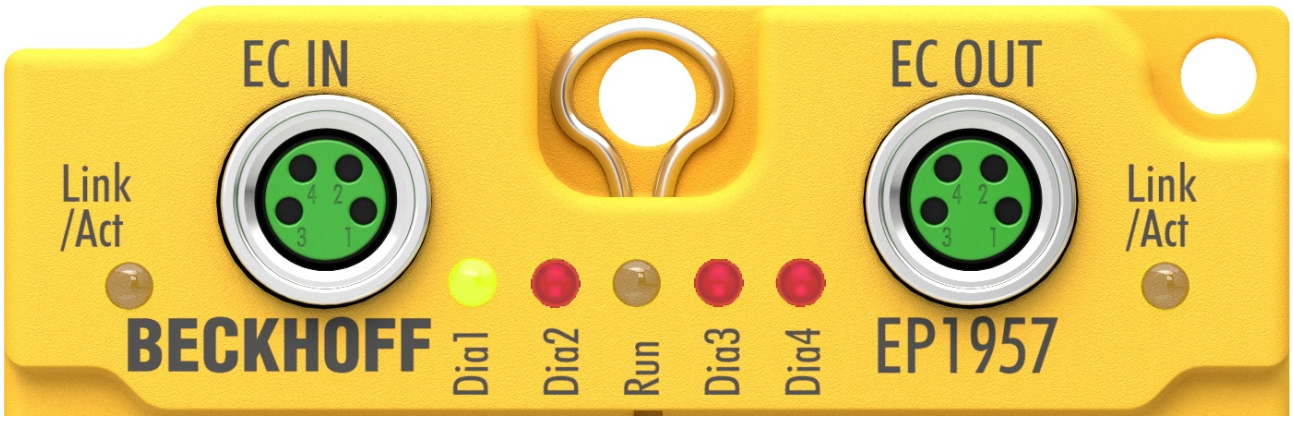


Fig. 31: EP1957 - diagnostic LEDs

LED displays

LED	lit	flashes	flickering	off
DIA1 (green)	Environment variables, operating voltage and internal tests are in the valid range • If DIA2 flashes, a logic error code applies	-		Environment variables, operating voltage and internal tests are outside the valid range • If DIA2 flashes, an environment error code applies
DIA2 (red)	Together with DIA3 and 4: Global Shutdown[1)] has occurred. (see diag history of the TwinSAFE components)	Logic or environment error code according to DIA1 and tables below is output	fault in a safe input or output module	Together with DIA3 and 4: Global Fault[1)] has occurred. (see diag history of the TwinSAFE components)
DIA3 (red)	Global fault or global shutdown on µC1[1)]	-		No global fault or global shutdown on µC1[1)]
DIA4 (red)	Global fault or global shutdown on µC2[1)]	-		No global fault or global shutdown on µC2[1)]

1. A global fault permanently disables the TwinSAFE component, so that it has to be replaced. A global shutdown temporarily disables the TwinSAFE component. The error can be reset by switching off and back on again.

Logic error codes of LED DIA2 (if LED DIA1 is lit)

Flashing Code	Description
1	Function block error in one of the TwinSAFE groups
2	Communication error in one of the TwinSAFE groups
3	Error combination: Function block and communication
4	General error in one of the TwinSAFE groups
5	Error combination: General and function block
6	Error combination: General and communication
7	Error combination: General, function block and communication

Environment error codes of LED DIA2 (if LED DIA1 is off)

Flashing Code	Description
1	Maximum supply voltage µC1 exceeded
2	Supply voltage µC1 below minimum value
3	Maximum supply voltage µC2 exceeded
4	Supply voltage µC2 below minimum value
5	Maximum internal temperature exceeded
6	Internal temperature below minimum value
7	Valid temperature difference between µC1 and µC2 exceeded
8	not used
9	not used
10	General error

4.5.4 Flash code display

LED	Display	Description
flashing		400 ms ON / 400 ms OFF 1 second pause between the flash codes
flickering		50 ms ON / 50 ms OFF

4.6 Maintenance

Maintenance

The TwinSAFE components are maintenance-free!

Environmental conditions

⚠ WARNING

Observe the specified environmental conditions!

