Operating Instructions for

EL2911

TwinSAFE Potential Supply Terminal with 4 digital fail-safe inputs

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 [▶ 55].

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.

Trademarks

Beckhoff®, TwinCAT®, EtherCAT®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC® and XTS® are registered trademarks of and licensed by Beckhoff Automation GmbH.
Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

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	• Certificate added • First release
0.0.5	• Overview screen updated
0.0.4	• Connection added • Parameter description updated
0.0.3	• Requirements for the potential group added
0.0.2	• Update after review
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 [▶ 52].

Date	Software version	Hardware version	Modifications
16.08.2018	01	00	First release of the EL2911

2 System description

2.1 The Beckhoff EtherCAT Terminal system

The Beckhoff EtherCAT Terminal system is used for decentralized connection of sensors and actuators to a controller. The components of the Beckhoff EtherCAT Terminal system are mainly used in industrial automation and building management systems. As a minimum, a bus station consists of an EtherCAT Coupler and connected EtherCAT Terminals. The EtherCAT Coupler forms the communication interface to the higher-level controller, while the EtherCAT Terminals form the interface to the sensors and actuators. The whole bus station is clipped onto a 35 mm DIN mounting rail (EN 60715). The mechanical link of the bus station is established with a slot and key system on EtherCAT Couplers and EtherCAT Terminals.

The sensors and actuators are connected with the terminals via the screwless (spring-loaded) connection system.

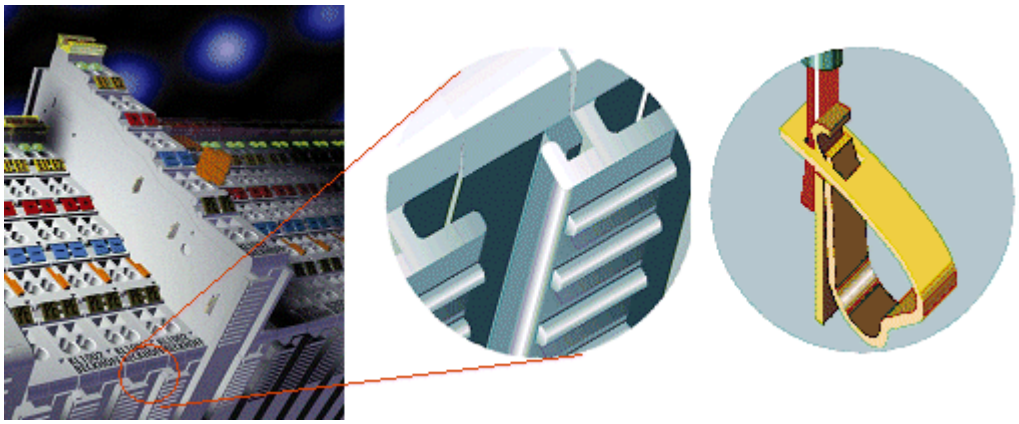

Fig. 1: Slot and key system and screwless (spring-loaded) connection system

2.1.1 EtherCAT Bus Coupler

Mechanical data	Bus Coupler
Material	polycarbonate, polyamide (PA6.6).
Dimensions (W x H x D)	44 mm x 100 mm x 68 mm
Mounting	on 35 mm mounting rail (EN 60715) with locking
Attachable by	double slot and key connection

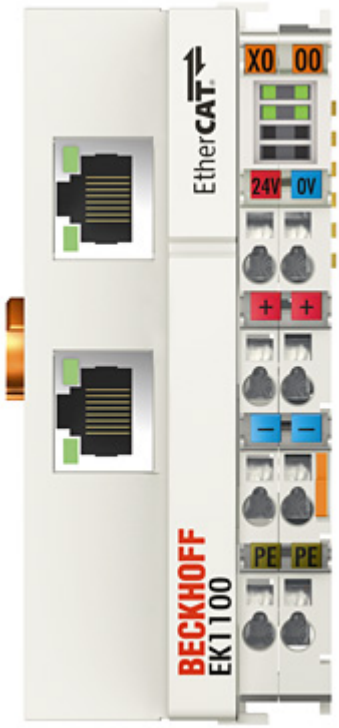

Fig. 2: Bus Coupler (EtherCAT)

Connection technology	Bus Coupler
Wiring	Spring-loaded system
Connection cross-section	0.08 mm² ... 2.5 mm², stranded wire, solid wire
Fieldbus connection	EtherCAT
Power contacts	3 spring contacts
Current load	10 A
Nominal voltage	24 V_{DC}

2.1.2 EtherCAT Terminals

Mechanical data	Bus Terminal
Material	polycarbonate, polyamide (PA6.6).
Dimensions (W x H x D)	12 mm x 100 mm x 68 mm or 24 mm x 100 mm x 68 mm
Mounting	on 35 mm mounting rail (EN 60715) with locking
Attachable by	double slot and key connection

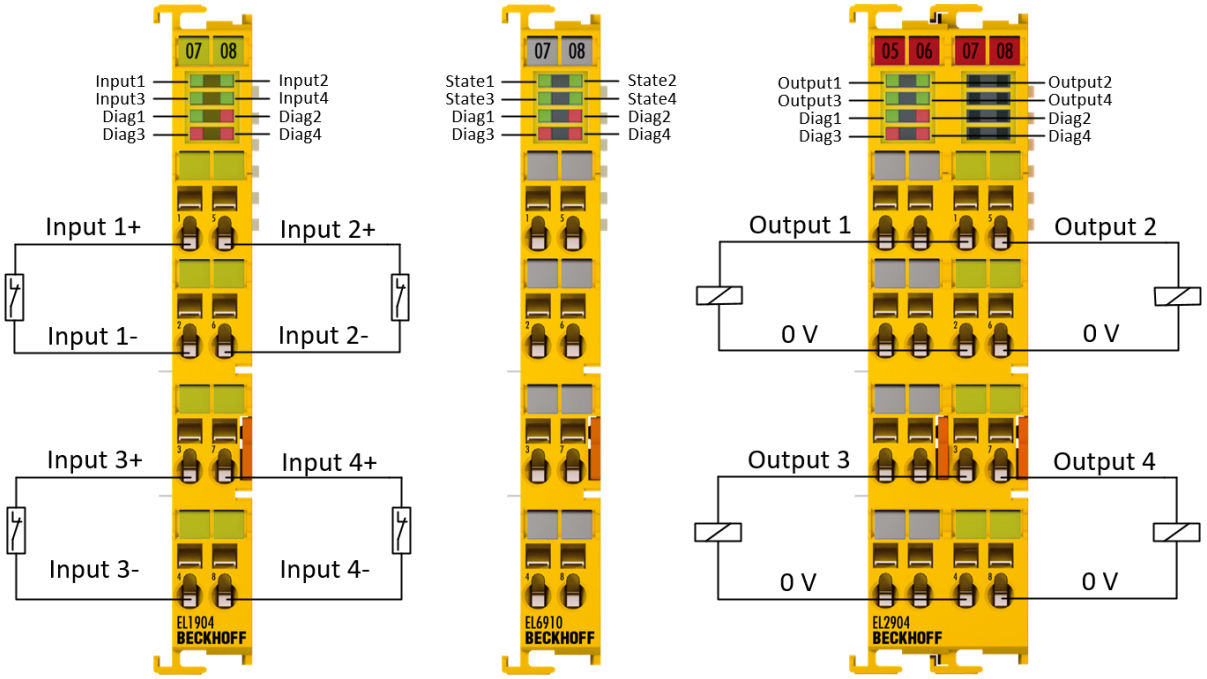

Fig. 3: Overview of EtherCAT Terminals

Connection technology	Bus Terminal
Wiring	Spring-loaded system
Connection cross-section	typically 0.08 mm² – 2.5 mm², stranded wire, solid wire
Communication	E-bus
Power contacts	Up to 3 blade/spring contacts
Current load	10 A
Nominal voltage	Depending on terminal type (typically 24 V_{DC})

2.1.3 E-bus

The E-bus is the data path within a terminal strip. The E-bus is led through from the Bus Coupler through all the terminals via six contacts on the terminals' side walls.

2.1.4 Power contacts

The operating voltage is passed on to following terminals via three power contacts. Terminal strip can be split into galvanically isolated groups by means of potential supply terminals as required. The supply terminals play no part in the control of the terminals, and can be inserted at any locations within the terminal strip.

2.2 TwinSAFE

2.2.1 The I/O construction kit is extended safely

The integrated TwinSAFE safety solution is the logical continuation of the open, PC-based Beckhoff control philosophy. Due to their modularity and versatility, the TwinSAFE components fit seamlessly into the Beckhoff control system. The I/O components are available in the formats Bus Terminal, EtherCAT Terminal, EtherCAT plug-in module and EtherCAT Box.

Thanks to the fieldbus-neutral safety protocol (TwinSAFE/Safety-over-EtherCAT), TwinSAFE devices can be integrated into any fieldbus system. They are integrated into existing networks with K-bus or EtherCAT and can be used directly in the machine as IP 67 modules. These safety I/Os form the interfaces to the safety-relevant sensors and actuators.

The possibility to transmit the safety-relevant signals over a standard bus system gives rise to substantial advantages in terms of planning, installation, operation, maintenance, diagnostics and costs.

The safety application is configured or programmed respectively in the TwinCAT software. This application is then transferred via the bus to a TwinSAFE logic component. These form the heart of the TwinSAFE system. All safety devices in the system communicate with this logic component. Due to the enormous flexibility of the system, several TwinSAFE logic components can also be operated simultaneously in a network.

2.2.2 Safety concept

TwinSAFE: Safety and I/O technology in one system

- Extension of the familiar Beckhoff I/O system with TwinSAFE Terminals
- Freely selectable mix of safe and standard signals
- Logic link of the I/Os in the TwinSAFE logic component, e.g. EL6910
- Safety-relevant networking of machines via bus systems

TwinSAFE protocol (FSoE / Safety-over-EtherCAT)

- Transfer of safety-relevant data via any media (“genuine black channel”)
- TwinSAFE communication via fieldbus systems such as EtherCAT, Lightbus, PROFIBUS or Ethernet
- IEC 61508:2010 SIL 3 compliant

TwinCAT software and TwinSAFE editor

- Safety application is configured or programmed in the TwinCAT software
- Certified function blocks such as emergency stop, operation mode, etc.
- simple handling
- Transfer of the application via the bus to the TwinSAFE logic component

TwinSAFE logic component, e.g. EL6910

- Processing of the safety-related application and communication with the TwinSAFE terminals
- No safety requirements for higher-level control system
- TwinSAFE enables a network with up to 65,535 TwinSAFE components.
- TwinSAFE logic component can establish up to 512 connections (TwinSAFE connections).
- Several TwinSAFE logic components can be operated in a network
- Suitable for applications up to SIL 3 according to IEC 61508:2010 and category 4 / PL e according to EN ISO 13849-1:2015.

TwinSAFE I/O components

- The TwinSAFE I/O components are available in the formats Bus Terminal, EtherCAT Terminal, EtherCAT plug-in module, EtherCAT Box and TwinSAFE Drive option card
- All common safety sensors and actuators can be connected
- Operation with a TwinSAFE logic component
- Typically meet the requirements of IEC 61508:2010 up to SIL 3 and EN ISO 13849-1:2015 up to Category 4, PL e. More detailed information can be found in the respective user documentation

2.2.3 The fail-safe principle (Fail Stop)

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.

⚠ CAUTION

Safe state

The safe state of the TwinSAFE system is always the **switched-off** and **de-energized** state.

3 Product description

3.1 EL2911 - TwinSAFE potential supply terminal with 4 digital fail-safe inputs

The EL2911 is a safe potential supply terminal for the power contacts for a downstream potential group. In addition, it has 4 fail-safe inputs for sensors with potential-free contacts for 24 V_{DC}.

The EL2911 meets the requirements of IEC 61508:2010 SIL 3 and EN ISO 13849-1:2015 (Cat 4, PL e). The safe inputs of the EL2911 meet the requirements of EN 62061:2005/A2:2015 up to SILCL3, the safe output up to SILCL2.

The TwinSAFE Terminal has the usual design of a 24 mm EtherCAT Terminal. It has no power contacts on the left side and therefore forms the start of a new potential group.

The safe inputs and the safe output are supplied from U_P.

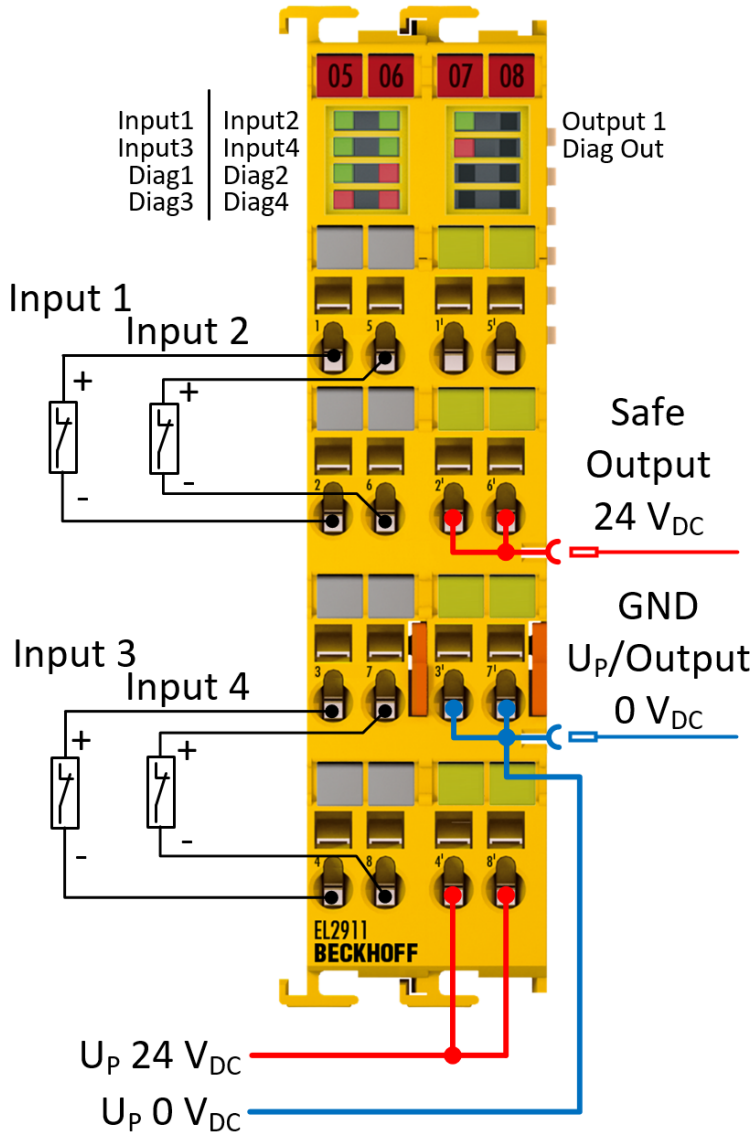

Fig. 4: EL2911 - TwinSAFE potential supply terminal with 4 fail-safe inputs

3.2 Intended use

⚠ WARNING

Caution - Risk of injury!

