BECKHOFF New Automation Technology

Operating Instructions | EN

EL1904

TwinSAFE Terminal with 4 digital fail-safe inputs

EL1904
BECKHOFF

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1   Notes on the documentation

1.1   Disclaimer

Beckhoff products are subject to continuous further development. We reserve the right to revise the operating instructions 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 these operating instructions.

In these operating instructions we define all permissible use cases whose properties and operating conditions we can guarantee. The use cases we define are fully tested and certified. Use cases beyond this, which are not described in these operating instructions, require the approval of Beckhoff Automation GmbH & Co KG.

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1.1.2   Patents

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- EP1590927
- EP1789857
- EP1456722
- EP2137893
- DE102015105702

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1.1.3   Limitation of liability

All components in this product as described in the operating instructions are delivered in a specific configuration of hardware and software, depending on the application regulations. Modifications and changes to the hardware and/or software configuration that go beyond the documented options are prohibited and nullify the liability of Beckhoff Automation GmbH & Co. KG.

The following is excluded from the liability:

- Failure to observe these operating instructions
- Improper use
- Use of untrained personnel
- Use of unauthorized spare parts

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Version: 3.3.0

1.2 Documentation issue status

Version	Comment
3.1.0	• Chapter Safety and instruction [▶ 13] revised
	• In chapter Technical data corrosive gas test and footnote for corrosive environment added
	• Warning added in chapter Installation on mounting rails
	• Chapter Lifetime revised
	• Certificate removed
3.0.0	• Migration
	• Foreword changed in Notes on the documentation [▶ 5] and For your safety [▶ 16]
	• In chapter Technical data link to download page of certificates added
	• Maintenance and cleaning [▶ 60] and Decommissioning [▶ 62] added
	• Appendix adapted and extended
2.2.1	• Technical data for *permissible air pressure* extended
2.2.0	• Reliability document updated
	• Safety parameters updated
	• Foreword revised
2.1.2	• Reliability document updated
2.1.1	• Certificate updated
2.1.0	• Company address changed
	• Document origin added
	• Version history added
	• EN954 example removed
	• Safety parameters extended
2.0.1	• Reference to EN 60068-2-29 removed
2.0.0	• Description of the configuration in the TwinCAT System Manager added
	• Certificates added
	• Note on test pulses of the outputs added
	• Tested devices extended
1.1.4	• Diagrams corrected
	• Flashing codes corrected
1.1.3	• Pin assignment corrected
1.1.2	• Technical data updated
1.1.1	• LED and graphics updated
1.1.0	• Technical data extended
	• Editorial amendments
1.0.3	• Description of LEDs and flashing codes updated
	• TwinSAFE description updated
1.0.2	• Note relating to qualified software tool amended
1.0.1	• LoP list incorporated
1.0.0	• First release

Currentness

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/twinsafe. In case of doubt, contact Support and Service [▶ 14].

Origin of the document

The original documentation is written in German. All other languages are derived from the German original.

Product features

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

1.3 Version numbers of the documentation

Version	Comment
3.3.0	• Machinery Directive changed to Machinery Regulation
	• References to EN 61511 added
	• Chapter renamed to "Version numbers of the documentation"
	• Test pulses added to the "Signal cables" chapter and wire size width added to the "Connecting" chapter
	• Editorially revised
3.2.0	• Chapter "Safety and instruction" revised
	• Certificate removed from appendix and links to certificates and declarations of conformity added
	• New chapters "Notes on information security", "Version history of the TwinSAFE product" and "Laser image" added
	• Chapter structure adapted
	• "Safety parameters" changed to "Target failure measures" and SFF value added in chapter "Target failure measures"
	• Editorially revised
3.1.1	• Certificate updated
3.1.0	• In chapter "Product data" harmful gas test and footnote for corrosive environment added
3.0.0	• Foreword changed to "Documentation notes" and "For your safety"
	• Added a link to certificate download page in chapter "Product data"
	• "Maintenance and cleaning" and "Decommissioning" adapted
	• Appendix adapted and extended
2.3.0	• Specification of overvoltage category added
	• Protection class III (SELV/PELV) added
	• Device type "Open equipment" added
	• Link in chapter Actuality updated
2.2.0	• Notes on heights, operation modes, fuses and wiring added
	• Notes on EN 81 added
	• Notes added in section *Intended Use*
	• Chapter *Identification* (ATEX) updated
2.1.1	• Technical data for *permissible air pressure* extended
2.1.0	• Chapter on *Address settings on TwinSAFE Terminals with 65535 possible addresses* updated
	• Links in the technical data corrected
2.0.0	• Migration and structural adaptation
	• Reliability document updated
	• Safety parameters updated
	• Foreword revised
1.5.2	• Block diagram updated
	• Numbering/table of contents changed (Chapter 4.1.5 to 4.1.7)
	• Description of the test pulses added
	• Description of the reaction times added
	• Reliability document updated
1.5.1	• Certificate updated
1.5.0	• Company address changed
	• Safety parameters extended
1.4.0	• Extended temperature range added
	• Temperature measurement described

Version	Comment
	• Characteristic input curve added
	• Description of date code extended
1.3.1	• Document origin added
1.3.0	• Clock output currents in the technical data added
	• Block diagram for EL1904 added
1.2.1	• Reference to EN 60068-2-29 removed
1.2.0	• ATEX notes added
	• Installation position / minimum distances extended
	• Notes regarding overvoltage protection added
	• Notes regarding cable length and clocked signals extended
	• Diagnostics for CoE object 0x800E described
1.1.0	• Minor amendments for EtherCAT
	• Copyright / disclaimer modified
	• Support / service addresses updated
1.0.0	• First released version

Currentness

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/twinsafe. In case of doubt, contact Support and Service [▶ 14].

Origin of the document

The original documentation is written in German. All other languages are derived from the German original.

Product features

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

1.4

1.5   Version history of the TwinSAFE product

This version history lists the software and hardware version numbers. You will also find a description of the changes to previous versions contained in each case. See the table below for more information.

ⓘ 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.

Software version	Hardware version	Modifications
08	10	The table is maintained from SW version 08 and HW version 10.

1.6   References

No.	Version	Description
[1]	/	Not used.
[2]	/	Not used.
[3]	1.4.1 or newer	**Operating Manual for EL6910 TwinSAFE Logic Module** The document contains a description of the logic functions of the EL6910 and its programming.
[4]	3.1.0 or newer	**Dokumentation TwinSAFE-Logic-FB** The document describes the safety-related function blocks that are available in the EL6910 and thus also in the TwinSAFE card and form the safety-related application.
[5]	3.1.0 or newer	**TwinSAFE Application Guide** The application guide provides the user with examples for the calculation of safety-related parameters for safety functions according to the standards DIN EN ISO 13849-1 and EN 62061 or EN 61508:2010, as they are typically used on machines.
[6]	2023/1230	**Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery and repealing Directive 2006/42/EC of the European Parliament and of the Council and Council Directive 73/361/EEC** This regulation, also known as the Machinery Regulation, defines requirements for placing machinery and machine-like components, such as safety components, on the market.
[7]	2017	**EN 61511-1:2017** The standard serves as a basic safety standard for functional safety in the process industry and is tailored to its safety-related systems.

1.7 Staff qualification

These operating instructions are intended exclusively for trained specialists in control technology and automation with the relevant knowledge.

The trained specialist personnel must ensure that the applications and use of the described product meet all safety requirements. This includes all applicable and valid laws, regulations, provisions and standards.

Trained specialists

Trained specialists have extensive technical knowledge from studies, apprenticeships or technical training. Understanding of control technology and automation is available. Trained specialists can:

- Independently identify, avoid and eliminate sources of hazard.
- Apply relevant standards and directives.
- Implement specifications from accident prevention regulations.
- Evaluate, prepare and set up the workplaces.
- Evaluate, optimize and execute work independently.

1.8 Safety and instruction

Read the contents that refer to the activities you have to perform with the product. Always read the chapter For your safety [▶ 16] in the operating instructions.

Observe the warnings in the chapters so that you can handle and work with the product as intended and safely.

Explanation of symbols

Various symbols are used for a clear arrangement:

1.　　　The numbering indicates an action that should be taken.
•　　　The bullet point indicates an enumeration.
[…]　　　The square brackets indicate cross-references to other text passages in the document.
[1]　　　The number in square brackets indicates the numbering of a referenced document.

The signal words used in the documentation are classified below.

Signal words

Warning of personal injuries

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
Notes
The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
Recommendations for action, assistance or further information on the product.

1.9 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.

Download finder

Our download finder contains all the files that we offer you for downloading. You will find application reports, technical documentation, technical drawings, configuration files and much more.

The downloads are available in various formats.

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You will also find further documentation for Beckhoff components there.

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1.10   Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our https://www.beckhoff.com/secguide.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

2 For your safety

Read this chapter containing general safety information. In addition, always observe the safety instructions and warnings in these operating instructions for your own safety, the safety of other persons and the safety of the product.

When working with control and automation products, many dangers can result from careless or incorrect use. Work particularly thoroughly, not under time pressure and responsibly towards other people.