Please ensure that the TwinSAFE components are only stored and operated under the specified conditions (see technical data).

If the TwinSAFE component is operated outside the permitted temperature range it will switch to *Global Shutdown* state.

Cleaning

Protect the TwinSAFE component from unacceptable soling during operation and storage!

If the TwinSAFE component was subjected to unacceptable soiling it may no longer be operated!

⚠ WARNING

Have soiled terminals checked!

Cleaning of the TwinSAFE component by the user is not permitted!
Please send soiled terminals to the manufacturer for inspection and cleaning!

4.7 Service life

The TwinSAFE EtherCAT Boxes have a service life of 20 years.

Due to the high diagnostic coverage within the lifecycle no special proof tests are required.

Date code

The TwinSAFE EtherCAT Boxes have a date code (D:), which is structured as follows:

Date code: WW YY SW HW

Key:	Example: Date code 16 18 01 02
WW: Calendar week of manufacture	Calendar week: 16
YY: Year of manufacture	Year: 2018
SW: Software version	Software version: 01
HW: Hardware version	Hardware version: 02

Serial number (S. no.)

In addition, the TwinSAFE EtherCAT Boxes have a unique serial number (S. no.).

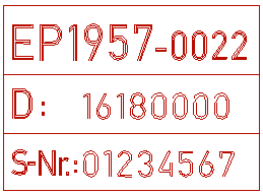


Fig. 32: EP1957 serial number

4.8 Decommissioning

⚠ DANGER

Serious risk of injury!

Bring the bus system into a safe, de-energized state before starting disassembly of the EtherCAT Boxes!

Disposal

The device must be removed for disposal.

- Housing components (Valox 855 - PBT+PET), made from recyclable plastic
- Sealing compound: Polyurethane resin
- Metal parts can be sent for metal recycling.
- Electronic parts such as disk drives and circuit boards must be disposed of in accordance with national electronics scrap regulations.

4.9 Firmware update of TwinSAFE products

For TwinSAFE products there is the option of performing a firmware update via the EtherCAT interface. The complete firmware of the TwinSAFE component is deleted and replaced by a new version.

The latest firmware can be downloaded from the Beckhoff website or requested from Beckhoff Support. The versions are available in an encrypted form and can only be loaded onto the matching TwinSAFE product. An incorrect firmware file is rejected by the respective TwinSAFE product.

Prerequisite for a firmware update

⚠ DANGER

Put the machine into a safe state!

A firmware update stops the current processing of the firmware of the TwinSAFE product. It is essential that you switch the TwinSAFE system to the safe state before you start an update.
All safe outputs must be in a safe, de-energized state. If hanging or pulling loads are present on the machine or the TwinSAFE system, these must also be brought into a safe state through external safety measures if necessary.

⚠ DANGER

Monitor the machine state!

It is necessary that you have control over the machine, i.e. you can see it and thus ensure that it is in a safe state and that a firmware update can be carried out without endangering the operators or other personnel.

NOTE

Avoid communication interruptions during the download

Please avoid disconnecting the EtherCAT connection while downloading the firmware under any circumstances. If a communication error does occur, the TwinSAFE product may subsequently be unusable and must be sent to the Beckhoff Service.

⚠ WARNING

Default project for TwinSAFE I/O components with local logic function!

After a firmware update, any implemented default project starts automatically. An EK1960, for example, would start up as a TwinSAFE I/O slave after a firmware update.

NOTE

Firmware update of TwinSAFE logics

If a firmware update is performed for a TwinSAFE logic component, e.g. on a TwinSAFE logic EL6910, the safety-related user program must be reloaded to the TwinSAFE logic after the update.

EtherCAT communication

When an EtherCAT component is updated, it is switched to BOOTSTRAP mode. This can have an effect on the EtherCAT communication with other EtherCAT devices.

Performing the firmware update

Click the button (1) in the TwinCAT system to enter Config mode. Confirm the query with OK (2). After that a further window appears which must be confirmed with Yes (Ja) (3). Deactivate the "Free Run" with No (Nein) (4). The system is now in "Configuration mode".