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

The TwinSAFE Terminals expand the application area of Beckhoff Bus Terminal system with functions that enable them to be used for machine safety applications. The TwinSAFE Terminals 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 switched-off and de-energized state. Fail-safety according to the relevant standards is required.

The TwinSAFE I/O components allow the connection of:

- 24 V_{DC} sensors such as
  emergency stop push-buttons, rope pull switches, position switches, two-hand switches, safety switching mats, light curtains, light barriers, laser scanners, etc.
- 24 V_{DC} actuators such as
  contactors, protective door switches with tumbler, signal lamps, servo drives, etc.

Test pulses

When selecting actuators please ensure that the test pulses of the TwinSAFE component do not lead to switching of the actuator or a diagnostic message of the TwinSAFE component.

The following TwinSAFE components were developed for these tasks:

- The EL1904 is an EtherCAT Terminal with 4 digital fail-safe inputs
- The EL2904 is an EtherCAT Terminal with 4 digital fail-safe outputs
- The EL6900 is an EtherCAT Terminal with integrated TwinSAFE logic

These TwinSAFE components are suitable for operation on the

- Beckhoff EKxxxx series Bus Couplers
- Beckhoff CXxxxx series Embedded PCs with E-bus connection

⚠ 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 these TwinSAFE components, 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 EL2911 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 Requirements for the potential group

⚠ WARNING

Prevention of feedback

Feedback must be prevented through the following measures:

- No switching of loads with a separate power supply
- Excluding a line short-circuit fault (see following alternatives)

⚠ CAUTION

Non-reactive EtherCAT Terminals

In the potential group connected through the EL2911, only non-reactive standard terminals must be used. A list the non-reactive EtherCAT Terminals can be found in the Beckhoff Information System under http://infosys.beckhoff.de

NOTE

Maximum achievable safety level for the safe output

Provided feedback is avoided by excluding line short-circuit faults, the following safety levels can be achieved:

- EN ISO 13849-1: max. Cat. 4 / PL e
- IEC 61508: max. SIL3
- EN 62061: max. SIL2

No switching of loads with a separate power supply

Loads that have their own power supply must not be switched by standard terminals, since in this case feedback via the load cannot be ruled out.

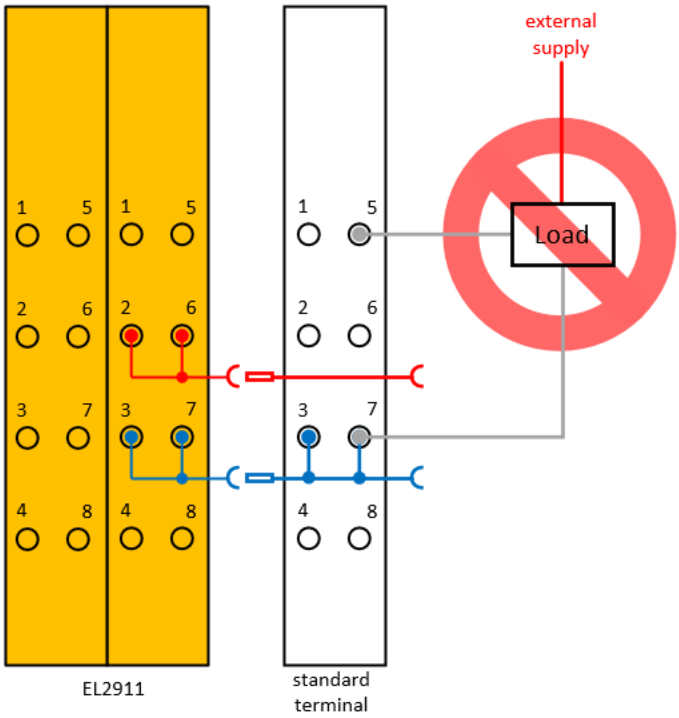

Fig. 5: External load

⚠ CAUTION

Exceptions

Exceptions to the general requirement are allowed only if the manufacturer of the connected load guarantees that feedback to the control input cannot occur.

Cable short-circuit fault exclusion

It must be possible to avoid the risk of feedback due to a short circuit in the line through further measures. The following measures can be implemented as an alternative.

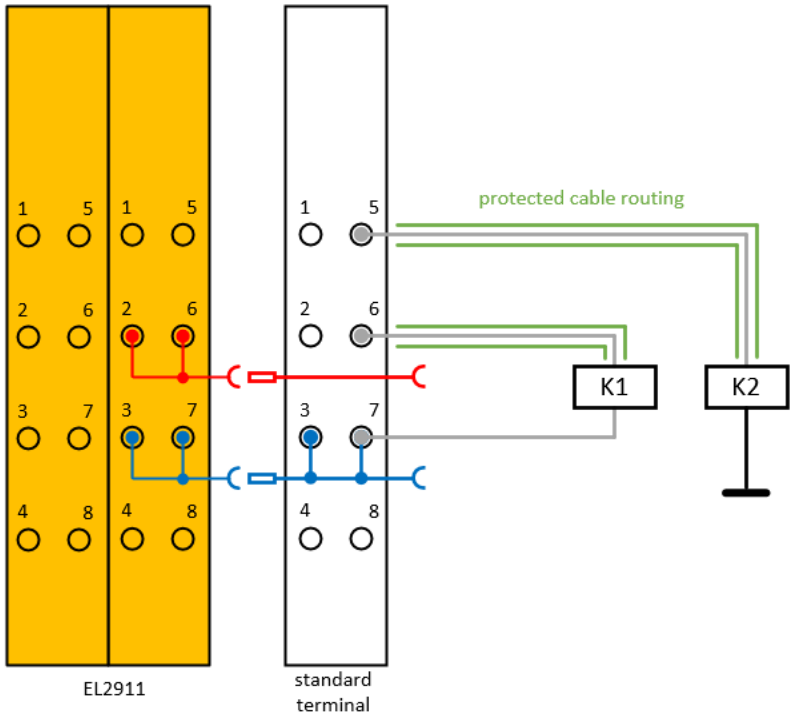

Fig. 6: protected wiring

Alternative 1: Load connection via separate sheathed cables

The non-safely switched potential of the standard terminal may not be conducted together with other potential-conducting cores inside the same sheathed cable

Alternative 2: Wiring only inside the control cabinet

All loads connected to the non-safe standard terminals must be located in the same control cabinet as the terminals. The cables are routed entirely inside the control cabinet.

Alternative 3: Dedicated earth connection per conductor

All conductors connected to the non-safe standard terminals are protected by a separate ground connection.

Alternative 4: Permanent (fixed) wiring, protected from external damage

All conductors connected to the non-safe standard terminals are permanently installed and protected from external damage, e.g. through a cable duct or an armored conduit.

⚠ CAUTION

Fault exclusion

The machine manufacturer or the user is solely responsible for the correct execution and evaluation of the applied alternatives.

3.4 Technical data

Product designation	EL2911-0000
Number of inputs	4
Number of outputs	1 (for the power and spring force contacts)
Status display	10 (one green LED for each input and output + 5 DIAG LEDs)
Reaction time (read input/write to E-bus)	typically: 4 ms, maximally: see error reaction time
Fault response time	≤ watchdog time
Cable length between sensor and terminal	unshielded max. 100 m (0.75 or 1 mm²) shielded max. 100 m (0.75 or 1 mm²)
Output current of the clock outputs	typically 10 mA, max. 12 mA
Safe output	max. 10 A (for the power and spring force contacts) Diagnosis: In switched-off state, external feeds are detected above 5 V.
Input process image	6 byte
Output process image	6 byte
EL2911 supply voltage (PELV)	24 V_{DC} (–15% / +20%)
Signal voltage "0" inputs	-3 V ... 5 V (EN 61131-2, type 3) see chapter Characteristic curve of the inputs [▶ 20]
Signal voltage "1" inputs	11 V ... 30 V (EN 61131-2, type 3) see chapter Characteristic curve of the inputs [▶ 20]
Current consumption of the module electronics at 24 V (without current consumption of sensors)	5 channels occupied: typically 29 mA 0 channels occupied: typically 5 mA
Current consumption via E-bus	5 channels occupied: approx. 180 mA
Power dissipation of the terminal	typically 2.7 W (at 10 A output current)
Electrical isolation (between the channels)	No
Electrical isolation (between the channels and the E-bus)	Yes
Insulation voltage (between the channels and the E-bus, under common operating conditions)	insulation tested with 500 V_{DC}
Dimensions (W x H x D)	24 mm x 100 mm x 68 mm
Weight	app. 98 g
Permissible ambient temperature (operation)	-25°C to +55°C (see chapter on Temperature measurement [▶ 24])
Permissible ambient temperature (transport/storage)	-40°C to +85°C
Permissible air humidity	5% to 95%, non-condensing
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)
Climate category according to EN 60721-3-3	3K3 (the deviation from 3K3 is possible only with optimal environmental conditions and also applies only to the technical data which are specified differently in this documentation)
Permissible level of contamination according to EN 60664-1	level of contamination 2 (note chapter Maintenance [▶ 50])
Inadmissible operating conditions	TwinSAFE Terminals must not be used under the following operating conditions: • under the influence of ionizing radiation (exceeding the natural background radiation) • in corrosive environments • in an environment that leads to unacceptable contamination of the TwinSAFE component
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	IP20
Permitted operating environment	In the control cabinet or terminal box, with minimum protection class IP54 according to IEC 60529
correct installation position	horizontal (see chapter Installation position and minimum distances [▶ 23])
Approvals	CE, TÜV SÜD

3.5 Safety parameters

Characteristic numbers	EL2911-0000
Lifetime [a]	20
Prooftest Interval [a]	not required [1]
PFH_D	4.50 E-09
PFD	5.00 E-05
$MTTF_D$	high
DC	high
Performance level	PL e
Category	4
HFT	1
Element classification [2]	Type B

1. Special proof tests are not required during the entire service life of the EL2911 EtherCAT Terminal.
2. Classification according to IEC 61508-2:2010 (chapter 7.4.4.1.2 and 7.4.4.1.3)

The EL2911 EtherCAT Terminal can be used for safety-related applications within the meaning of 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.

3.6 Safe inputs and outputs

The safe inputs and corresponding clock outputs are consolidated in a module. This has the advantage that a two-channel safe sensor can be used on any of the EL2911 channels, and a fault such as cross-circuit or external feed results in shutdown of the whole module.

The safe output module has a single-channel design.

NOTE

Clocked signals inside a sheathed cable

The clocked signals (clock outputs for the safe inputs) can be used in any way that may be required within a sheathed cable, since faults such as cross-circuit or external feed result in shutdown of the whole input module.

NOTE

Safe inputs in Cat.4 / PL e

If two safe input channels in category 4 structure are to be used, any of the EL2911 channels can be used.

3.7 Characteristic curve of the inputs

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

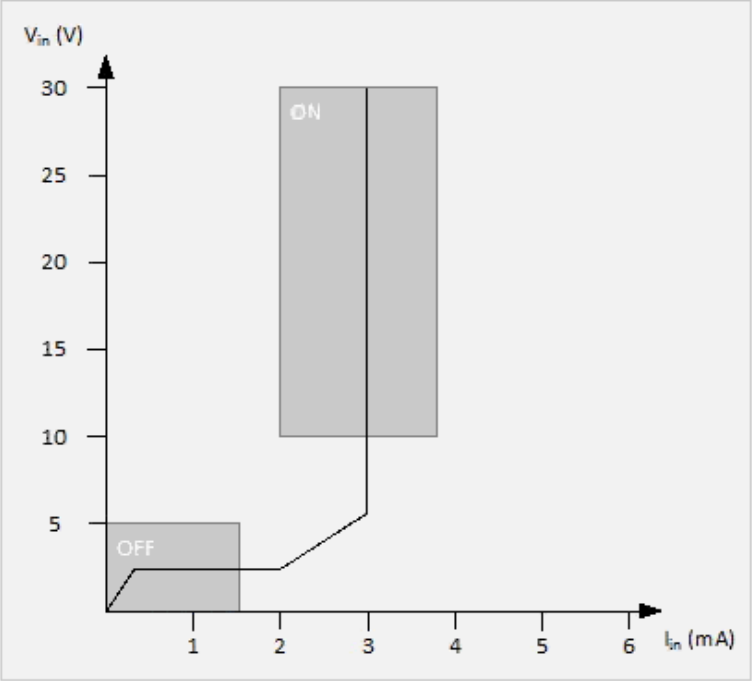

Fig. 7: Characteristic curve of the inputs

3.8 Dimensions

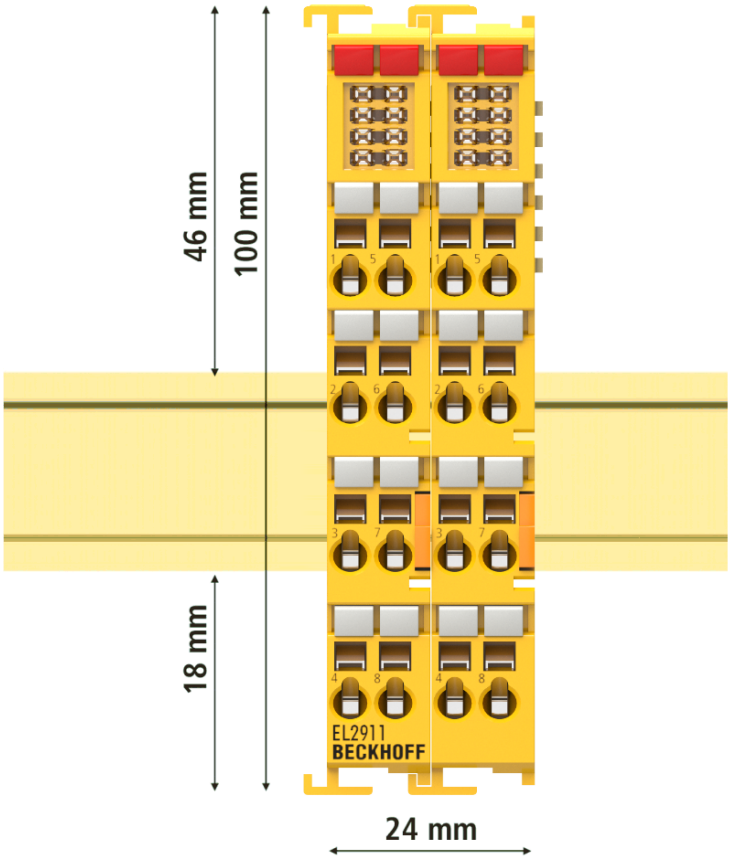

Fig. 8: EL2911 dimensions

Width: 24 mm (side-by-side installation)
Height: 100 mm
Depth: 68 mm

4 Operation

4.1 Environmental conditions

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

⚠ WARNING

Risk of injury!