2.1 Duty of care

ⓘ **Read entire documentation for TwinSAFE component**
- TwinSAFE application manual
- EL6910 TwinSAFE logic terminal operating manual
- TwinSAFE Logic FB documentation manual

The operator must comply with all the requirements and notes specified in these operating instructions in order to fulfill his duty of care. This includes in particular that you

- comply with the provisions defined in the chapter Limitation of liability [▶ 6].
- only operate the TwinSAFE component when it is in perfect working order.
- provide the operating instructions in a legible condition and complete at the place of use of the TwinSAFE component.
- do not remove the safety markings attached to the TwinSAFE component and maintain their legibility.

The operator is also responsible for the safe operation of the system. This includes risk assessment. The following standards apply for risk assessment:

- EN ISO 12100:2010, Safety of machinery – General principles for design – Risk assessment and risk reduction
- ISO 13849-1, Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

Beckhoff is not responsible for the safe operation of the system.

No disposal in domestic waste
Products marked with a crossed-out waste bin must not be disposed of with domestic waste. The device is considered waste electrical and electronic equipment when it is disposed of. Observe the national regulations for the disposal of waste electrical and electronic equipment.

2.2   Safety image signs

Beckhoff products feature safety pictograms, either on stickers or printed, which vary depending on the product. They serve to protect people and to prevent damage to the products. Safety pictograms may not be removed and must be legible for the user.
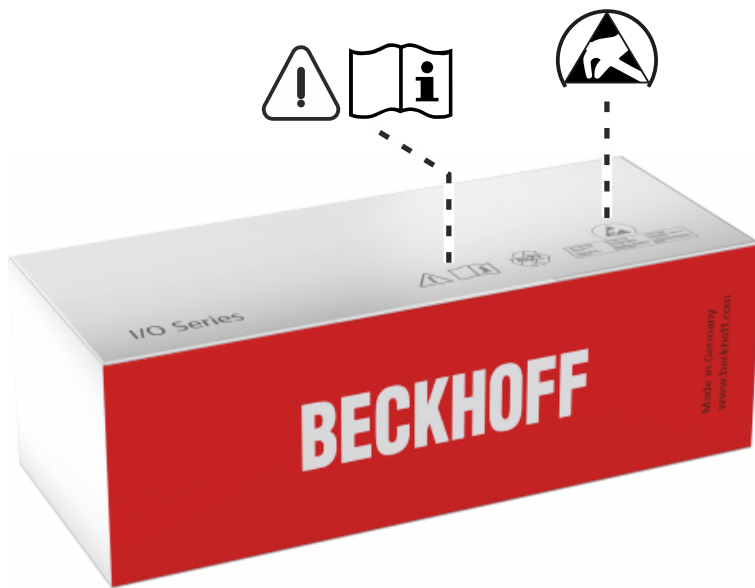
Read and observe the operating instructions
Commissioning is only permitted if the operating instructions have been read and understood beforehand. This applies in particular to the safety instructions and the warnings.

Electrostatic sensitive components
Work with and on the TwinSAFE component is only permitted at protected workplaces.

2.3 General safety instructions

2.3.1 Before operation

Use in machines according to the Machinery Regulation and EN 61511

Only use the TwinSAFE component in machines that comply with the Machinery Directive and the EN 61511 standard for the process industry. This will ensure safe operation.

Refer to the documents [6] and [7] under References [▶ 11].

Ensure traceability

Ensure the traceability of the TwinSAFE component via the serial number.

Use SELV/PELV power supply

Use a SELV/PELV power supply unit with an output-side voltage limit of $U_{max} = 36$ V_{DC} to supply the TwinSAFE component with 24 V_{DC}.

Failure to observe this will endanger the safety function of the product. Depending on the machine, death and danger to life, serious physical injury and damage to the machine may result.

Use ferrules with plastic collars

If you use fine-wire cables for the signal connections, use ferrules with plastic collars. This leads to a higher system availability when the test pulses for the corresponding channels are switched off.

Carry out commissioning test

Before commissioning, wiring faults to the sensors must be excluded. Before commissioning, carry out a commissioning test. After a successful commissioning test, you can use the TwinSAFE component for the intended safety-related task.

In case of wiring errors, the safety function of the product is at risk. Depending on the machine, death and danger to life, serious bodily injury and damage to the machine may result.

Use of permissible engineering tools and procedures

The TÜV SÜD certificate applies to these TwinSAFE components, the function blocks available in it, the documentation and the engineering tool. Engineering tools allowed are TE9000 - TwinCAT 3 Safety Editor and TE9200 - TwinSAFE Loader. Use only the latest versions of the engineering tools. You will find this on the Beckhoff website.

Procedures or engineering tools that deviate from this are not covered by the certificate. This is especially true for externally generated xml files for the TwinSAFE import.

2.3.2 During operation

Interference due to emitted interference

Do not operate the following devices in the vicinity of the TwinSAFE component: for example, radio telephones, radios, transmitters or high-frequency systems.

TwinSAFE components comply with the requirements of the applicable electromagnetic compatibility standards with regard to interference emission and immunity. If you exceed the limits for emitted interference specified in the standards, the function of the TwinSAFE component may be impaired.

2.3.3   After operation

De-energize and switch off components before working on them

Check all safety-relevant equipment for functionality before working on the TwinSAFE component. Secure the working environment. Secure the machine or plant against being inadvertently started up. Observe the chapter Decommissioning [▶ 62].

2.3.4   According to EN 81

⚠ **WARNING**
Observe approval according to EN 81-20, EN 81-22 and EN 81-50
The design and installation of elevators must meet the requirements of EN 81-20, EN 81-22 and EN 81-50 for approval.   *Failure to do so may result in injury. Damage and malfunctions to the product may also result.*

2.3.4.1   Criteria

Observe the following criteria:

Use in machines according to EN 60204-1

Only use the TwinSAFE component in machines that are designed and installed in accordance with the requirements of the EN 60204-1 standard.

Use surge filter

Provide a surge filter against overvoltages for the supply voltage of the TwinSAFE component. This reduces the overvoltage category of the TwinSAFE component to overvoltage category II.

Select a safe temperature threshold

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 get off.

To ensure you can get off at a stop, take the following application measures.

- When the maximum permissible temperature of the respective TwinSAFE component is reached, the system switches off immediately. Read the internal terminal temperature of the TwinSAFE component. See chapter Sample configuration for temperature measurement [▶ 36].
- Select a temperature threshold below the maximum temperature so that a stop can always be reached before the maximum temperature is reached. Information on the optimum terminal configuration can be found under Arrangement instructions [▶ 34] and Sample configuration for temperature measurement [▶ 36].

Observe the error shutdown of the TwinSAFE component

Observe the necessary precautions when approaching a stop to get off. If the TwinSAFE component is operated outside the permissible temperature range, it changes to "Global Shutdown" state.

A global shutdown temporarily disables the TwinSAFE component. You can reset the error by switching off and on again. For further information, refer to the chapter Diagnosis.

Observe lifetime

Observe the lifetime of the TwinSAFE component. The lifetime is 20 years.

Observe the safe state of the application

The safe state of the application must be the de-energized state (quiescent current principle). The safe state of the TwinSAFE component is always the de-energized and switched off state.

2.3.4.2   Environmental conditions

Observe the following ambient conditions:

For indoor use

Use the TwinSAFE component indoors.

Comply with ambient conditions

Observe the ambient conditions and comply with the defined specifications. The ambient conditions can be found in the chapter .

Secure TwinSAFE component against direct contact

Secure the TwinSAFE component against direct contact.

Use a suitable control cabinet

Install the TwinSAFE component in a control cabinet with protection class IP54 in accordance with EN 60529. The requirement for pollution degree 3 is reduced to pollution degree 2 in accordance with EN 60664-1.

Using the SELV/PELV power supply unit

Supply the TwinSAFE component with a SELV/PELV power supply with a maximum voltage of $U_{max} \leq 36\ V_{DC}$.

Comply with ATEX conditions

Comply with the operating conditions in hazardous areas (ATEX).

3 Product overview

3.1 Product description

The EL1904 is a digital input terminal for encoders with potential-free contacts for 24 V_{DC}. The bus terminal has 4 fail-safe inputs.

With two-channel connection, the TwinSAFE component meets the requirements of IEC 61508:2010 (SIL 3), EN ISO 13849-1:2023 (Cat 4, PL e), IEC 61511 (SIL 3), NRTL, UL508, UL1998 and UL991.

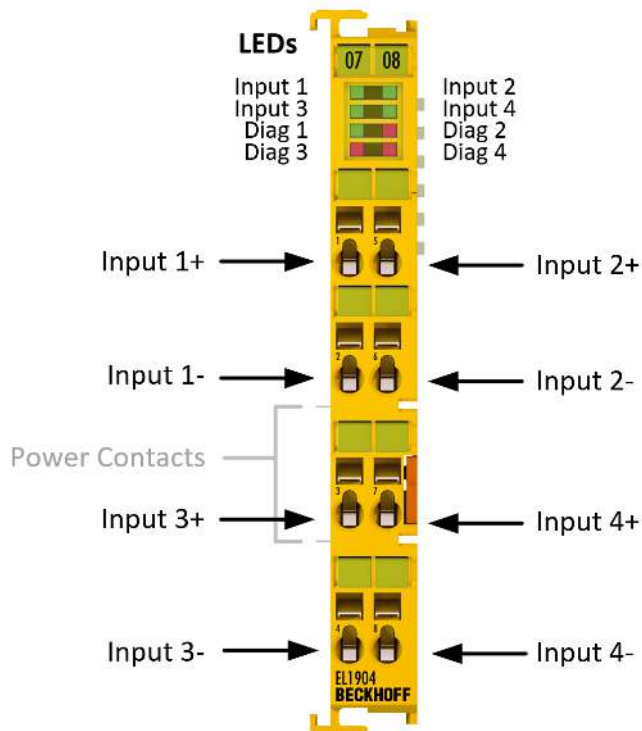The TwinSAFE Terminal has the typical design of an EtherCAT Terminal.