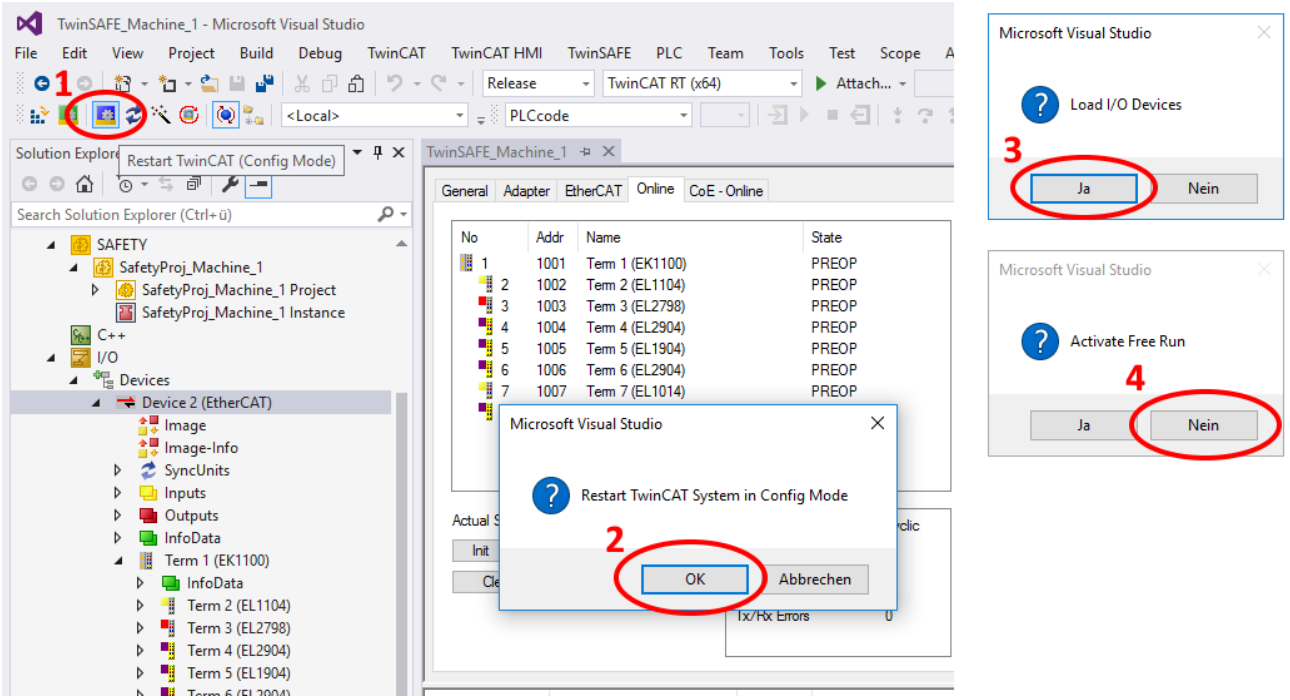


Fig. 33: Firmware update of TwinSAFE products - Part 1

To perform the firmware update, select the "Online" tab (6) for the "EtherCAT Device" (5). If you want to update several components, you can select the corresponding components (7) together; for individual components, select only these. Subsequently, click with the right mouse button inside the selected area and select the command "Firmware Update..." (8) in the command overview.