The TwinSAFE components must not be used under the following operating conditions.

- under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation)
- in corrosive environments
- in an environment that leads to unacceptable soiling of the TwinSAFE component

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 Safety instructions

Before installing and commissioning the TwinSAFE components please read the safety instructions in the foreword of this documentation.

4.2.2 Transport / storage

Use the original packaging in which the components were delivered for transporting and storing the TwinSAFE components.

⚠ CAUTION

Note the specified environmental conditions

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

4.2.3 Mechanical installation

⚠ DANGER

Risk of injury!

Bring the bus system into a safe, de-energized state before starting installation, disassembly or wiring of the devices!

4.2.3.1 Instructions for ESD protection

NOTE

Devices can be destroyed by electrostatic charging!

The devices contain electrostatically sensitive components which can be damaged by improper handling.

- Please ensure you are electrostatically discharged when handling the components; also avoid touching the spring contacts directly (see illustration).
- Avoid contact with highly insulating materials (synthetic fibers, plastic films etc.)
- When handling the components, ensure good grounding of the environment (workplace, packaging and persons)
- Each bus station must be terminated on the right side with the EL9011 or EL9012 end cap to ensure the protection class and ESD protection.

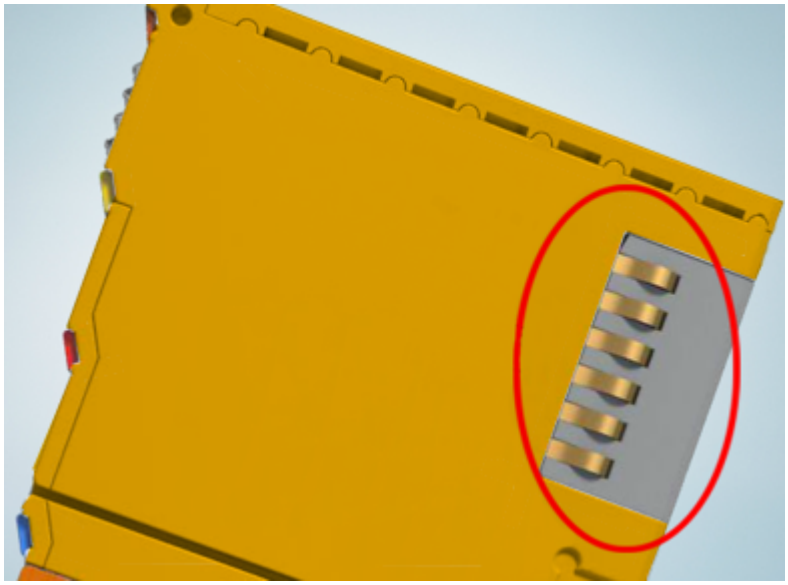

Fig. 9: Spring contacts of Beckhoff I/O components

4.2.3.2 Control cabinet / terminal box

The TwinSAFE terminals must be installed in a control cabinet or terminal box with IP54 protection class according to IEC 60529 as a minimum.

4.2.3.3 Installation position and minimum distances

For the prescribed installation position the mounting rail is installed horizontally and the mating surfaces of the EL/KL terminals point toward the front (see illustration below). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. The direction indication “down” corresponds to the direction of positive acceleration due to gravity.

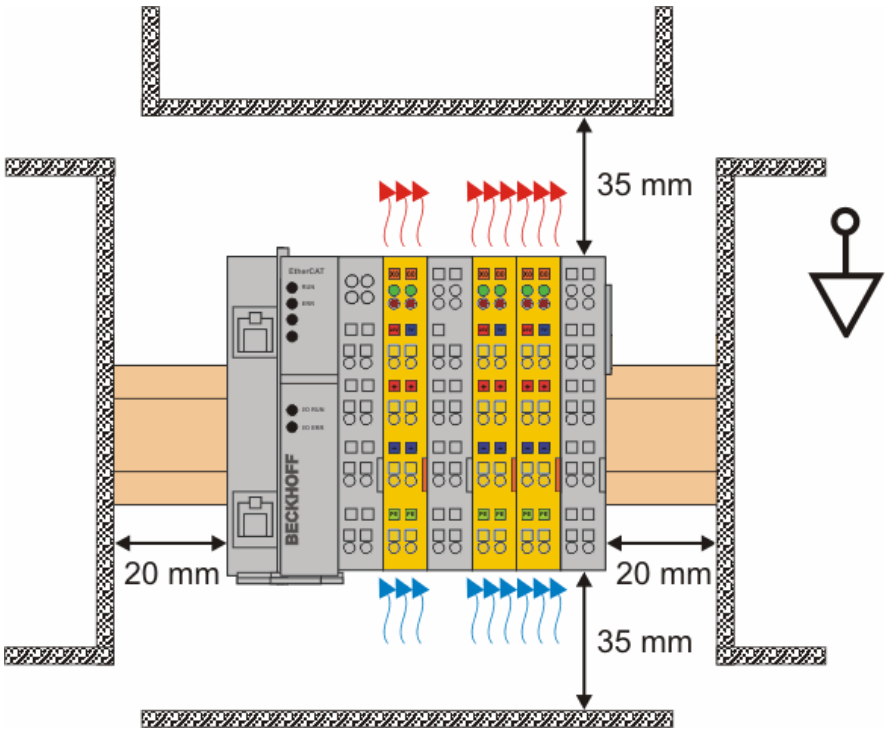

Fig. 10: Installation position and minimum distances

In order to ensure optimum convection cooling, the distances to neighboring devices and to control cabinet walls must not be smaller than those shown in the diagram.

4.2.3.4 Temperature measurement

The temperature measurement consists of an EK1100 EtherCAT Coupler, to which EtherCAT Terminals are attached, based on the typical distribution of digital and analog signal types at a machine. On the EL6910 a safety project is active, which reads safe inputs and enables safe outputs during the measurement.

NOTE

External heat sources / radiant heat / impaired convection

The maximum permissible ambient temperature of 55°C was checked with the example configuration described above. Impaired convection, an unfavorable location near heat sources or an unfavorable configuration of the EtherCAT Terminals 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.

4.2.3.5 Notes on the arrangement of TwinSAFE components

The following notes show favorable and unfavorable arrangement of the terminals in relation to thermal aspects. Components with higher waste heat are marked with a red symbol  and components with low waste heat with a blue symbol  .

EtherCAT coupler EK11xx and power supply terminal EL9410

The more terminals are connected behind an EtherCAT coupler or a power supply terminal, the higher is the E-Bus current, which must be supplied by their power supply units. As the current increases, the waste heat of the power supply units is also increased..

EL69x0

The EL69x0 has a rather high waste heat because it has a high internal clock and high logic power.

EL2904

The EL2904 has a rather high waste heat, due to the possibly high output current of the connected actuators.

EL1904

Even the EL1904 has a rather high waste heat, although the external load by clock outputs and safe inputs is rather low.

Thermally unfavorable arrangement of the TwinSAFE terminals

The following structure is rather unfavorable, since terminals with rather high waste heat are connected directly to couplers or power supply terminals with high E-Bus load. The additional external heating of the TwinSAFE terminals by the adjacent power supply units increases the internal terminal temperature, which can lead to the maximum permissible temperature being exceeded. This leads to a diagnosis message "overtemperature”.

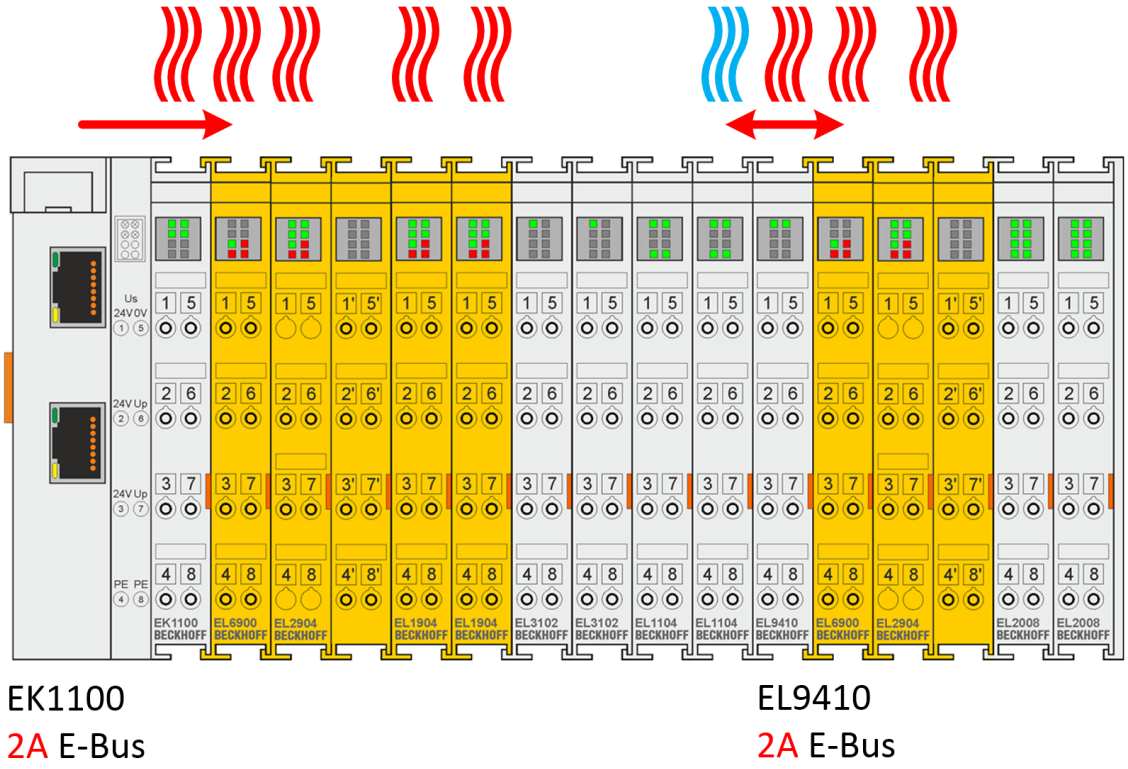

Fig. 11: Thermally unfavorable arrangement of the TwinSAFE terminals

Thermally favorable arrangement of the TwinSAFE terminals

The following structure is thermally favorable, since between the coupler / power supply terminal and terminals with rather high waste heat, terminals with low current consumption and thus rather low waste heat are placed.

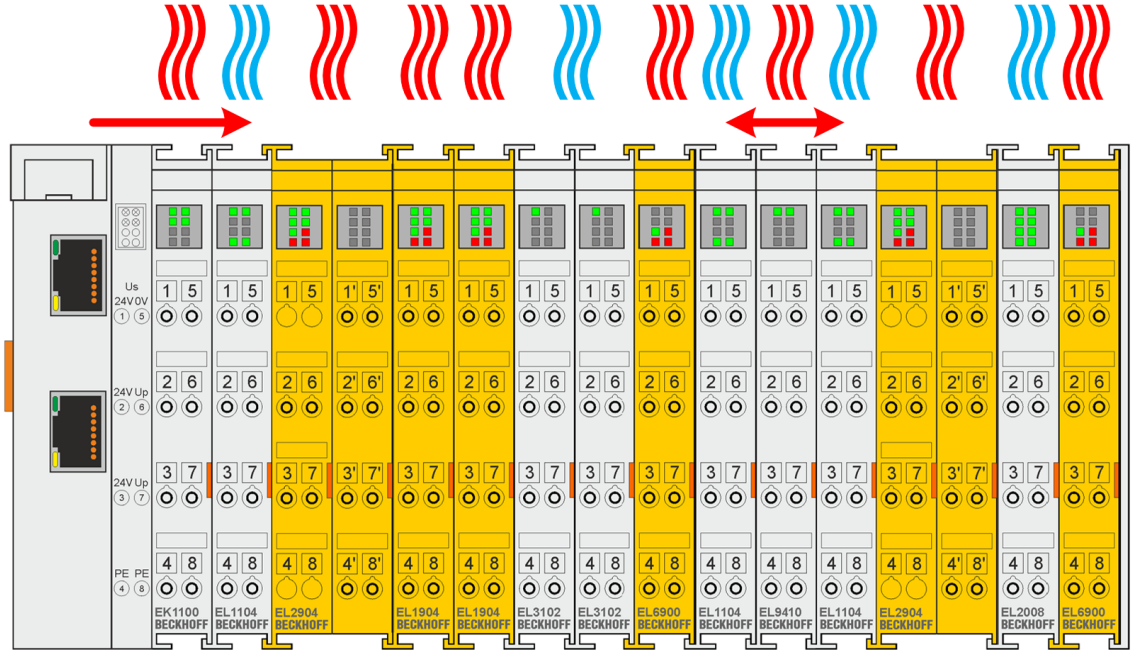

Fig. 12: Thermally favorable arrangement of the TwinSAFE terminals

4.2.3.6 Installation on mounting rails

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the Bus Terminals!