Fig. 1: EL1904 – TwinSAFE Terminal with 4 digital fail-safe inputs

The TwinSAFE Terminals enable connection of:

- 24 V_{DC} sensors (EL1904) such as
  emergency shutdown push buttons, rope pull switches, position switches, two hand switches, safety switching mats, light curtains, light barriers, laser scanners, etc.
- 24 V_{DC} actuators (EL2904) such as
  contactors, protective door switches with tumbler, signal lamps, servo drives, etc.

ℹ Test pulses

When selecting actuators, please ensure that the EL2904 test pulses do not lead to actuator switching or a diagnostic message from the EL2904.

BECKHOFF
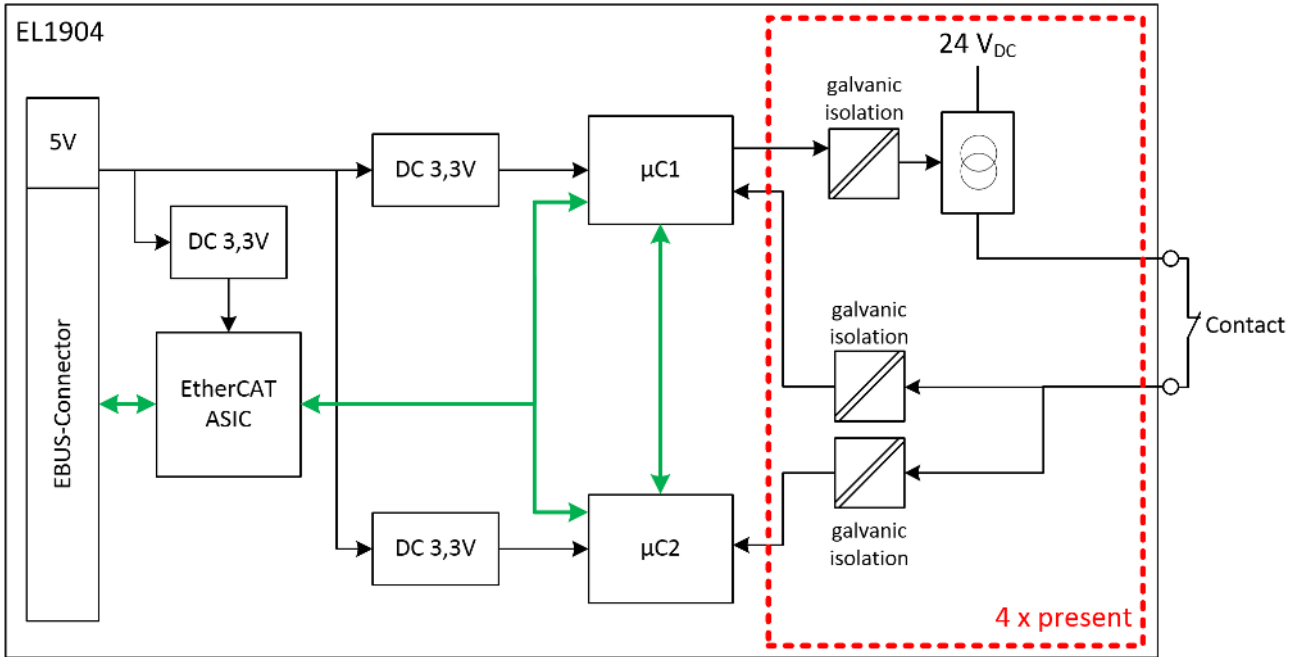
3.2 Block diagram of the EL1904

Fig. 2: Block diagram of the EL1904

The block diagram shows the basic configuration of a channel in the EL1904. The part with a red border is present four times in the terminal.
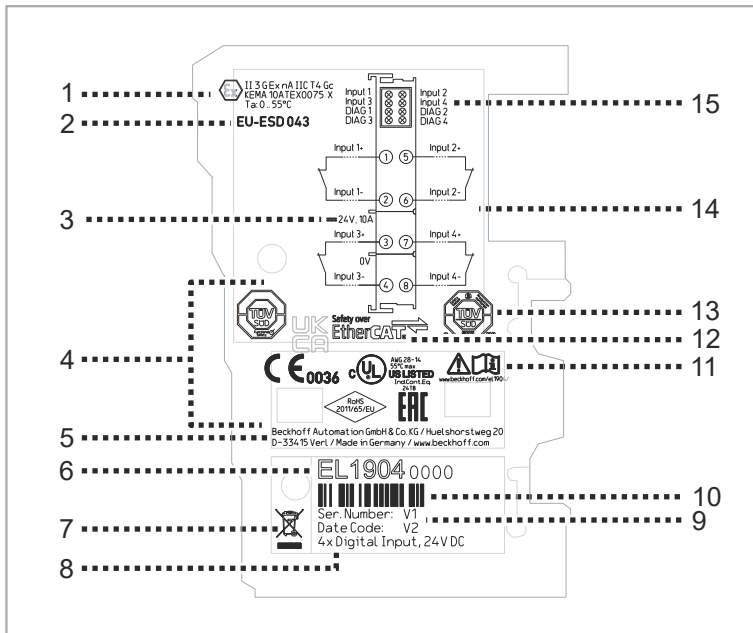
3.3 Laser image

Fig. 3: EL1904 Laser image

Item number	Explanation
1	Mark of conformity for ATEX
2	Number of the EC type examination certificate in accordance with Annex IV, paragraph A of Directive 2014/33/EU
3	Supply voltage
4	Mark of conformity • CE • cULus • EAC • RoHS • UKCA • TÜV SÜD functional safety
5	Address of the vendor, country of manufacture, website
6	Product designation
7	Labeling of products that must not be disposed of with domestic waste in accordance with Directive 2012/19/EU
8	Product description
9	Serial Number Date Code WW = calendar week of manufacture JJ = year of manufacture SW = software version HW = hardware version
10	Barcode
11	Product label "Read operating instructions", website
12	Safety over EtherCAT logo
13	TÜV SÜD mark for NRTL
14	Supply and inputs
15	Status LEDs Diagnostic LEDs

3.4 Intended use

Operate the TwinSAFE component exclusively for the intended activities defined in this documentation, taking into account the prescribed values.

The functions allow the Beckhoff TwinSAFE components to be used in the field of machine safety and as safety devices for the process industry. The intended field of application for TwinSAFE components is safety functions on machines and process control technology in accordance with EN 61511 and the directly associated tasks in industrial automation.

TwinSAFE components are therefore only approved for applications with a defined "fail-safe state". This safe state is the de-energized. Fail-safety according to the relevant standards is required.

⚠ WARNING
Improper use
Any use which exceeds the permissible written values from the chapter <u>Technical data [▶ 25]</u> or which does not observe other specifications from these operating instructions or other documents of the overall documentation is considered to be not in accordance with the intended use and is therefore prohibited.
This applies in particular to the use cases defined by Beckhoff Automation, which have been fully tested and certified and whose properties and operating conditions can be guaranteed. Use cases beyond this are regarded as inappropriate and require the approval of Beckhoff Automation.
Improper use will result in loss of safety and invalidation of certifications and approval.

4 Technical data

4.1 Product data

The current certificates of all TwinSAFE products with the underlying standards and directives can be found at https://www.beckhoff.com/en-en/support/download-finder/certificates-approvals/.

Hardware data		Explanation
Electrotechnical data		
• Supply voltage	24 VDC (- 15 % / + 20 %) (A 10 A fuse should be provided for the potential group) SELV/PELV with maximum 36 V_{DC}	According to IEC 61508-1:2010.
• Output current of the clock outputs	typically 10 mA, max. 15 mA	
• Power loss of the terminal	typically 1 W	
• Insulation voltage	≥ 500 V_{DC}	Insulation voltage between the channels and the E-bus, under common operating conditions.
• Number of inputs	4	
• Cable length between sensor and terminal	unshielded max. 100 m (0.75 or 1 mm²)	
	shielded max. 100 m (0.75 or 1 mm²)	
Current consumption		
• Current consumption via E-bus	4 channels occupied: approx. 200 mA	
• Current consumption of the module electronics at 24 V (without current consumption of sensors)	4 channels occupied: typically 12 mA 0 channels occupied: typically 1.4 mA	
Electrical isolation		
• between the channels	no	
• between the channels and the E-bus	yes	
Signal voltage		
• "0" inputs	-3 V to 5 V	According to DIN EN 61131-2:2008-04, type 3, see chapter Characteristic curve of the inputs [▶ 29].
• "1" inputs	11 V to 30 V	
General		
• Dimensions	12 mm x 100 mm x 68 mm	width x height x depth See chapter Dimensions [▶ 29].
• Weight	approx. 50 g	
• Status LEDs	• 4 diagnostic LEDs	See chapter Diagnostic LEDs [▶ 57].