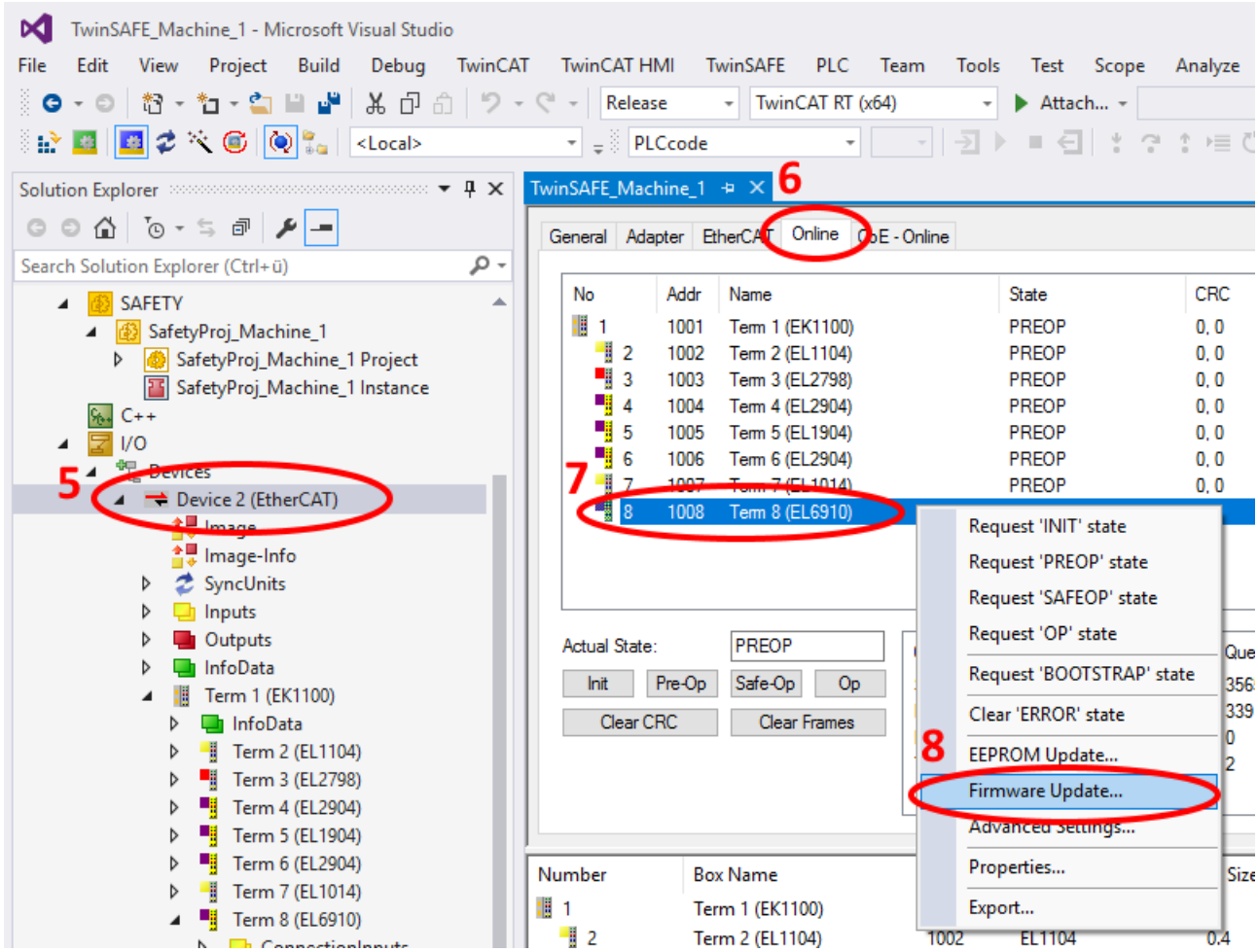


Fig. 34: Firmware update of TwinSAFE products - Part 2

In the place where you have stored the desired firmware version, select the firmware file (9) and click "Open" (10). Confirm the window that then opens with "OK" (11); the firmware update is then performed. After successful completion you must click OK (12) in the concluding "Function Succeeded" window. You can then switch the system back to Run mode and use the TwinSAFE system.