Mounting

The Bus Couplers and Bus Terminals are attached to commercially available 35 mm mounting rails (according to EN 60715) by applying slight pressure:

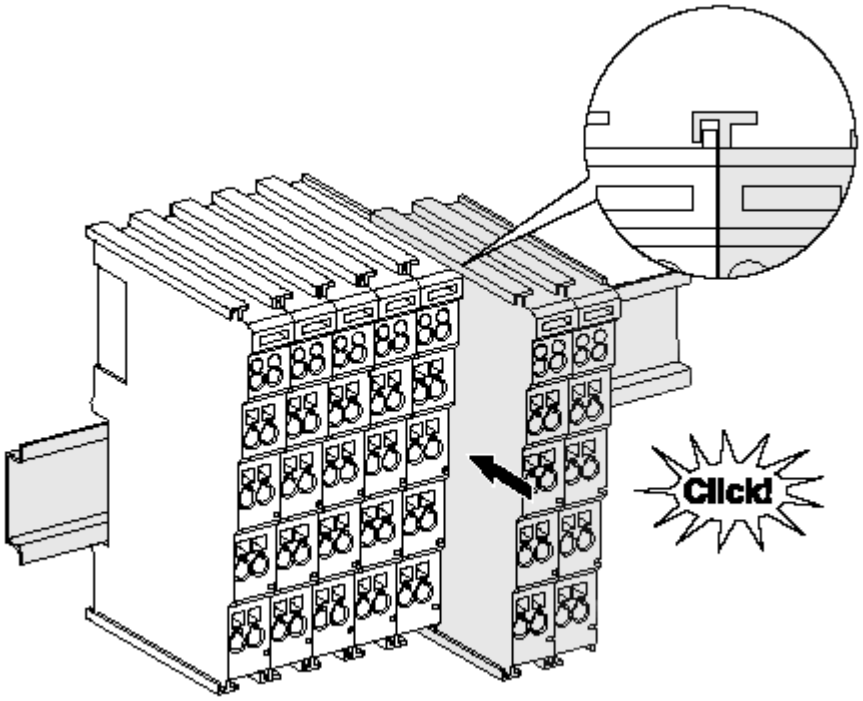

Fig. 13: Installation on the mounting rail

1. First attach the Fieldbus Coupler to the mounting rail.
2. The Bus Terminals are now attached on the right-hand side of the fieldbus Coupler. Join the components with slot and key and push the terminals against the mounting rail, until the lock clicks onto the mounting rail.
   If the terminals are clipped onto the mounting rail first and then pushed together without slot and key, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.

Fastening of mounting rails

The locking mechanism of the terminals and couplers protrudes into the profile of the mounting rail. When installing the components, make sure that the locking mechanism doesn't come into conflict with the fixing bolts of the mounting rail. For fastening mounting rails with a height of 7.5 mm under the terminals and couplers, use flat fastening components such as countersunk head screws or blind rivets.

Removal

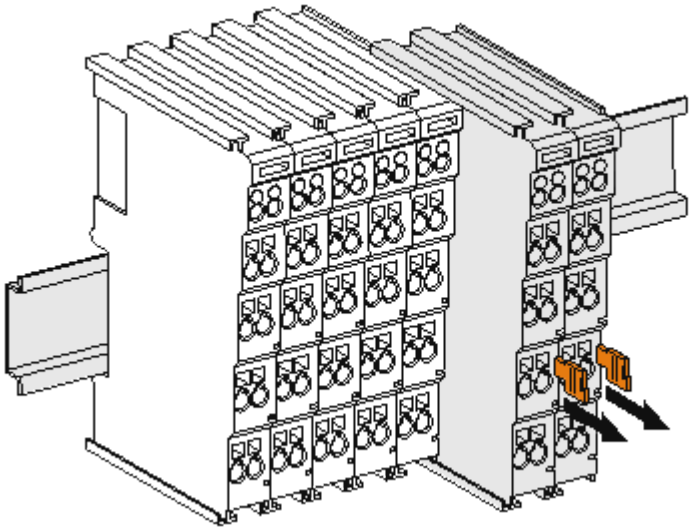

Fig. 14: Removal of mounting rails

1. Carefully pull the orange-colored lugs approximately 1 cm out of the disassembled terminal, until they protrude loosely. The lock with the mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal away from the mounting rail.

4.2.4 Electrical installation

4.2.4.1 Connections within a Bus Terminal block

The electric connections between the Bus Coupler and the Bus Terminals are automatically realized by joining the components:

Spring contacts (E-bus)

The six spring contacts of the E-bus deal with the transfer of the data and the supply of the Bus Terminal electronics.

NOTE

Observe the E-bus current

Observe the maximum current that your Bus Coupler can supply to the E-bus! Use the EL9410 Power Supply Terminal if the current consumption of your terminals exceeds the maximum current that your Bus Coupler can feed to the E-bus supply.

Power contacts

The power contacts deal with the supply for the field electronics and thus represent a supply rail within the Bus Terminal block. The power contacts are supplied via terminals on the Bus Coupler.

Note the connection of the power contacts

During the design of a Bus Terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts.
Potential supply terminals (EL91xx, EL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

PE power contact

The power contact labelled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.

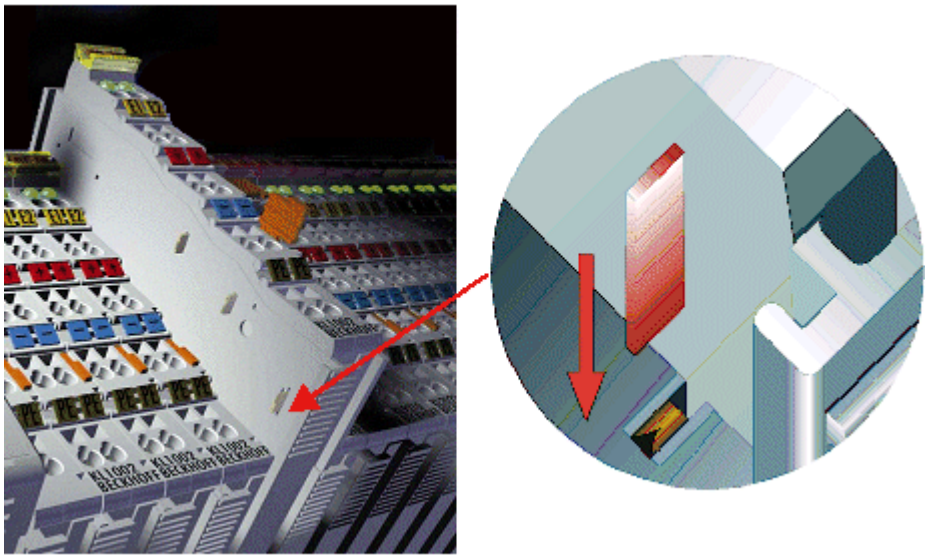

Fig. 15: PE power contact

⚠ CAUTION

Insulation tests

Note that, for reasons of electromagnetic compatibility, the PE contacts are capacitatively coupled to the mounting rail. This may lead to incorrect results during insulation testing or to damage on the terminal (e.g. disruptive discharge to the PE line during insulation testing of a consumer with a rated voltage of 230 V). For insulation testing, disconnect the PE supply line at the Bus Coupler or the Potential Supply Terminal! In order to decouple further feed points for testing, these Power Feed Terminals can be released and pulled at least 10 mm from the group of terminals.

⚠ DANGER

Serious risk of injury!

The PE power contact must not be used for other potentials!

4.2.4.2 Overvoltage protection

If protection against overvoltage is necessary in your plant, provide a surge filter for the voltage supply to the Bus Terminal blocks and the TwinSAFE terminals.

4.2.4.3 Wiring

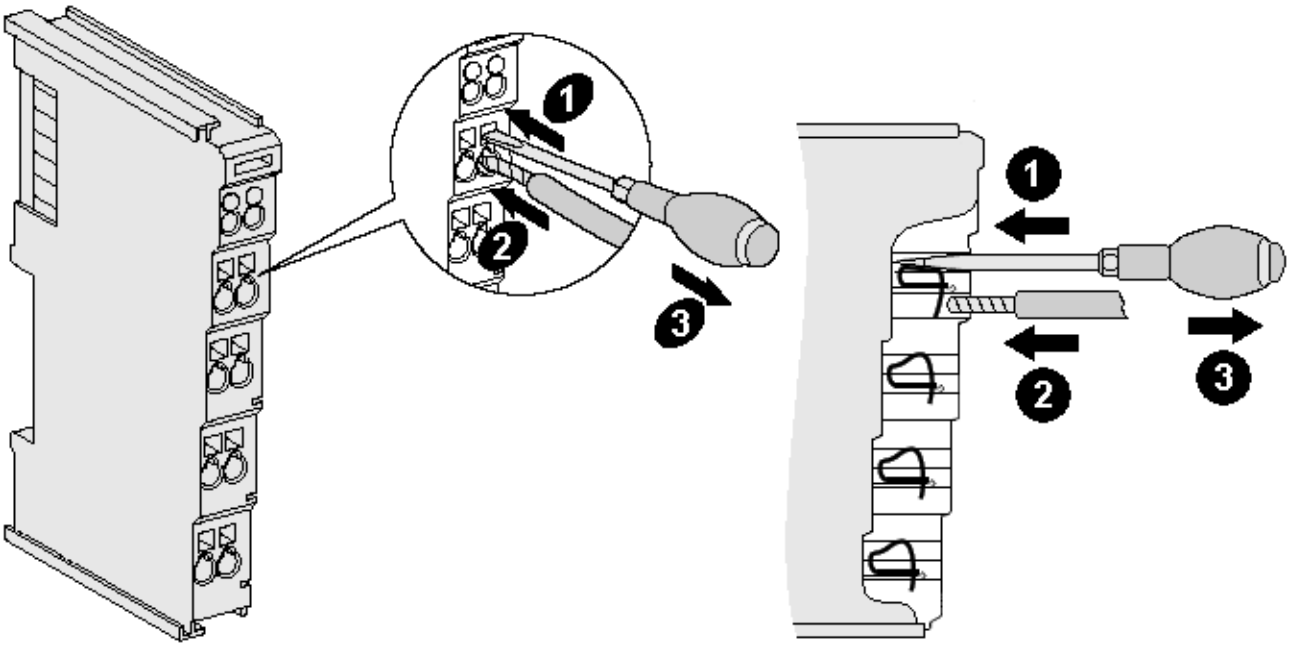

Fig. 16: Connection of a cable to a terminal point

Up to eight terminal points enable the connection of solid or finely stranded cables to the Bus Terminal. The terminal points are implemented in spring force technology. Connect the cables as follows:

1. Open a terminal point by pushing a screwdriver straight against the stop into the square opening above the terminal point. Do not turn the screwdriver or move it alternately (don't toggle).
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal closes automatically when the pressure is released, holding the wire safely and permanently.

See the following table for the suitable wire size width.

Wire size width (single core wires)	0.08 ... 2.5 mm^2
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm^2
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm^2
Wire stripping length	8 ... 9 mm

4.2.4.4 EL2911 pin assignment

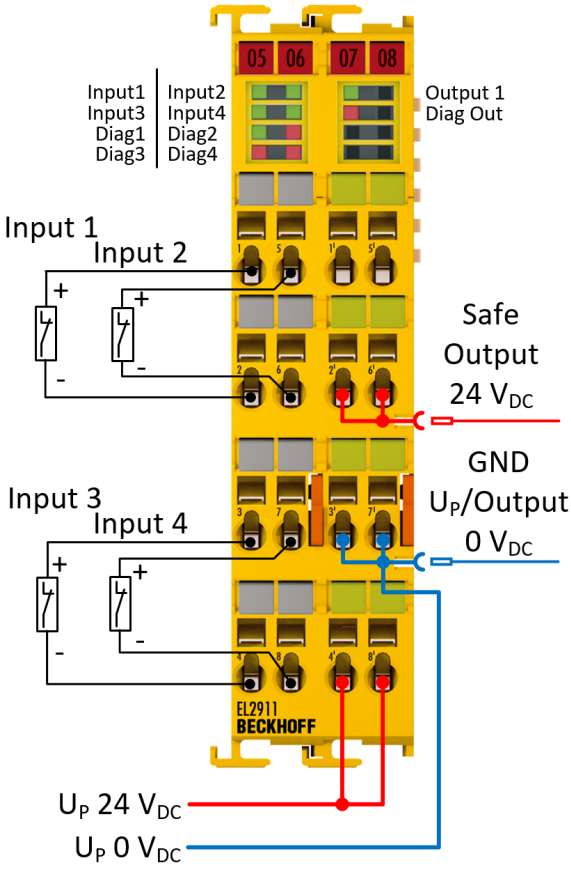

Fig. 17: EL2911 - pin assignment

Terminal point	Input / Output	Signal
1	In1	Input 1+ (clock output)
2		Input 1- (safe input)
3	In3	Input 3+ (clock output)
4		Input 3- (safe input)
5	In2	Input 2+ (clock output)
6		Input 2- (safe input)
7	In4	Input 4+ (clock output)
8		Input 4- (safe input)
1‘	-	not used
2‘	Out1	Safe output 1
3‘	-	GND U_P (0 V_{DC} for power supply and safe output)
4‘	-	24 V_{DC} power supply U_P
5‘	-	not used
6‘	Out1	Safe output 1
7‘	-	GND U_P (0 V_{DC} for power supply and safe output)
8‘	-	24 V_{DC} power supply U_P
Power contact (top)	Out1	Safe output 1
Power contact (low)	-	GND U_P (0 V_{DC} for power supply and safe output)