Software data	Explanation
Reaction times	

Software data		Explanation
• Reaction time in operation *read input/write to E-bus*	4 ms maximum see fault reaction time	
• Fault reaction time	Adjustable ≤ watchdog time	
Process image		
• Input	6 bytes	
• Output	6 bytes	

4.2 Target failure measures

i **Calculation of the MTTF$_D$ value from the PFH$_D$ value**

For calculation and estimation of the values described in the following table, refer to the following documentation:

  • TwinSAFE Application Guide
  • EN ISO 13849-1:2023; table K.1.

In terms of target failure measures, the FSoE communication is considered with 1 % of SIL 3 according to the protocol specification.

Target failure measures		Explanation
Lifetime	20 a	
Proof test interval	/	Special proof tests during the entire lifetime of the TwinSAFE component are not required.
PFH$_D$	1.11E-09	
%SIL 3	1.11%	
PFD	8.29E-05	
%SIL 3	8.29%	
MTTF$_D$	High	
DC	High	
SIL CL	3	According to EN 62061:2005/A2:2015
SIL	3	According to IEC 61508:2010.
Performance Level	e	According to EN ISO 13849-1:2023.
Category	4	According to EN ISO 13849-1:2023.
SFF	99.29%	
HFT	1	
Element classification	Type B	According to EN 61508-2:2010 Chapter 7.4.4.1.2 and 7.4.4.1.3.

4.3 Environmental conditions

Beckhoff products are designed for operation under certain environmental conditions, which vary according to the product. The following specifications must be observed for operation and environment in order to achieve the optimum service life of the products as well as to ensure product safety.

⚠ **WARNING**
Do not use TwinSAFE components under the following operating conditions: • under the influence of ionizing radiation (exceeding the natural background radiation) • in corrosive environments[1] • in an environment that leads to unacceptable contamination of the TwinSAFE component

[1] *A corrosive environment exists when corrosion damage becomes apparent.*

Permissible requirements for the environment		Explanation
Environmental conditions		
• Class for climatic environmental conditions	3K3	According to EN 60721-3-3:1995/A2:1997. The deviation from 3K3 is only possible under optimum environmental conditions and also applies only to the technical data which are specified differently in this documentation.
• Harmful gas test	Test duration: 21 days • Hydrogen sulfide: (50 ± 5) ppb • Nitrogen dioxide: (1250 ± 20) ppb • Chlorine: (10 ± 5) ppb • Sulfur dioxide: (300 ± 20) ppb	According to DIN EN 60068-2-60:2016-06, method 4 with increased concentrations according to ANSI/ISA 71.04:2013 Level GX Group A
• Device type	Classified as open equipment	According to DIN EN IEC 61010-2-201:2019-04.
• Pollution degree	2	According to EN 60664-1:2007.
• Overvoltage category	II	See chapter Sample configuration for temperature measurement [▶ 36].
• Protection class	III	By using a SELV/PELV power supply unit.
• Utilization category	DC-13	According to EN 60947-5-1:2017.

Permissible requirements for the environment	Explanation	
Operating conditions		
• Fieldbus	EtherCAT	
• EMC requirements	Severity level conforms to SIL 3 Zone B	In accordance with EN 61326-3-1:2017 and EN 61131-2:2017 chapters 6.2 and 7.
• Vibration resistance	5 Hz ≤ f < 8.4 Hz; 3.5 mm$_{peak}$ 8.4 Hz ≤ f < 150 Hz; 10 m/s²$_{peak}$	Conforms to DIN EN 60068-2-6:2008-10.
• Shock resistance	15 g with a pulse duration 11 ms in all three axes	According to EN 60068-2-27:2010-02.
• Protection rating	IP20	According to EN 60529:1991 + A1:2000 + A2:2013.
• Permitted operating environment	In a control cabinet or terminal box, with minimum protection rating IP54	According to EN 60529:1991 + A1:2000 + A2:2013.

BECKHOFF

Permissible requirements for the environment	Explanation	
• Correct installation position	Mounted horizontally on a mounting rail	See chapter Installation position [▶ 33].
Temperatures		
Tested according to IEC 60068-2-1:2007, IEC 60068-2-2:2007 and IEC 60068-2-14:2009.		
The measuring device has a tolerance range of ± 3 °C for the minimum temperature and ± 2 °C for the maximum temperature.		
• in operation up to SW 05	-0 °C…+55 °C	See chapter Example configuration for temperature measurement in the Application Guide. See [1] in this document.
• in operation from SW 06	-25 °C…+55 °C	
		For altitudes above 2000 m, the derating factors in the following table apply.
• during transport and storage	-40 °C…+70 °C	
Ambient air		
• Air humidity	5% to 95%	Non-condensing
• Air pressure (operation/storage/transport)	750 hPa to 1100 hPa	Corresponds to an altitude of approx. -690 m to 2450 m above sea level, assuming an international standard atmosphere.

Derating table for altitudes above 2000 m

The derating table (table 8) from the IEC 61131-2:2017 standard can be referred to for the use of the TwinSAFE components above the specified maximum altitude.

Altitude in m	Derating factor for the temperature[1]
0 to 2000[2]	1.0
3000	0.9
4000	0.8
5000	0.7
Note: Linear interpolation is permissible between the altitudes	

[1] Ambient temperature of the device at an altitude of 2000 m

[2] The air pressure and air density increase as the altitude decreases. Therefore the derating factor for 0 to 2000 m (1.0) is used for altitudes below sea level.

Calculation example

In the following example the calculation is performed for a TwinSAFE component at an operating altitude of 4000 m.

Permissible ambient temperature up to 2000 m above sea level = 55 °C

Permissible ambient temperature up to 4000 m above sea level = 55 °C * 0.8 = **44 °C**

⚠ CAUTION
Compliance with the temperature limits
The TwinSAFE component has a maximum internal temperature at which a switch-off takes place. This is designed for the maximum permissible ambient temperature. If the derating factor for the temperature for higher altitudes is used, the user is solely responsible for ensuring that the calculated maximum ambient temperature is complied with.

4.4   Characteristic curve of the inputs

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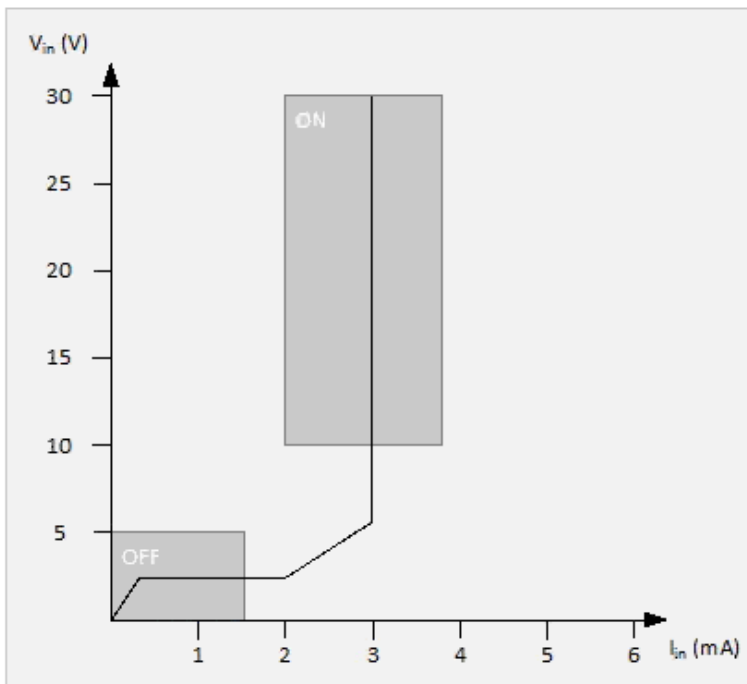

Fig. 4: Characteristic curve of the inputs
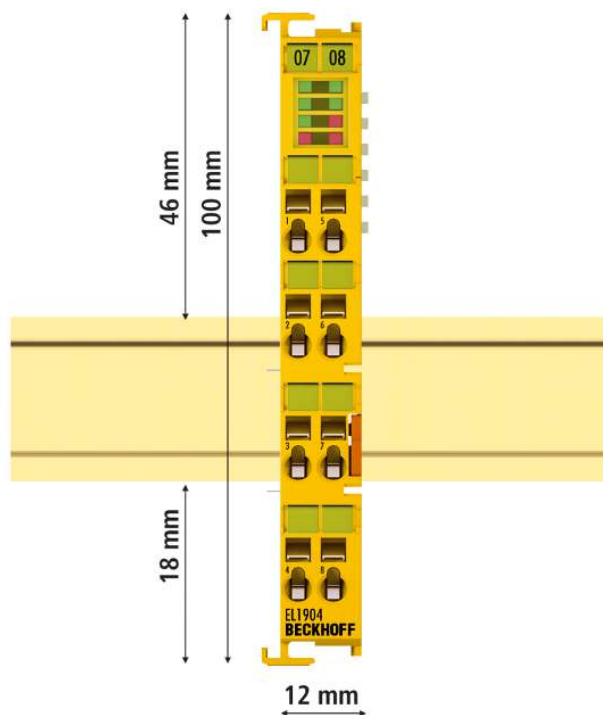
4.5   Dimensions

Fig. 5: Dimensions of the EL1904

Width: 12 mm (side-by-side installation)
Height: 100 mm
Depth: 68 mm

4.6   Lifetime

TwinSAFE components have a lifetime of 20 years, during which the target failure measures are guaranteed. For more information, see chapter Target failure measures [▶ 26].