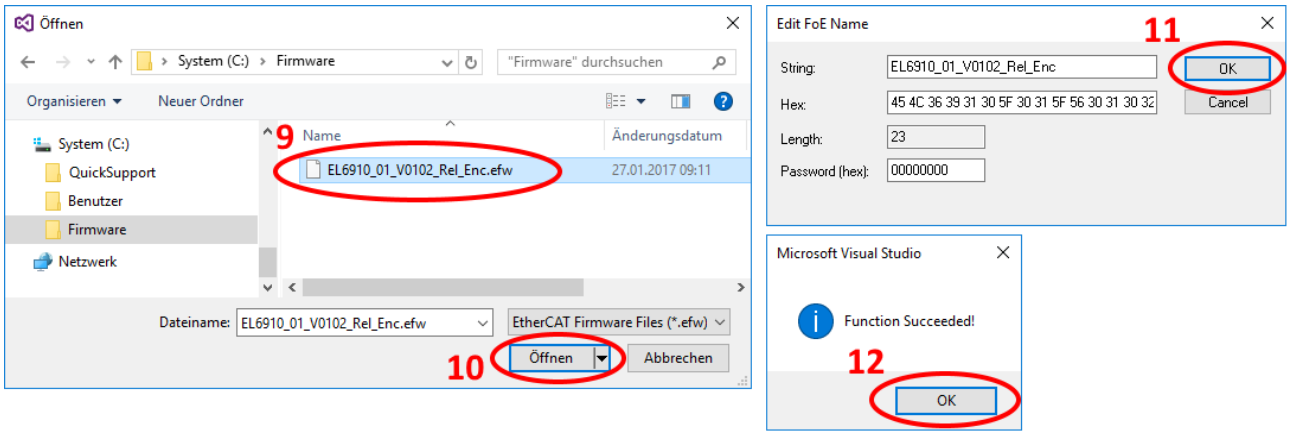


Fig. 35: Firmware update of TwinSAFE products - Part 3

5 Appendix

5.1 Protection classes according to IP code

The levels of protection are defined and divided into different classes in the IEC 60529 standard (DIN EN 60529). The designation follows the scheme below.

1st digit: Protection against ingress of dust and access to hazardous parts

1st digit	Meaning
0	Non-protected
1	Protection against access to hazardous parts with back of hand. Protection against ingress of solid foreign objects = 50 mm diameter
2	Protection against access to hazardous parts with a finger. Protection against ingress of solid foreign objects = 12.5 mm diameter
3	Protection against access to hazardous parts with a tool. Protection against ingress of solid foreign objects = 2.5 mm diameter
4	Protection against access to hazardous parts with a wire. Protection against ingress of solid foreign objects = 1 mm diameter
5	Protection against access to hazardous parts with a wire. Protection against ingress of dust. Ingress of dust is not prevented completely, although the quantity of dust able to penetrate is limited to such an extent that the proper function of the device and safety are not impaired
6	Protection against access to hazardous parts with a wire. Dust-proof. No ingress of dust

2nd digit: Protection against ingress of water*

2nd digit	Meaning
0	Non-protected.
1	Protection against dripping water.
2	Protection against dripping water when housing tilted up to 15°.
3	Protection against spraying. Water sprayed at an angle of up to 60° from vertical must not have any adverse effect.
4	Protection against splashing. Water splashing against the housing from any direction must not have any adverse effects.
5	Protection against jetting.
6	Protection against powerful jetting.
7	Protection against the effects of temporary immersion. The quantity of water being able to penetrate if the housing is submerged in water for 30 minutes at a depth of 1 m must not have any adverse effects.

*) These protection classes only define protection against water, not against other liquids.

5.2 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages:
http://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49(0)5246/963-0
Fax:	+49(0)5246/963-198
e-mail:	info@beckhoff.com

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49(0)5246/963-157
Fax:	+49(0)5246/963-9157
e-mail:	support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

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- repair service
- spare parts service
- hotline service

Hotline:	+49(0)5246/963-460
Fax:	+49(0)5246/963-479
e-mail:	service@beckhoff.com

5.3 Certificates

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT TÜV SÜD

Product Service

CERTIFICATE

No. Z10 062386 0057 Rev. 00

Holder of Certificate: **Beckhoff Automation GmbH & Co. KG**
Hülshorstweg 20
33415 Verl
GERMANY

Factory(ies): 062386

Certification Mark:

Product: **Safety components**

Model(s): **EP1957**

Parameters:

Supply voltage:	24VDC (-15%/+20%)
Ambient temperature:	-25°C...+60°C
Protection class:	IP67

Tested according to:
2006/42/EC
EN 61508-1:2010 (SIL1-3)
EN 61508-2:2010 (SIL1-3)
EN 61508-3:2010 (SIL1-3)
EN 62061:2005/A2:2015 (SIL CL3)
EN 81-20:2014
EN 81-22:2014
EN 81-50:2014
EN ISO 13849-1:2015 (Cat 4, PL e)

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: BV92792T

Valid until: 2023-08-15

Date, 2018-08-16 (Peter Weiß)

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TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

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