4.2.4.5 Signal cables

Cable routing

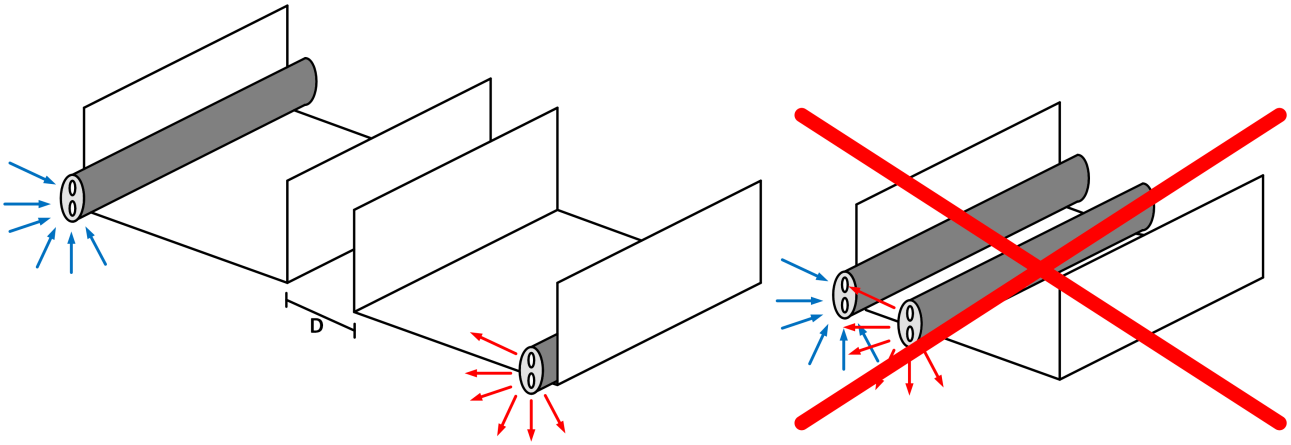

Fig. 18: Cable routing

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 terminal in TwinCAT

⚠ CAUTION

Do not change CoE objects!

Do not change any of the CoE objects in the TwinSAFE terminals. Any modifications (e.g. via TwinCAT) of the CoE objects will permanently set the terminals to the Fail-Stop state or lead to unexpected behavior of the terminals!

4.3.1 Inserting a Bus Coupler

See TwinCAT automation software documentation.

4.3.2 Inserting a Bus Terminal

See TwinCAT automation software documentation.

4.3.3 Adding an EL2911

An EL2911 is added in exactly the same way as any other Beckhoff EtherCAT Terminal. Open *TwinSAFE Terminals* item in the list and select the EL2911.

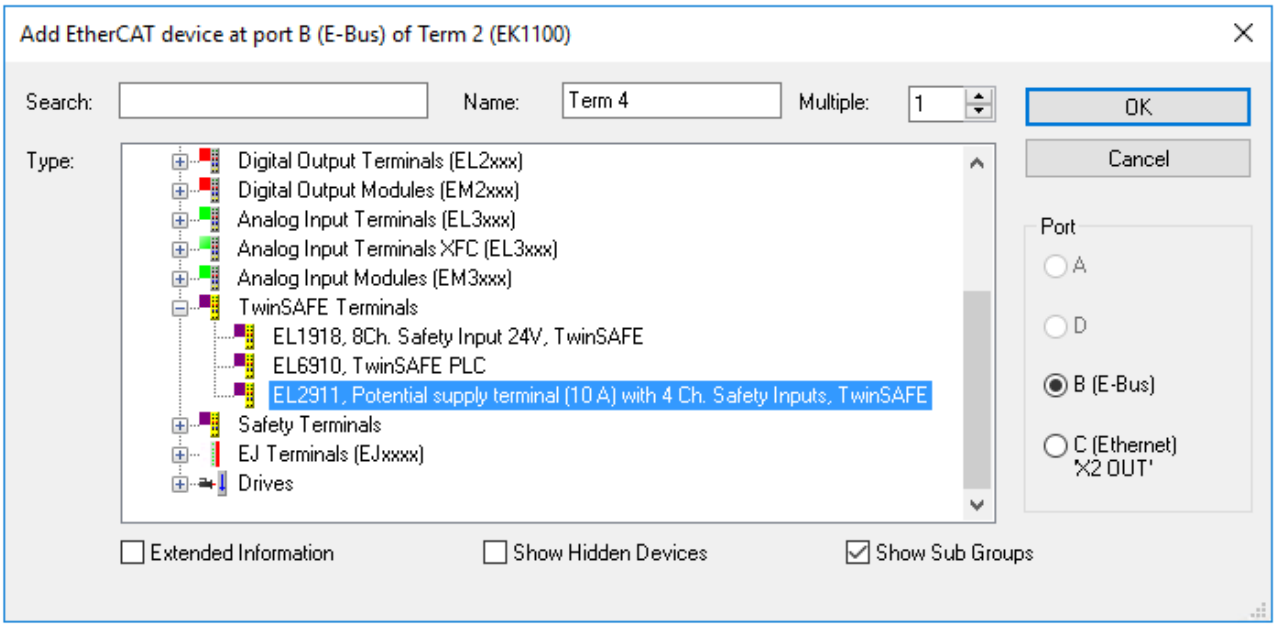

Fig. 19: Adding an EL2911

4.3.4 Using the integrated TwinSAFE Logic functions

On delivery, the EL2911 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 EP2911 can be used. To this end please create a TwinSAFE project in the Safety Editor and select the EL2911 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 EP2911 again as a safe TwinSAFE I/O slave, please delete the logic, the mapping and the parameter data on the EtherCAT Terminal and switch the voltage off and on again.

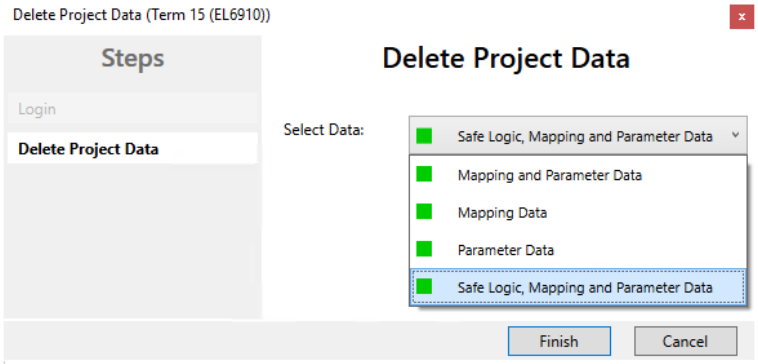

Fig. 20: Delete project data

4.3.5 Project design limits of EL2911

Project design limits

The maximum project design size for EL2911 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. 1484 byte
Standard PLC outputs	dynamic (memory-dependent), max. 1484 byte

NOTE

Project development

TwinCAT 3.1 Build 4022.25 or newer is required to use the internal logic functions. If the EL2911 is used as TwinSAFE slave with the default project, at least an EL6910, EK1960 or newer logic component is required as TwinSAFE master.

4.3.6 Address settings on TwinSAFE terminals with 1023 possible addresses

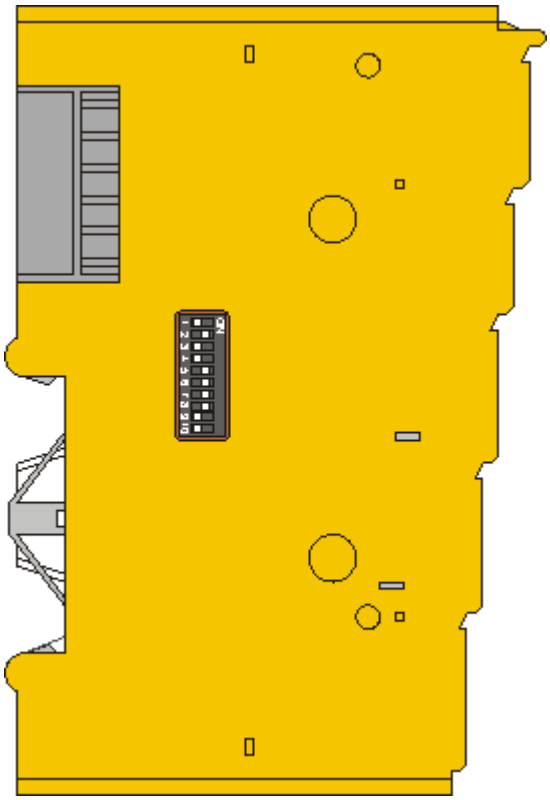

Fig. 21: Address settings on TwinSAFE terminals with 1023 possible addresses

The TwinSAFE address of the terminal is set via the 10-way DIP switch on the left-hand side of the TwinSAFE terminal. TwinSAFE addresses between 1 and 1023 are available.

DIP switch										Address
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1
OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
ON	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	4
ON	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	5
OFF	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	6
ON	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	7
...	...	...	...	...	...	...	...	...	...	...
ON	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	1023

⚠ WARNING

TwinSAFE address

Each TwinSAFE address may only be used once within a network / a configuration!
The address 0 is not a valid TwinSAFE address!

4.3.7 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.

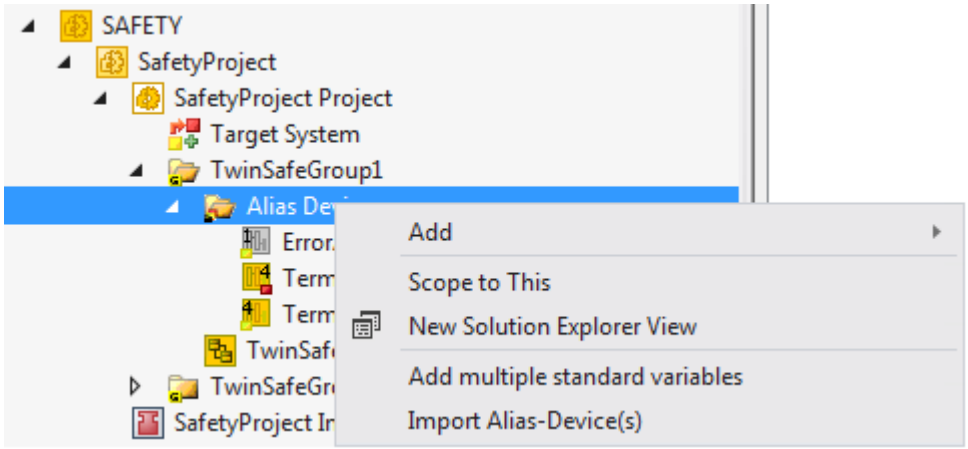

Fig. 22: Starting the automatic import from the I/O configuration

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.

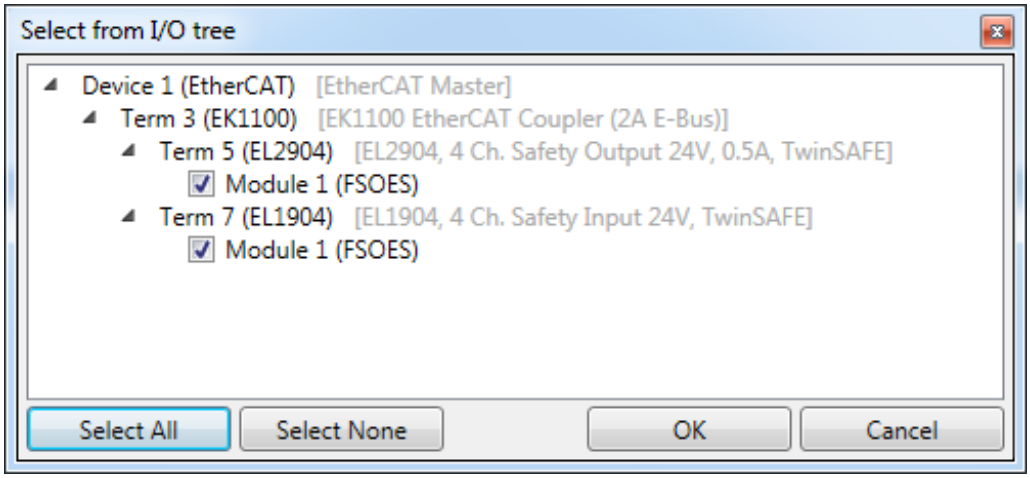

Fig. 23: Selection from the I/O tree

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.