The lifetime starts from the date of manufacture according to the Date Code.

⚠ WARNING
Replace TwinSAFE component after 20 years
After a lifetime of 20 years, the target failure measures are no longer guaranteed.
Use beyond the lifetime may result in loss of safety.

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

The TwinSAFE components bear a Date Code, which is composed as follows:

Date Code: CW YY SW HW

Legend:	Example: 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 components bear a unique serial number.

Fig. 6: Date Code and serial number

5   Transport and storage

⚠ WARNING
Observe the specified environmental conditions
Ensure that the digital TwinSAFE components are only transported and stored under the specified ambient conditions. The ambient conditions can be found in the chapter Environmental conditions.
The TwinSAFE components can be damaged if they are transported or stored incorrectly.

Ensure that the TwinSAFE component is not damaged during transportation and storage. Use the original manufacturer's packaging.

The TwinSAFE components can be stored for shorter or longer periods. Observe the conditions specified in chapter Environmental conditions.

● **Check the seal for damage**

ℹ Check the barcode sticker used to seal the outer packaging for damage. If the sticker is missing, opened or damaged, contact Beckhoff Support and Service.

6   Installation

6.1   Safety instructions

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

6.2   Mechanical installation

⚠ WARNING
Only work in a de-energized state
The bus terminal system is under tension. Bring the bus terminal system into a safe, de-energized state before starting installation, disassembly or wiring of the TwinSAFE component.
Failure to do so may result in injury from electric shock. Damage and malfunctions to the product may also result.

	Use a suitable control cabinet
i	For operation, the TwinSAFE component must be installed in a control cabinet or terminal box with IP54 protection rating according to IEC 60529 as a minimum.

6.2.1   ESD protection

⚠ WARNING
Prevent electrostatic charging
Comply with the following instructions.
The devices contain electrostatically sensitive components which can be damaged by improper handling.
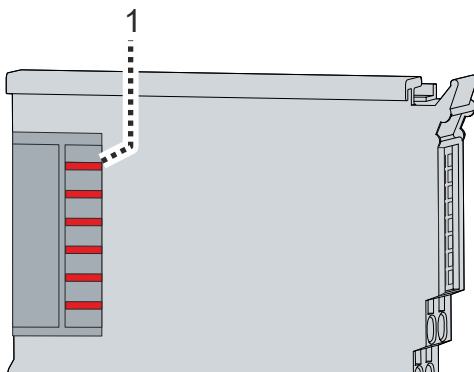
Fig. 7: Spring contacts

- They must be electrostatically discharged when handling the components.
- Avoid direct contact with the spring contacts on both sides [1]. See the figure.
- Avoid contact with highly insulating materials such as synthetic fibers or plastic films.
- When handling the components, ensure that the surroundings are well earthed. This includes the workplace, packaging and people.
- Terminate each bus station on the right-hand side with the end cap EL9011 or EL9012 to ensure the protection rating and ESD protection.

6.2.2   Installation position

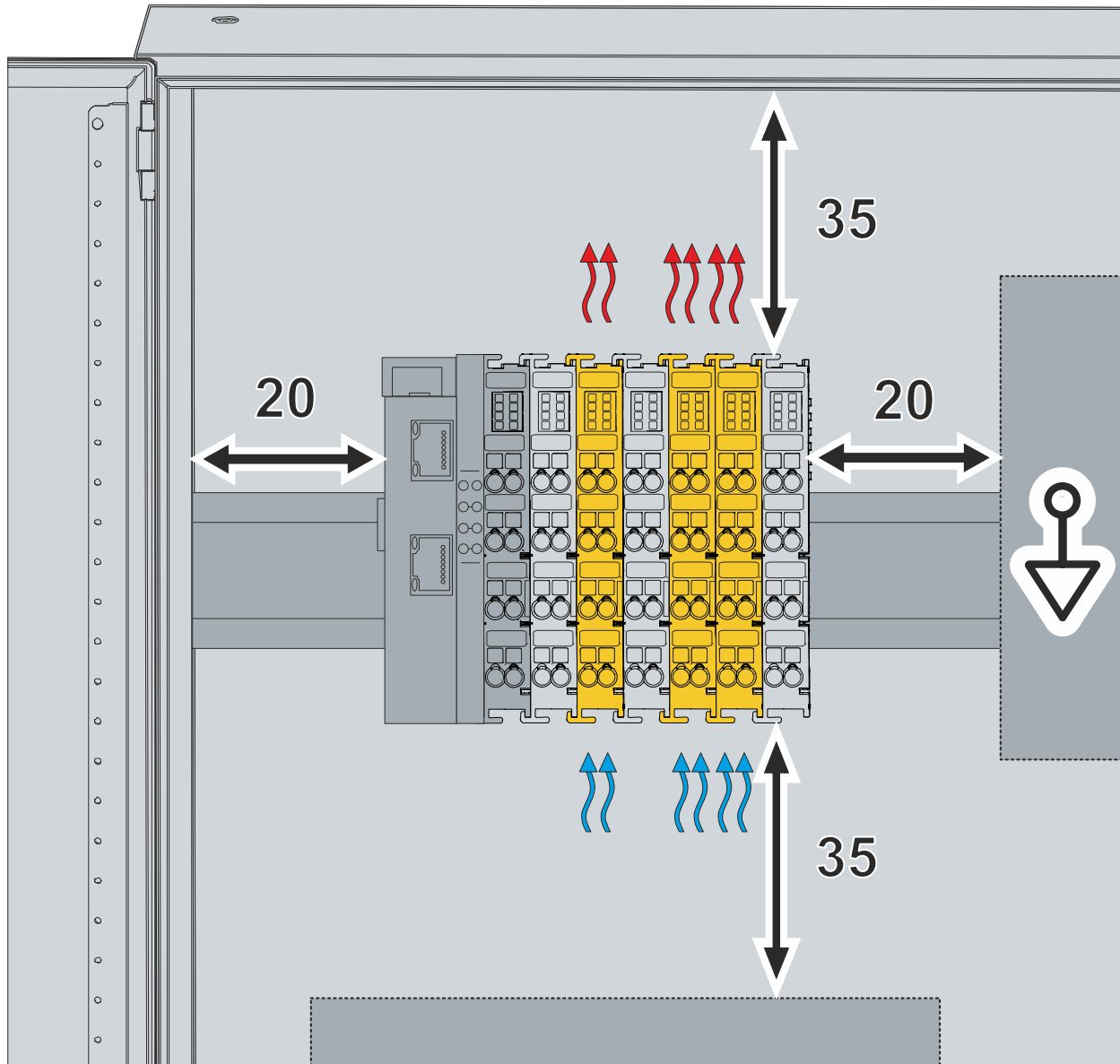| NOTICE |
|---|
| **Maintain minimum distances** |
| Observe the distances to neighboring devices and control cabinet walls shown in the figure. This ensures optimum convection cooling. |
| *If not observed, the TwinSAFE component may overheat. Shutdown of the TwinSAFE component and low availability are the result.* |

Fig. 8: Installation position

• All figures in millimeters

Mount the mounting rail horizontally for the prescribed installation position. The connection surfaces of the EL terminals or KL terminals must point to the front. This can be seen in the figure below.

The TwinSAFE components are ventilated from below, which enables optimum cooling of the electronics through convection. The direction indication "down" corresponds to the direction of positive acceleration of gravity.

6.2.3   Arrangement instructions

The more components are plugged behind the EK11xx EtherCAT Coupler or the EL9410 Power Supply Terminal, the higher the E-bus current that the power supply units must provide. With increasing current the waste heat from the power supply units also increases.

The following notes show thermally good and thermally bad arrangements of the TwinSAFE components.

Components with higher waste heat are marked with a red symbol �})) . Components with lower waste heat are marked with a blue symbol 〚)) .

6.2.3.1   Thermally good

This arrangement is thermally well designed.

Between the EtherCAT Coupler, the power supply terminal and terminals with higher waste heat, there are terminals with lower current consumption and therefore lower waste heat.