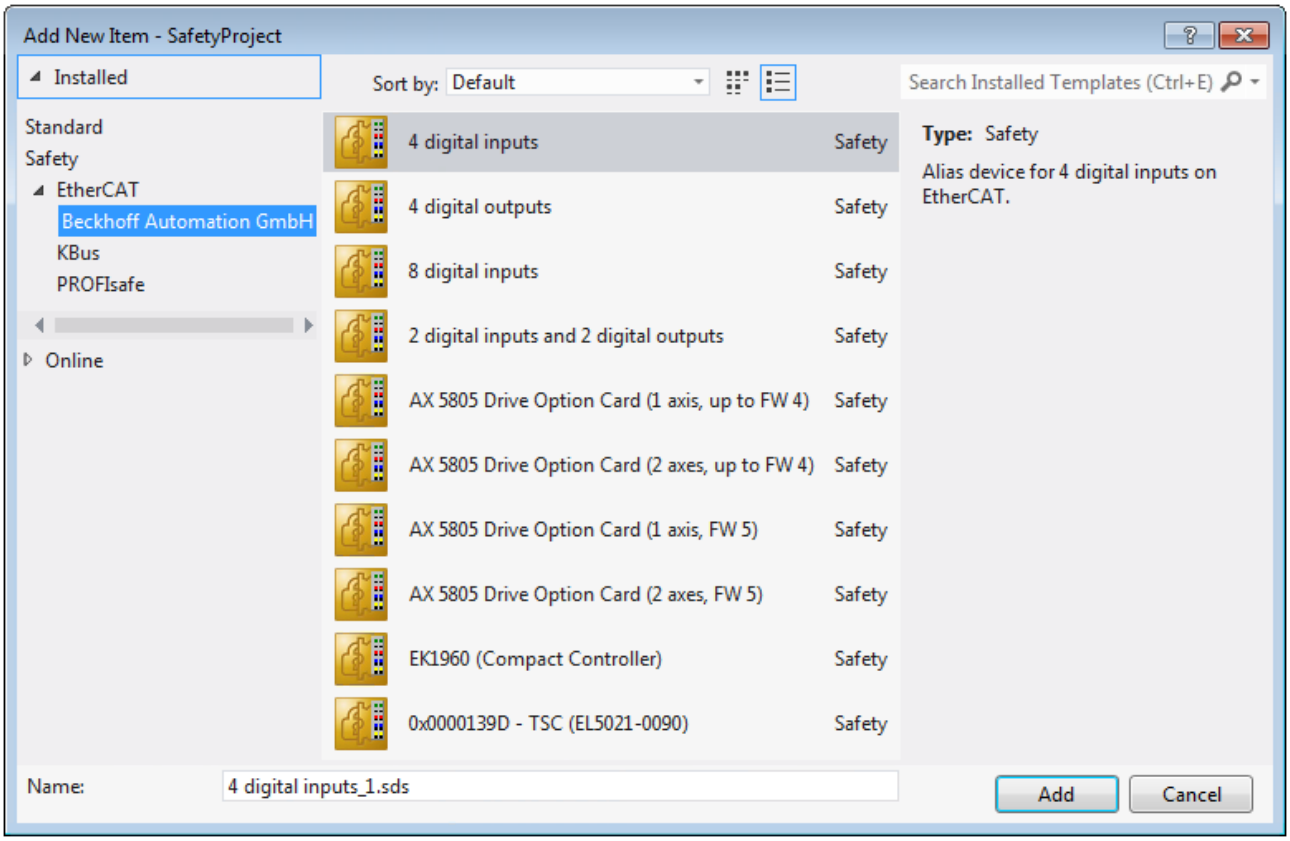

Fig. 24: Creating alias devices by the user

4.3.8 EL2911 parameters in TwinCAT

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.

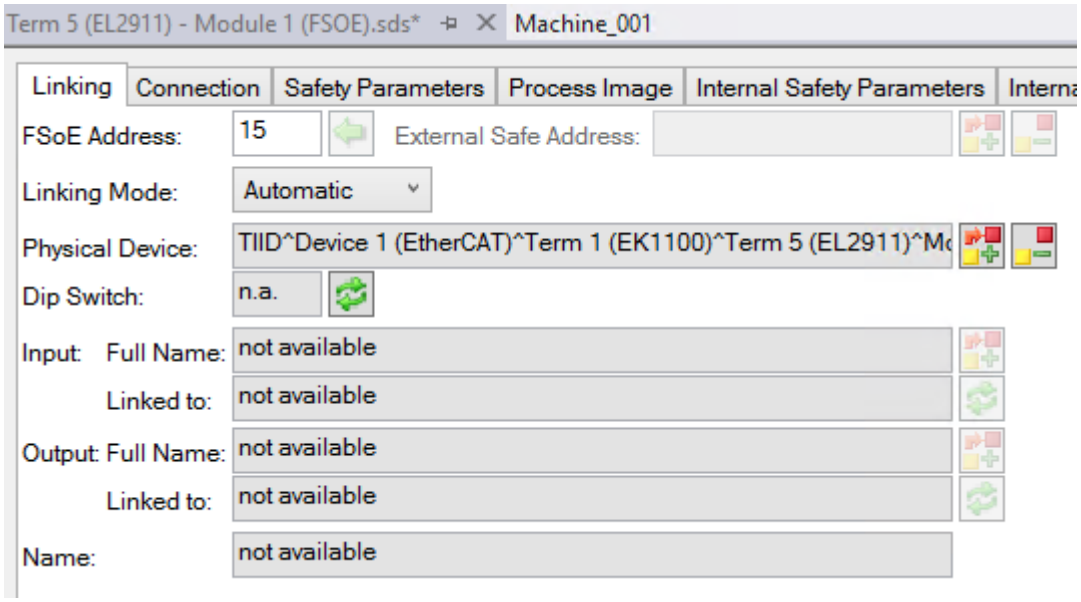

Fig. 25: Linking tab of the alias device

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.

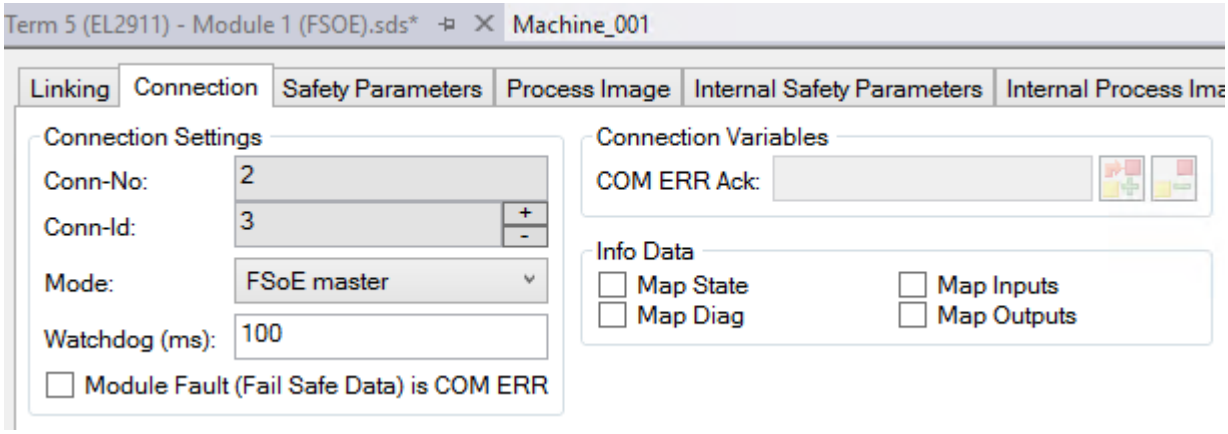

Fig. 26: Connection tab of the alias device

The *Safety Parameters* tab contains the parameters of the EL2911 to be set. The output is parameterized via parameter 0x8000. The inputs are configured via the objects 0x8010 and 0x8011.

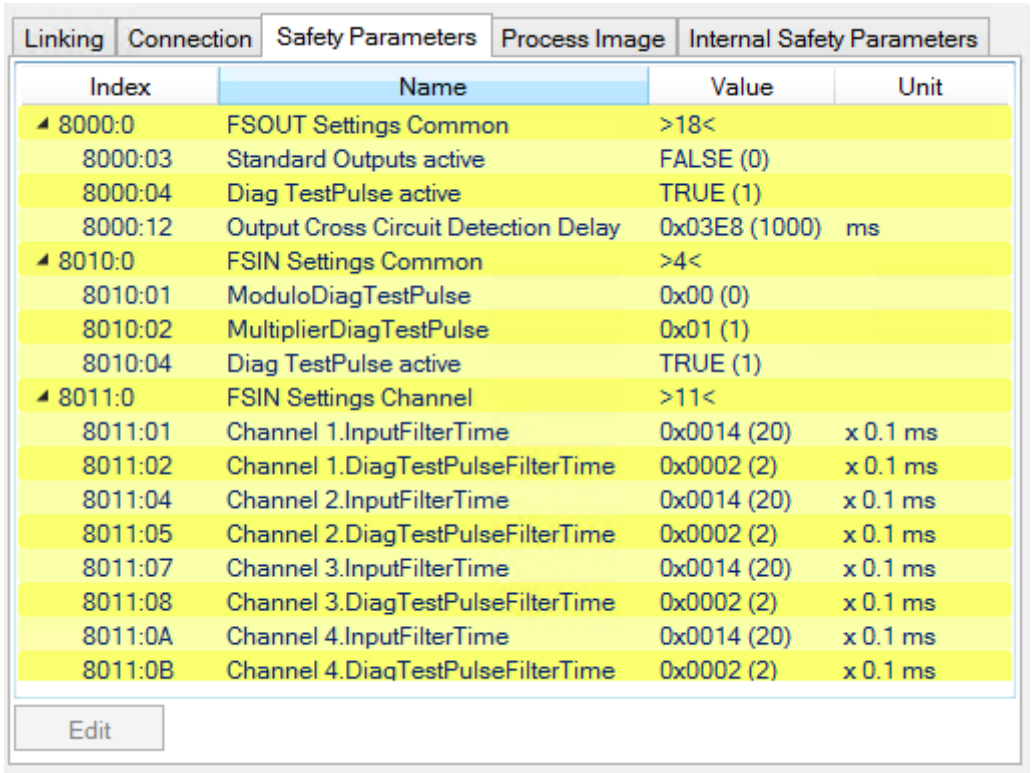

Fig. 27: EL2911 parameters

Index	Name	Default value/ unit	Description
8000:03	Standard outputs active	FALSE / Boolean	Activation of the logical AND operator of the safe and standard outputs of the module
8000:04	Diag TestPulse active	TRUE / Boolean	Switching the internal clocking of the output module on/off ($24V_{DC}$ at the output is always without clocking)
8000:12	Output cross-circuit detection delay	0x03E8 / 1 ms	After the output is switched off, the system waits for the set delay time before the voltage is read at the output. If the voltage exceeds 5 V, a module error is generated.

Index	Name	Default value/ unit	Description
8010:01	ModuloDiagTestPulse	0x00 / integer	Modulo value for the frequency of generating a test pulse. 0 -> every time 1 -> every 2nd time ...
8010:02	MultiplierDiagTestPulse	0x01 / integer	Length of the test pulse in multiples of 400 µs
8010:04	Diag TestPulse active	TRUE / Boolean	Activation of test pulses for the corresponding input module
8011:01	Channel1.InputFilterTime	0x0014 / 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 and cannot can be switched off.
8011:02	Channel1.DiagTestPulseFilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal
8011:04	Channel2.InputFilterTime	0x0014 / 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 and cannot can be switched off.
8011:05	Channel2.DiagTestPulseFilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal
8011:07	Channel3.InputFilterTime	0x0014 / 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 and cannot can be switched off.
8011:08	Channel3.DiagTestPulseFilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal
8011:0A	Channel4.InputFilterTime	0x0014 / 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 and cannot can be switched off.
8011:0B	Channel4.DiagTestPulseFilterTime	0x0002 / 0.1 ms	Input filter for the test pulse signal

4.3.9 EL2911 process image

The process image of the EL2911 consists 6 bytes of process data in the input and the output.

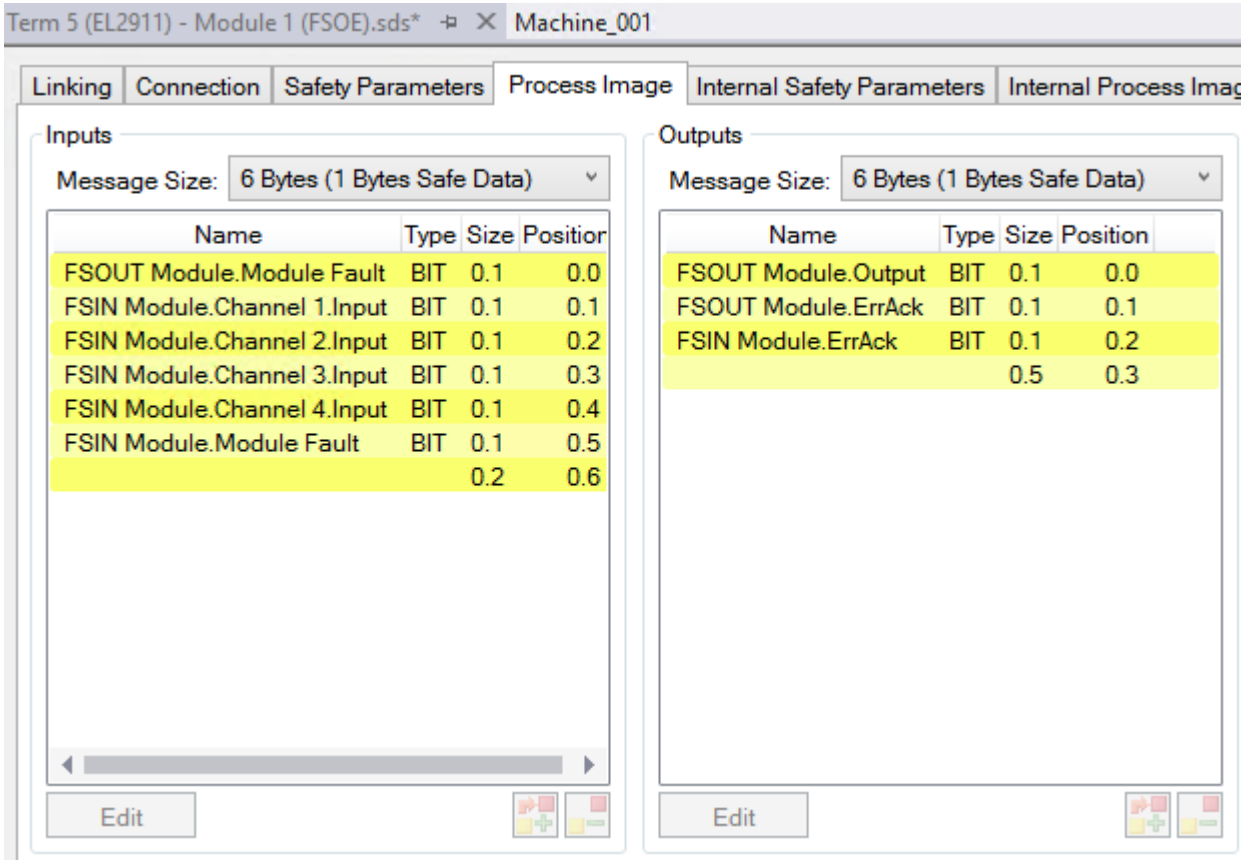

Fig. 28: EL2911 process image

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

Name	Process image	Bit position	Description
FSOUT Module.Module Fault	IN	0.0	Module error information for safe output
FSIN Channel1.Channel1.Input	IN	0.1	Safe input channel 1
FSIN Channel2.Channel1.Input	IN	0.2	Safe input channel 2
FSIN Module.Channel3.Input	IN	0.3	Safe input channel 3
FSIN Module.Channel4.Input	IN	0.4	Safe input channel 4
FSIN Module.Module Fault	IN	0.5	Module error information for safe input module
FSOUT Module Output	OUT	0.0	Safe output to power contact
FSOUT Module.ErrAck	OUT	0.1	Error acknowledge for safe output module
FSIN Module.ErrAck	OUT	0.2	Error acknowledge for safe input module

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.

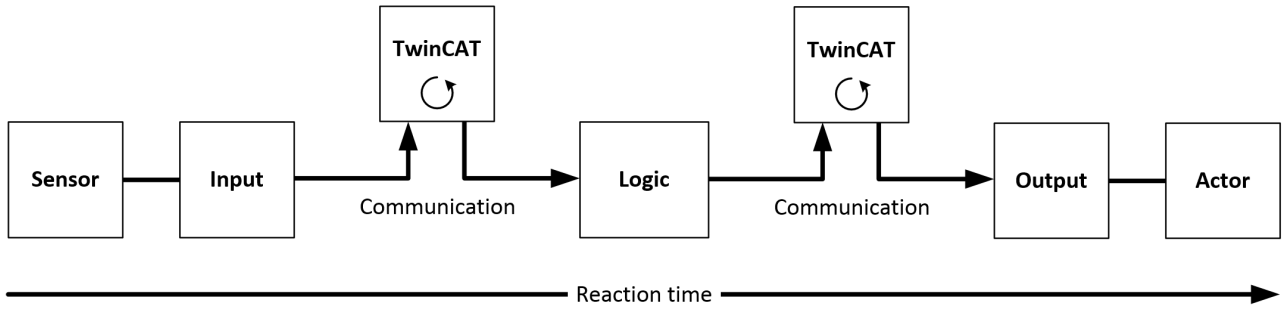

Fig. 29: Typical reaction time

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.

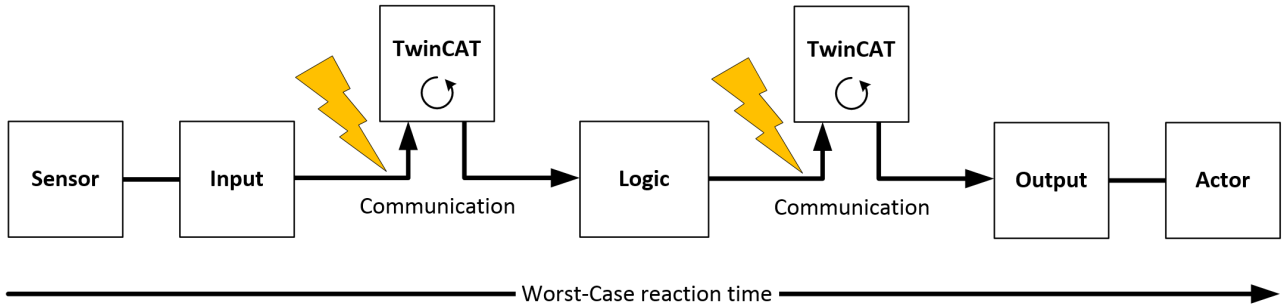

Fig. 30: Worst-case reaction time

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 Status LEDs

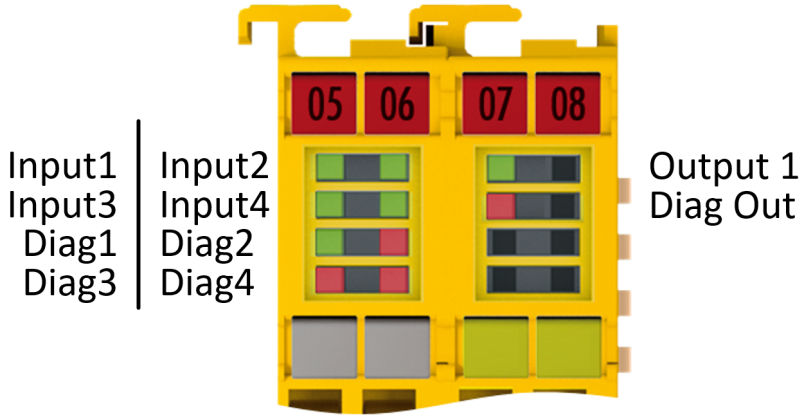

Fig. 31: EL2911 status and diagnostics LEDs

LED	Color	Description
Input 1	green	Status display for the respective input and output LED lights up: Input/output is set LED not lit: Input/output is not set
Input 2		
Input 3		
Input 4		
Output 1		

4.5.2 Diagnostic LEDs

Diagnostic LEDs

LED	lit	flashes	off
Diag 1 (green)	Environment variables, operating voltage and internal tests are in the valid range • If Diag 2 flashes, a logic error code applies	-	Environment variables, operating voltage and internal tests are outside the valid range • If Diag 2 flashes, an environment error code applies
Diag 2 (red)	Together with Diag 3 and 4: Global Shutdown[1)] has occurred. (see diag history of the TwinSAFE components)	Logic or environment error code according to Diag1 and tables below is output	Together with Diag 3 and 4: Global Fault[1)] has occurred. (see diag history of the TwinSAFE components)
Diag 3 (red)	Global fault or global shutdown on µC1[1)]	-	No global fault or global shutdown on µC1[1)]
Diag 4 (red)	Global fault or global shutdown on µC2[1)]	-	No global fault or global shutdown on µC2[1)]
Diag Out (red)	Module error in the output module	-	No error in the output module

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 Diag 2 (if LED Diag 1 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 Diag 2 (if LED Diag 1 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

4.5.3 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

4.5.4 Diagnosis History

The diagnostic history of the TwinSAFE devices that support this function is implemented in accordance with the ETG guideline ETG.1020 Chapter 13 "Diagnosis Handling". The diagnostic messages are saved by the TwinSAFE device in a dedicated CoE object under 0x10F3 and can be read out by the application or by TwinCAT.

Both the control entries and the history itself can be found in the CoE object 0x10F3. The entry Newest Message (0x10F3:02) contains the subindex of 0x10F3, which contains the latest diagnostic message, e.g. 0x06 for diagnostic message 1.

Index $10F3_{hex}$ Diagnosis History

Index (hex)	Name	Meaning	Data type	Flags	Default
10F3:0	Diagnosis History				
10F3:01	Maximum Messages	Maximum number of stored messages. A maximum of 64 messages can be stored. After that the respective oldest messages are overwritten.	UINT8	RO	0x40 (64_{dec})
10F3:02	Newest Message	Subindex of the latest message	UINT8	RO	0x00 (0_{dec})
10F3:03	Newest Acknowledged Message	Subindex of the last confirmed message	UINT8	RW	0x00 (0_{dec})
10F3:04	New Messages Available	Indicates that a new message is available	BOOLEAN	RO	0x00 (0_{dec})
10F3:05	Flags	Set via the startup list. If set to 0x0001, the diagnostic messages are additionally sent by emergency to the EtherCAT master	UINT16	RW	0x0000 (0_{dec})
10F3:06	Diagnosis Message 001	Diagnostic message 1	BYTE[32]	RO	{0}
...	...	...	...	...	...
10F3:45	Diagnosis Message 064	Diagnostic message 64	BYTE[32]	RO	{0}

Structure of the diagnostic messages

- DiagCode (4 bytes) – in this case always 0x 0000 E000
- Flags (2 bytes) - diagnosis type (info, warning or error), timestamp and number of parameters contained (see the following table)
- Text ID (2 bytes) – ID of the diagnostic message as a reference to the message text from the ESI/XML
- Timestamp (8 bytes) – local slave time in ns since switching on the TwinSAFE device
- dynamic parameters (16 bytes) – parameters that can be inserted in the message text (see following table)

Flags in diagnostic messages

Data type	Offset	Description	
UINT16	Bits 0 to 3	DiagType (value)	
		0	Info message
		1	Warning message
		2	Error message
		3…15	reserved
	Bit 4	If the bit = 1, the timestamp contained in the message is the local timestamp of the TwinSAFE device. The age of the diagnostic message can be deduced by calculation with the current timestamp from the CoE object 0x10F8.	
	Bits 5 to 7	reserved	
	Bits 8 to 15	Number of parameters in this diagnostic message	

Dynamic parameters in the diagnostic messages

Type	Data type	Description	
Flags parameter 1	UINT16	Describes the type of parameter 1	
		Bits 12 to 15 = 0	Bits 0 to 11 = data type of parameter 1 0x0001 - BOOLEAN 0x0002 - INT8 0x0003 - INT16 0x0004 - INT32 0x0005 - UINT8 0x0006 - UINT16 0x0007 - UINT32 0x0008 - REAL32 0x0011 - REAL64 0x0015 - INT64 0x001B - UINT64 Text parameters and formats are specified in ETG.2000.
Parameter 1	Data type in accordance with flags	Value of parameter 1	
Flags parameter 2	UINT16	see Flags parameter 1	
Parameter 2	Data type in accordance with flags	Value of parameter 2	
...			

The diagnostic messages are saved in text form in the ESI/XML file belonging to the TwinSAFE device. On the basis of the Text ID contained in the diagnostic message, the corresponding plain text message can be found in the respective languages. The parameters can be inserted in the appropriate positions. In the following example, %x is used for a hexadecimal representation of the parameters.

Fig. 32: ESI/XML message text

Via the entry *New Messages Available* the user receives information that new messages are available. The messages can be read out via CompleteAccess (a CoE read command for the complete CoE object 0x10F3). The *New Messages Available* bit is reset after reading the messages.

The sending of emergency messages to the EtherCAT master is activated by adding the CoE object 0x10F3:05 to the startup list (Transition IP, value 0x0001). If new diagnostic messages arrive, they are entered in object 0x10F3 and additionally sent by emergency to the EtherCAT master.

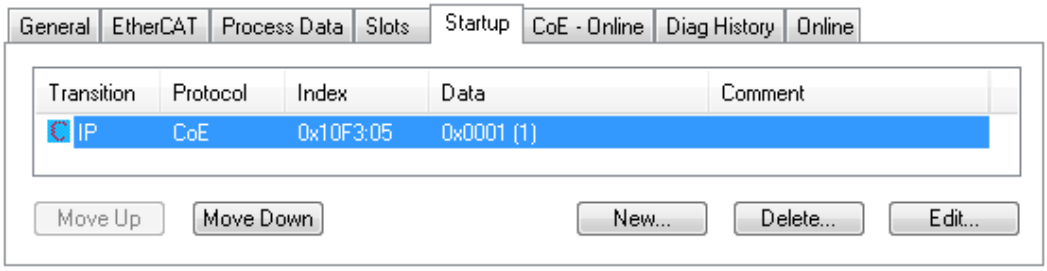

Fig. 33: Startup list

4.5.5 Diag History tab

All errors occurring within the TwinSAFE components are stored in their diag history. The diag history can be viewed by selecting the corresponding TwinSAFE component in the I/O tree structure and then selecting the *Diag History* tab. Use the *Update History* button to fetch the current data from the TwinSAFE component. Errors within the logic, the function blocks, the connections or the component itself are stored with a corresponding time stamp.

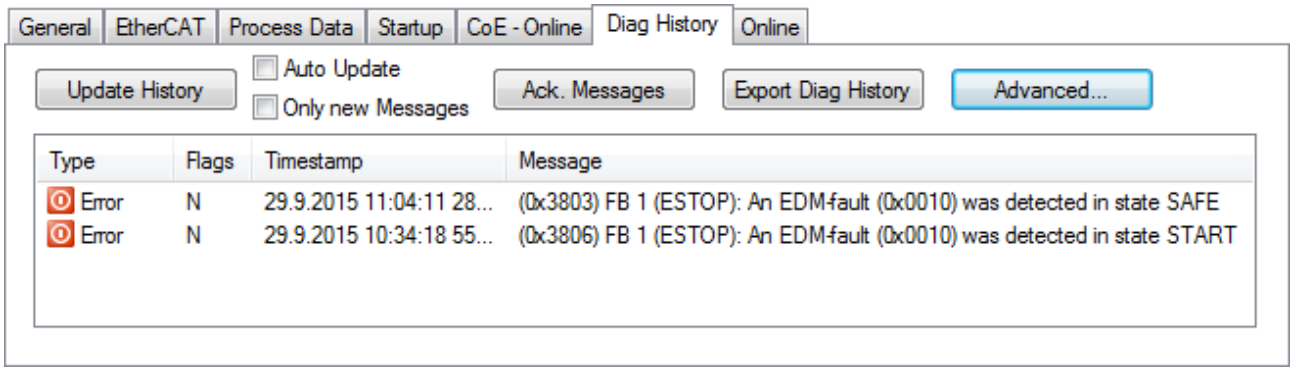

Fig. 34: Diag history

Use the *Advanced…* button to open the advanced settings. Here, the user can customize the behavior of the diag history.