EK1100
2A E-Bus

EL9410
2A E-Bus
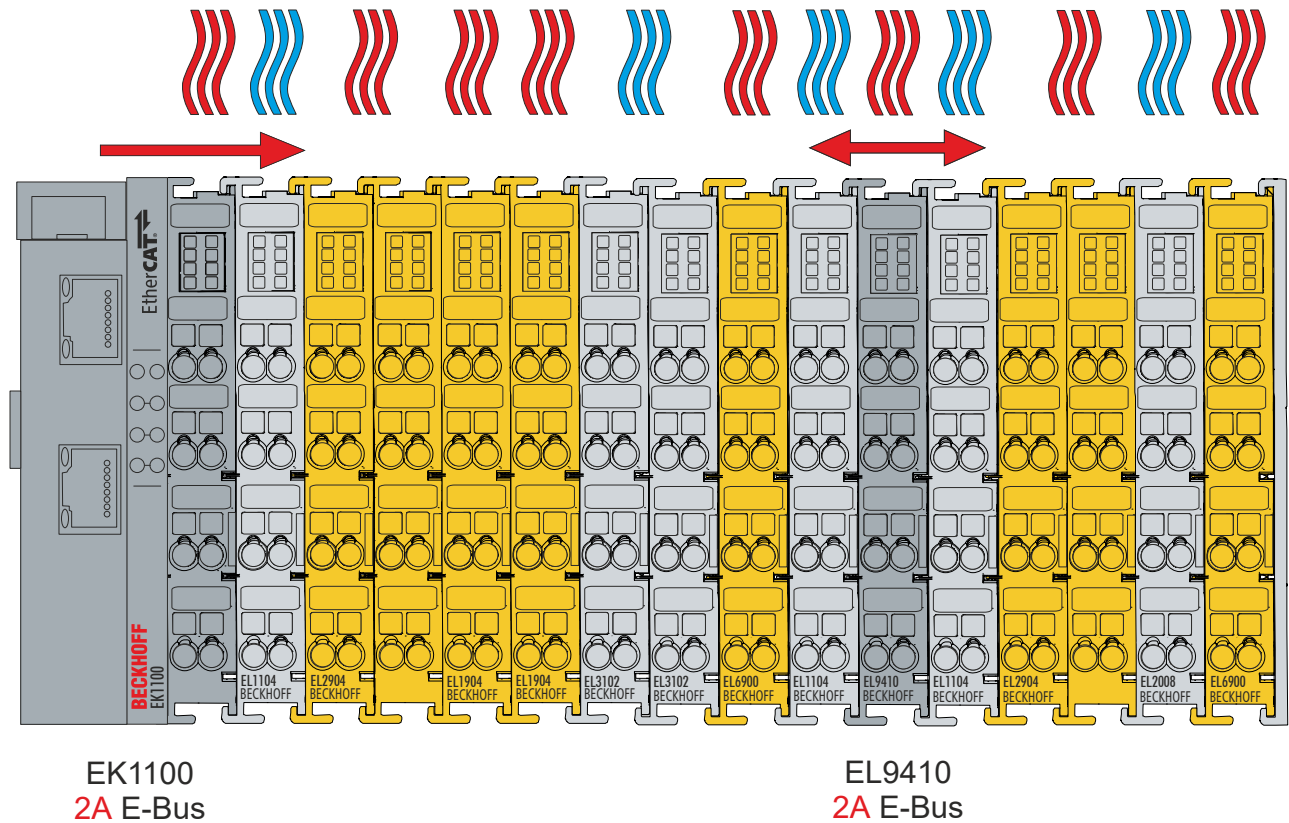
Fig. 9: Thermally good arrangement

6.2.3.2 Thermally poor

This arrangement is rather bad.

Terminals with a higher waste heat are located directly next to the EtherCAT Coupler or the power supply terminal with a high E-bus load.

The additional external heating of the TwinSAFE Terminals by the adjacent power supply units increases the internal terminal temperature. This can lead to the maximum permissible temperature being exceeded. The diagnostic message "Overtemperature" appears.
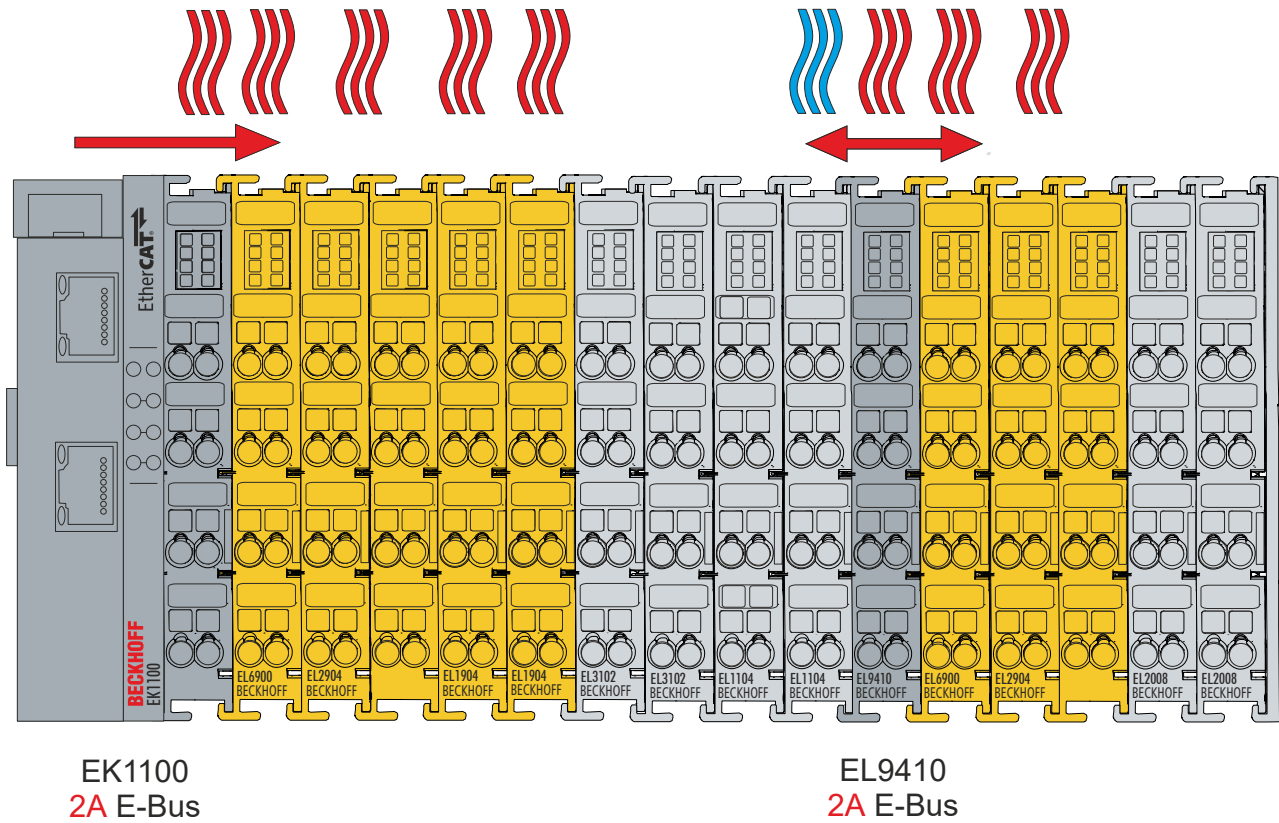

EK1100
2A E-Bus

EL9410
2A E-Bus

Fig. 10: Thermally poor arrangement

6.2.3.3 Sample configuration for temperature measurement

NOTICE
Ensure adequate convection
The maximum permissible ambient temperature of 55 °C has been tested with the example configuration described in these operating instructions.
Disturbed convection or an unfavorable position at heat sources can have a negative effect on the internal heating of the TwinSAFE component and damage the component. *The key parameter is always the maximum permitted internally measured temperature of 95 °C, above which the TwinSAFE terminals switch to safe state and report an error. The internal temperature can be read from the TwinSAFE components via CoE. See the chapter* Diagnosis.

i **Switching the TwinSAFE component to global shutdown**

From an internally measured temperature above the switch-off temperature, the TwinSAFE component automatically switches to the safe state "Global Shutdown" and reports an error.

The switch-off temperature can be found in the chapter . For more information on the global shutdown, see chapter .

You can read out the internal temperature via CoE.

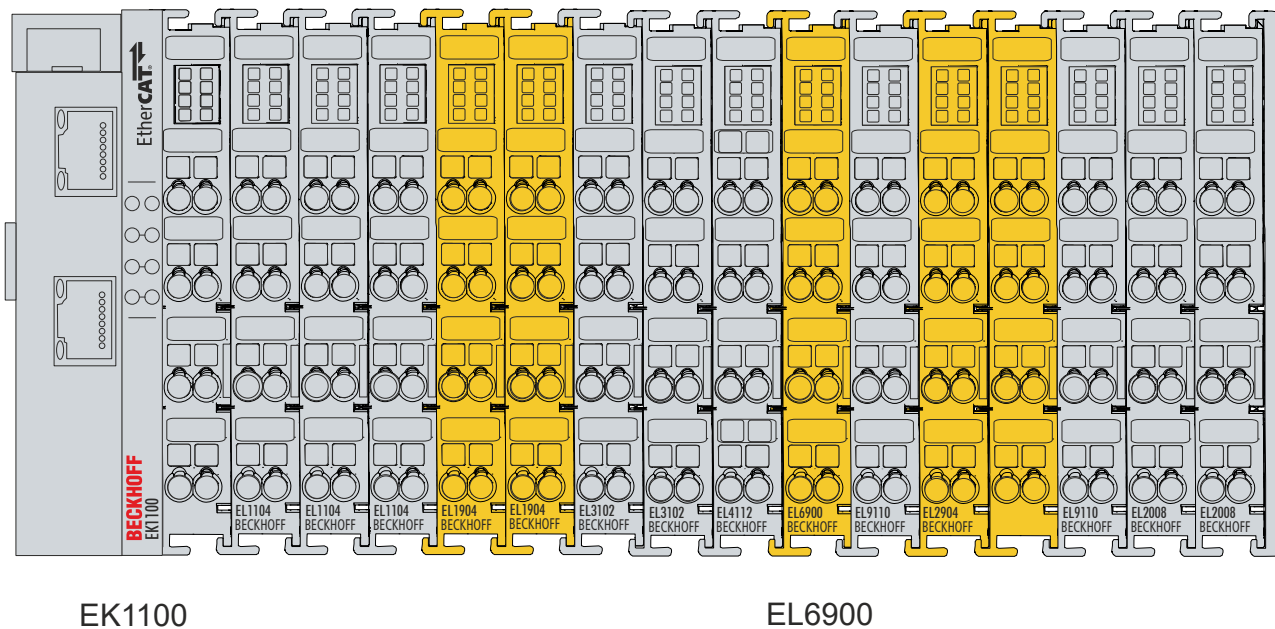EK1100   EL6900

Fig. 11: Example configuration for temperature measurement

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

6.2.4 Mounting

NOTICE
Material damage due to improper installation
Pressing on the LED strip can damage the TwinSAFE component and impair the function of the LEDs.
• Do not press on the LED strip when pushing the TwinSAFE component against the mounting rail. Instead, grasp the TwinSAFE component at the top and bottom edge or at the height of the orange tab to slide it onto the mounting rail.

i **Ensure a functional component connection**

Observe the assembly sequence described. First connect adjacent TwinSAFE components together using tongue and groove. Only slide the TwinSAFE component onto the mounting rail after it has been plugged together.

If the tongue and groove do not interlock, a functional connection will not be established. When correctly assembled, no significant gap should be visible between the housings.

Use suitable mounting rail fastening

The locking mechanism of the TwinSAFE components 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 TwinSAFE components, use flat fastening components such as countersunk head screws or blind rivets.

The TwinSAFE components are clamped onto standard 35 mm mounting rails by applying light pressure. The mounting rails are DIN rails in accordance with EN 60715.
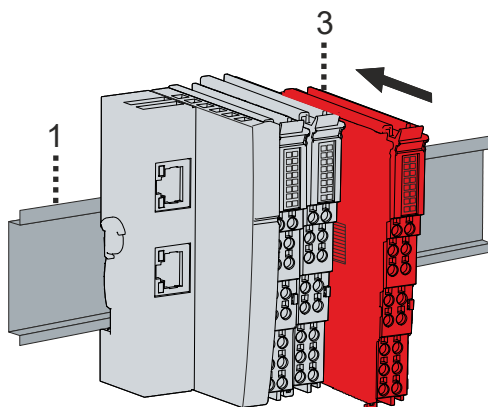
Install the TwinSAFE components as follows:
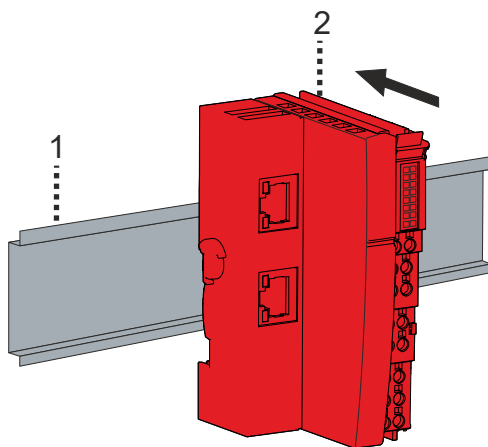
1. Plug the EtherCAT Coupler [2] onto the mounting rail [1]
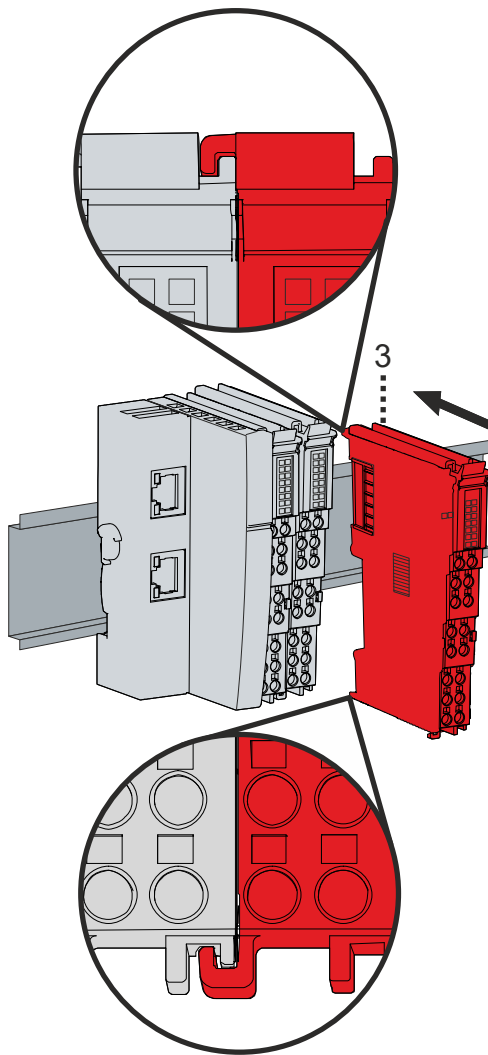
2. Push the TwinSAFE Terminal [3] together with the adjacent component with tongue and groove

3. Push the TwinSAFE Terminal [3] against the mounting rail [1] until the locking mechanism audibly engages on the mounting rail

6.3   Electrical installation

6.3.1   Overvoltage protection

Provide a surge filter against overvoltage for the supply voltage of the bus terminal block and the TwinSAFE components if protection against overvoltage is required in your system.
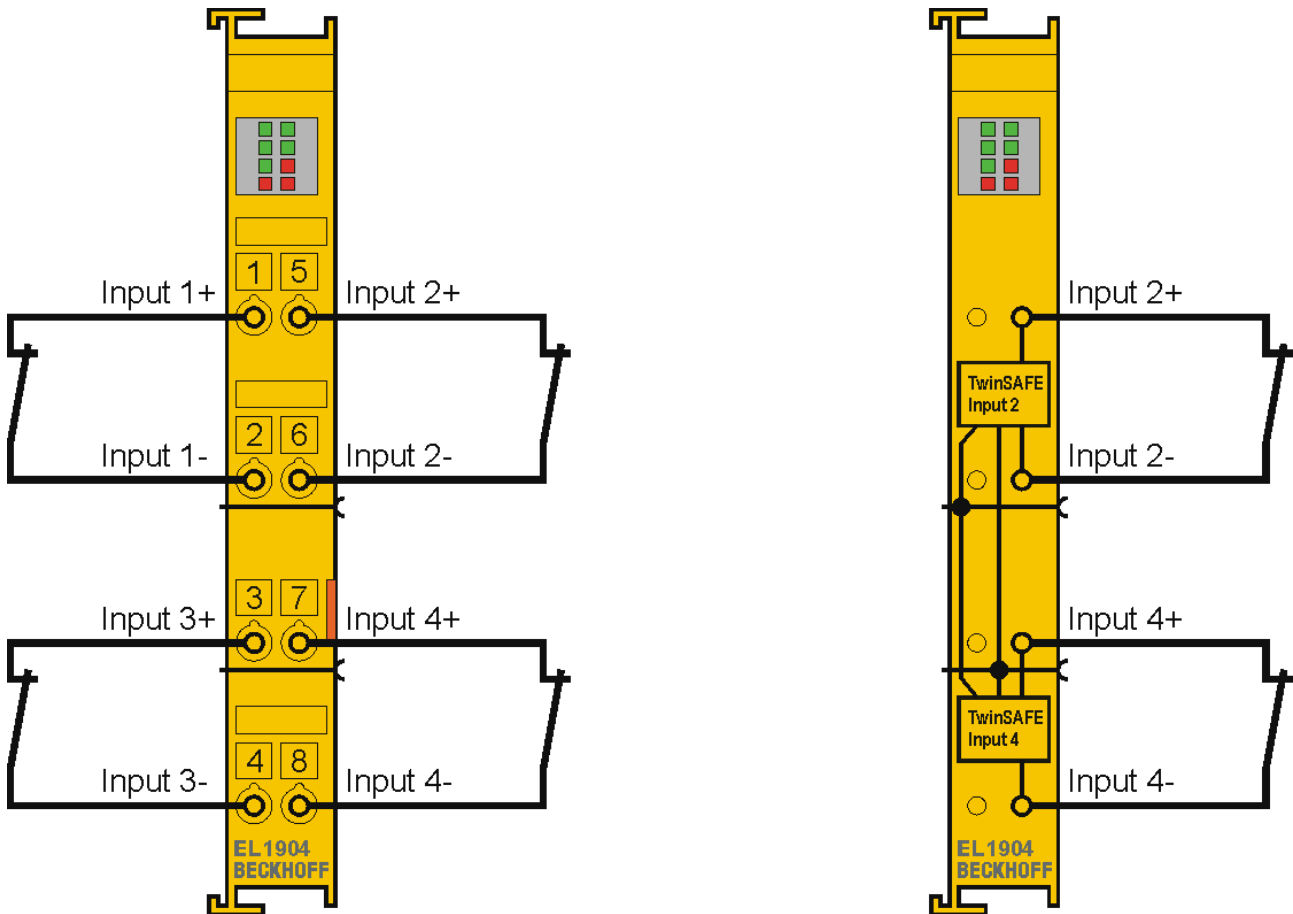
6.3.2   EL1904 pin assignment

Fig. 12: EL1904 pin assignment

Terminal point	Input	Signal
1	1	Input 1+
2		Input 1-
3	3	Input 3+
4		Input 3-
5	2	Input 2+
6		Input 2-
7	4	Input 4+
8		Input 4-

i **Configurable inputs**

The inputs 1 to 4 can be occupied as you want with normally closed contacts or normally open contacts. The corresponding analysis is carried out in the safety PLC.