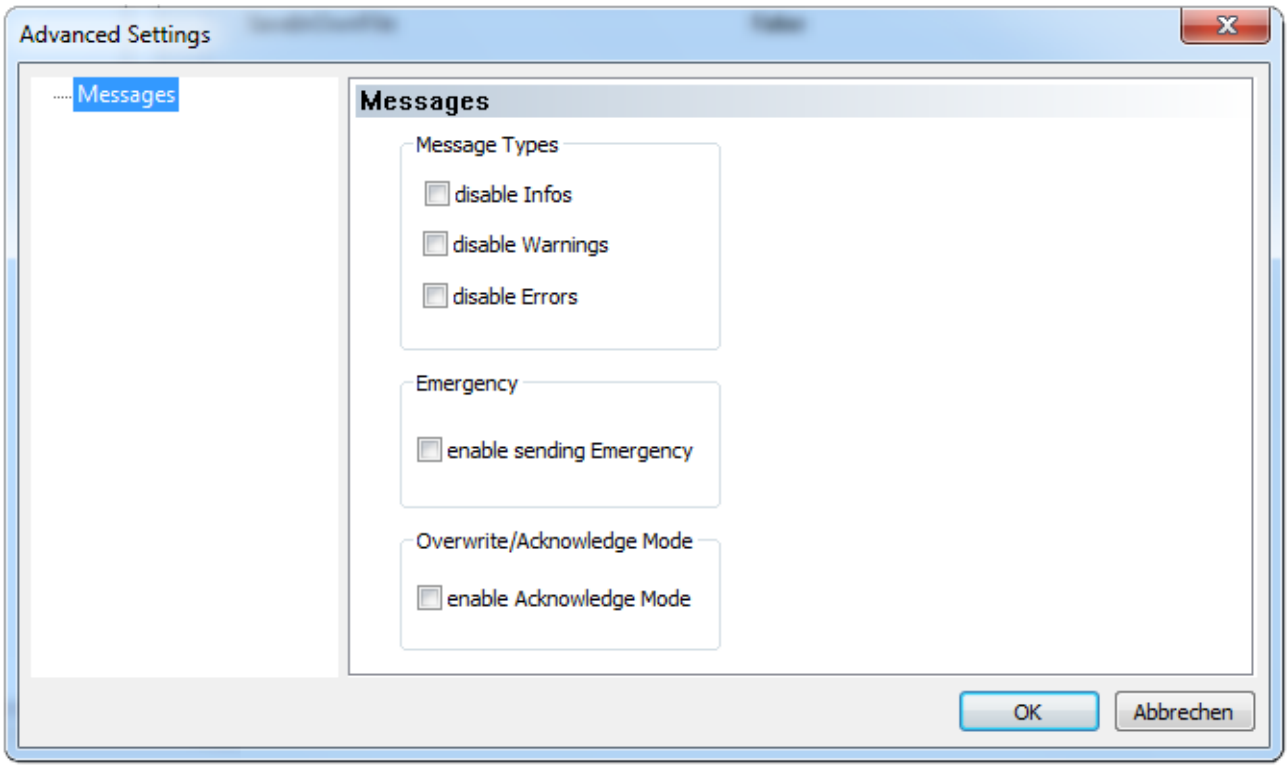

Fig. 35: Diag history – advanced settings

Advanced Settings

Setting	Description
Message Types	• disable Info Messages with status *Info* are not stored in the diag history • disable Warnings Messages with status *Warning* are not stored in the diag history • disable Errors Messages with status *Error* are not stored in the diag history
Emergency	In addition to saving the message in the diag history, an emergency object is also sent and displayed in the TwinCAT logger window.
Overwrite / Acknowledge Mode	This setting is currently not supported.

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 terminals are designed for a service life of 20 years.

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

The TwinSAFE terminals bear a date code, which is composed as follows:

Date code: CW YY SW HW

Legend:	Sample: Date Code 17 11 05 00
CW: Calendar week of manufacture	Calendar week: 17
YY: Year of manufacture	Year: 2011
SW: Software version	Software version: 05
HW: Hardware version	Hardware version: 00

In addition the TwinSAFE terminals bear a unique serial number.

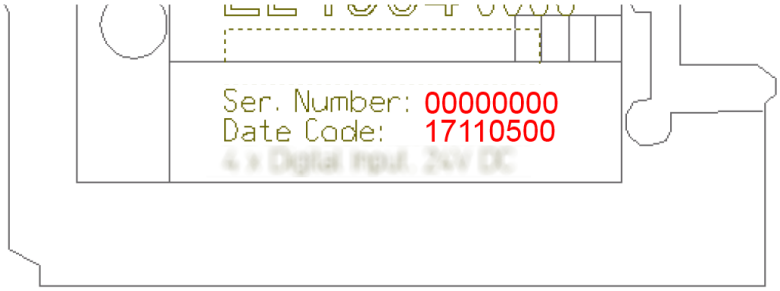

Fig. 36: Unique serial number of a TwinSAFE terminal

4.8 Decommissioning

⚠ DANGER

Serious risk of injury!

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

Disposal

In order to dispose of the device, it must be removed and fully dismantled.

- Housing components (polycarbonate, polyamide (PA6.6)) are suitable for plastic recycling.
- 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".

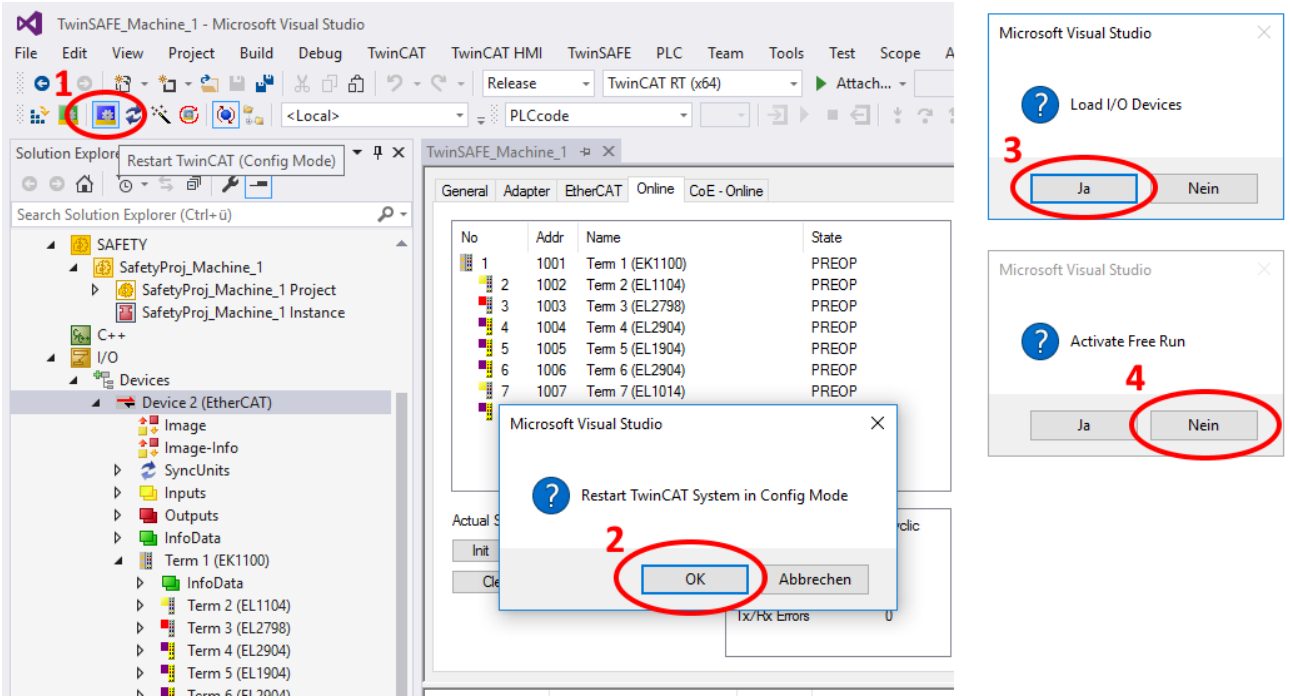

Fig. 37: Firmware update of TwinSAFE products - Part 1

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.

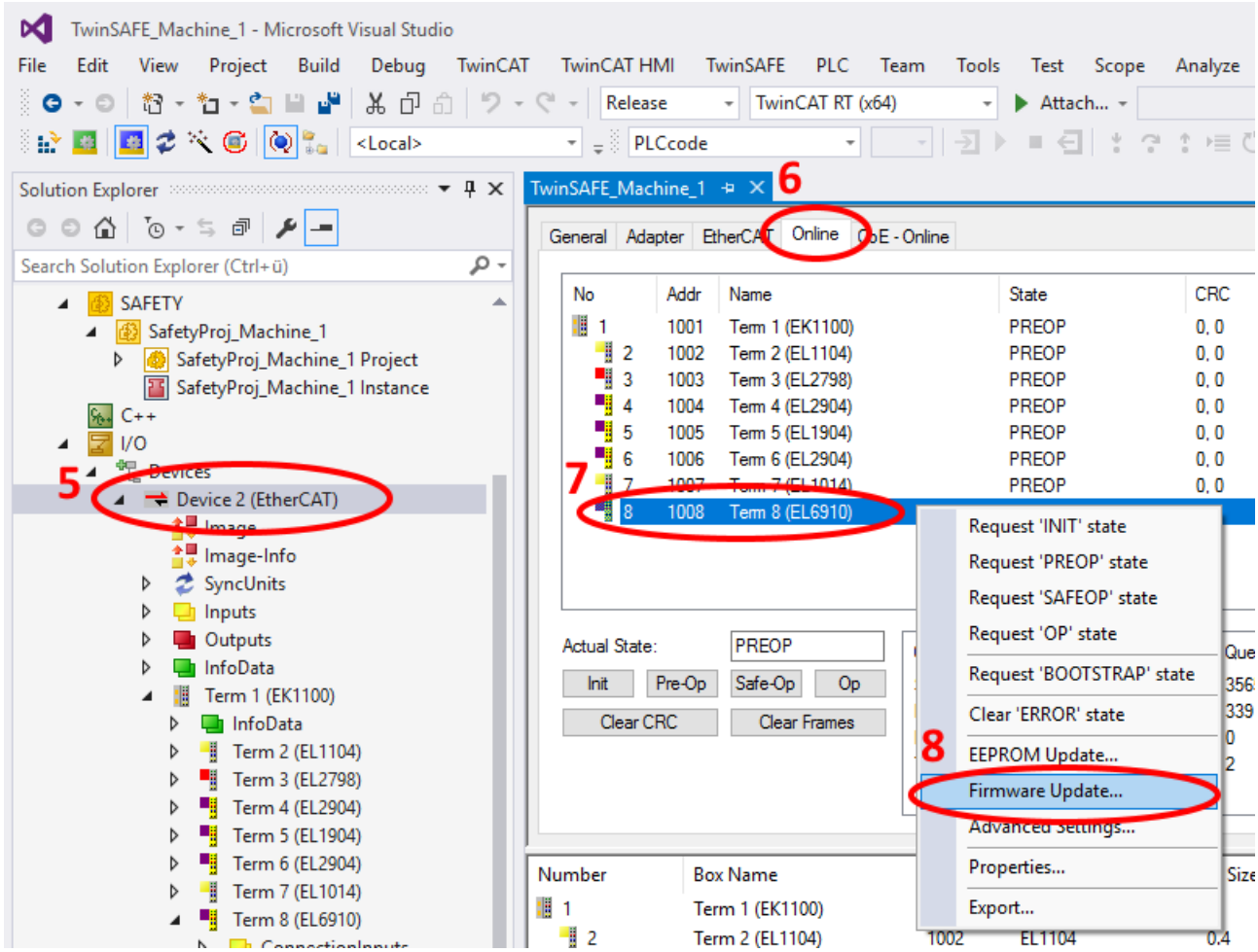

Fig. 38: Firmware update of TwinSAFE products - Part 2

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.

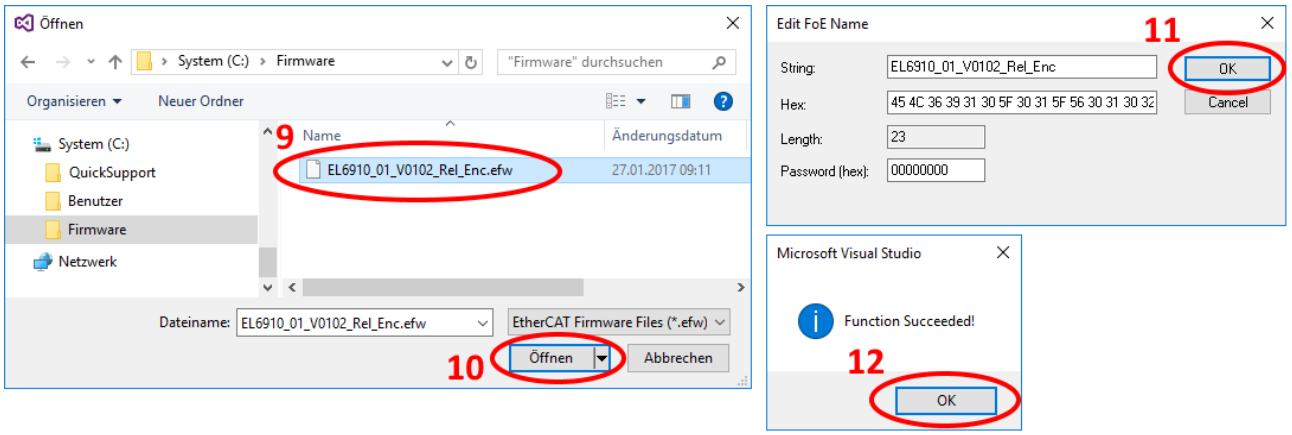

Fig. 39: Firmware update of TwinSAFE products - Part 3

5 Appendix

5.1 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:

- on-site service
- repair service
- spare parts service
- hotline service

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

5.2 Certificates

Product Service

CERTIFICATE

No. Z10 062386 0056 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): **EL2911**

Parameters:

Supply voltage:	24VDC (-15%/+20%)
Ambient temperature:	-25°C...+55°C
Protection class:	IP20

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.: BV92381T

Valid until: 2023-08-15

Date, 2018-08-16 (Peter Weiß)

Page 1 of 1
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

List of figures