6.3.3   Connecting

i **Several conductors on one connection**

If you want to connect several conductors to one connection, connect the conductors in an upstream wiring, for example with terminal blocks.

The permissible wire size width can be found in the following table.

Wire size width (single core wires)	0,08 to 2,5 mm^2
Wire size width (fine-wire conductors)	0,08 to 2,5 mm^2

| Wire size width (conductors with a wire end sleeve)	0,14 to 1,5 mm^2
Wire stripping length	8 to 9 mm

6.3.3.1 Conductor with ferrule

Solid and fine-stranded conductors with ferrules can be inserted directly into the terminal point without actuation. For all other ladder types, follow the instructions in the following chapter.

6.3.3.2 Other conductors

Up to 16 terminal points enable the connection of solid or fine-wire cables to the TwinSAFE component. The terminal points are spring-loaded.

Connect the conductors as follows:
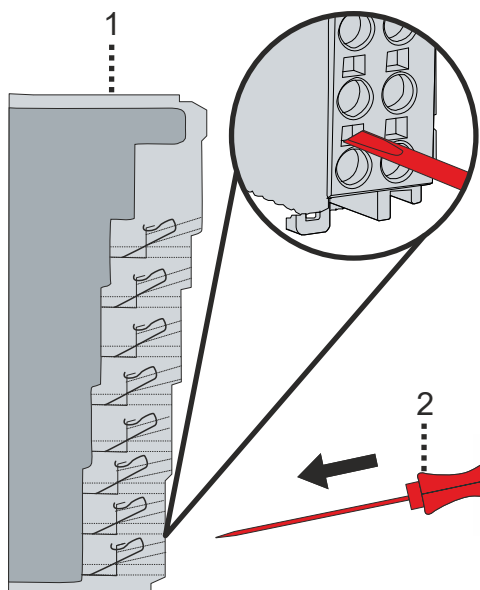
1. Push the screwdriver [2] straight into the square opening above the terminal point of the terminal [1] as far as it will go

Do not turn, move back and forth or lever the screwdriver. The terminal point opens.
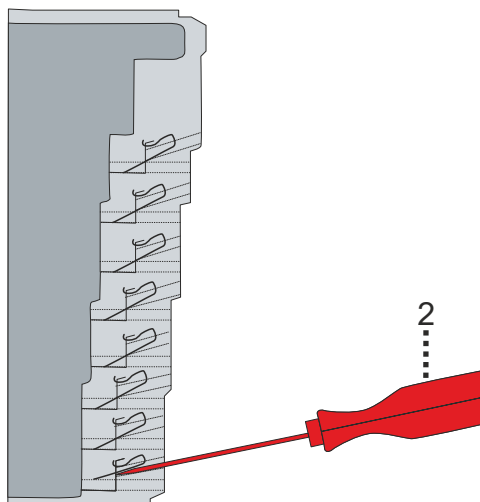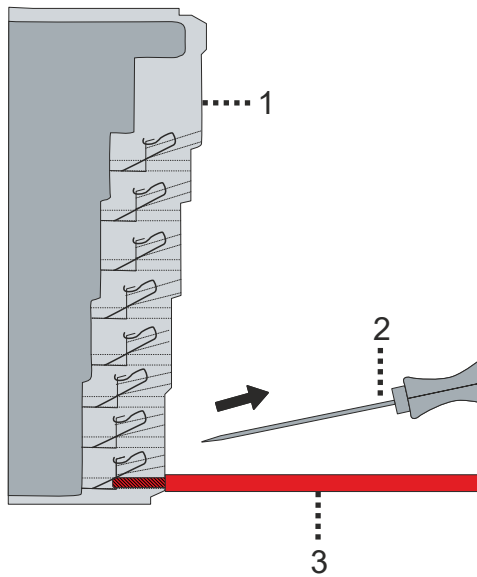
2. Keep screwdriver [2] pressed
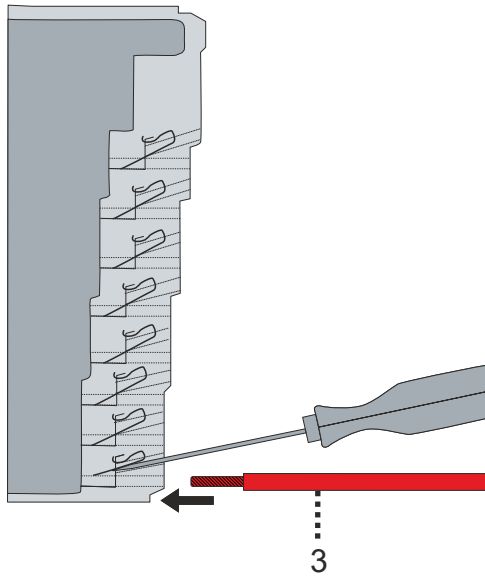
3. Insert the wire [3] into the round terminal opening

4. Pull the screwdriver [2] out of the opening

The terminal [1] closes automatically when the pressure is released. The wire [3] is held securely and permanently.

The permissible conductor cross-section can be found in the technical data.

6.3.4   Connections

The electrical connections between the TwinSAFE components are realized automatically by plugging the components together.
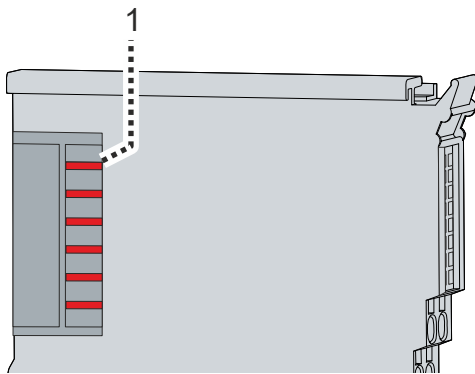
6.3.4.1   Spring contacts of the E-bus

| *NOTICE* |
|---|
| **Observe the E-bus current** |
| Observe the maximum current that your EtherCAT Coupler can supply to the E-bus. Use the EL9410 Power Supply Terminal if the current consumption of your TwinSAFE Terminals exceeds the maximum current that your EtherCAT coupler can supply for the E-bus supply. |
| *Failure to do so may result in product damage.* |

The 6 spring contacts [1] of the E-bus deal with the transfer of the data and the supply of the bus terminal electronics.
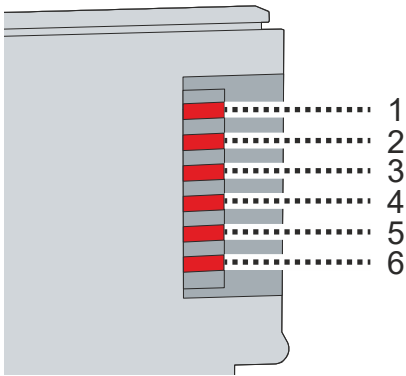
6.3.4.1.1   E-bus cables

Input side
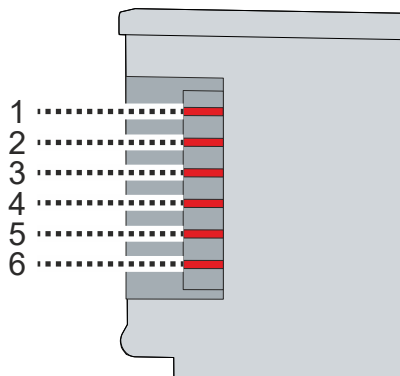
| Key	
1	+5VDC supply voltage of the E-bus
2	0 VDC ground of the E-bus supply voltage
3	Receive line RX +
4	Receive line RX -
5	Transmission line TX +
6	Transmission line TX -

Output side

Key	
1	+5VDC supply voltage of the E-bus
2	0 VDC ground of the E-bus supply voltage
3	Transmission line TX +
4	Transmission line TX -
5	Receive line RX +
6	Receive line RX -

6.3.4.2   Power contacts

i **Note the connection of the power contacts**

During the design of a bus terminal block, note the contact assignments of the individual TwinSAFE components, as some components do not loop through the power contacts or do not loop them through completely. This can be the case with analog bus terminals or digital 4-channel bus terminals, for example.

Power feed terminals interrupt the power contacts and thus represent the start of a new supply rail. Possible Power Supply Terminals are the EL91xx and the EL92xx.
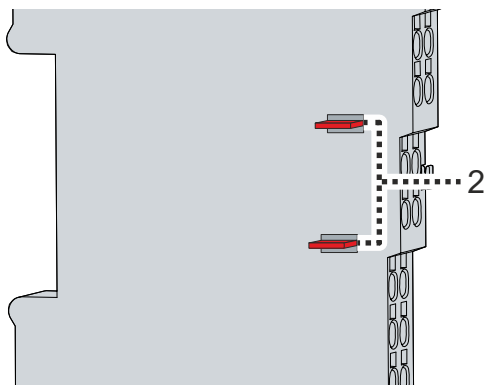
The power contacts [2] deal with the supply for the field electronics and thus represent a supply rail within the bus terminal block. The power contacts are supplied via terminals on the EtherCAT Coupler.

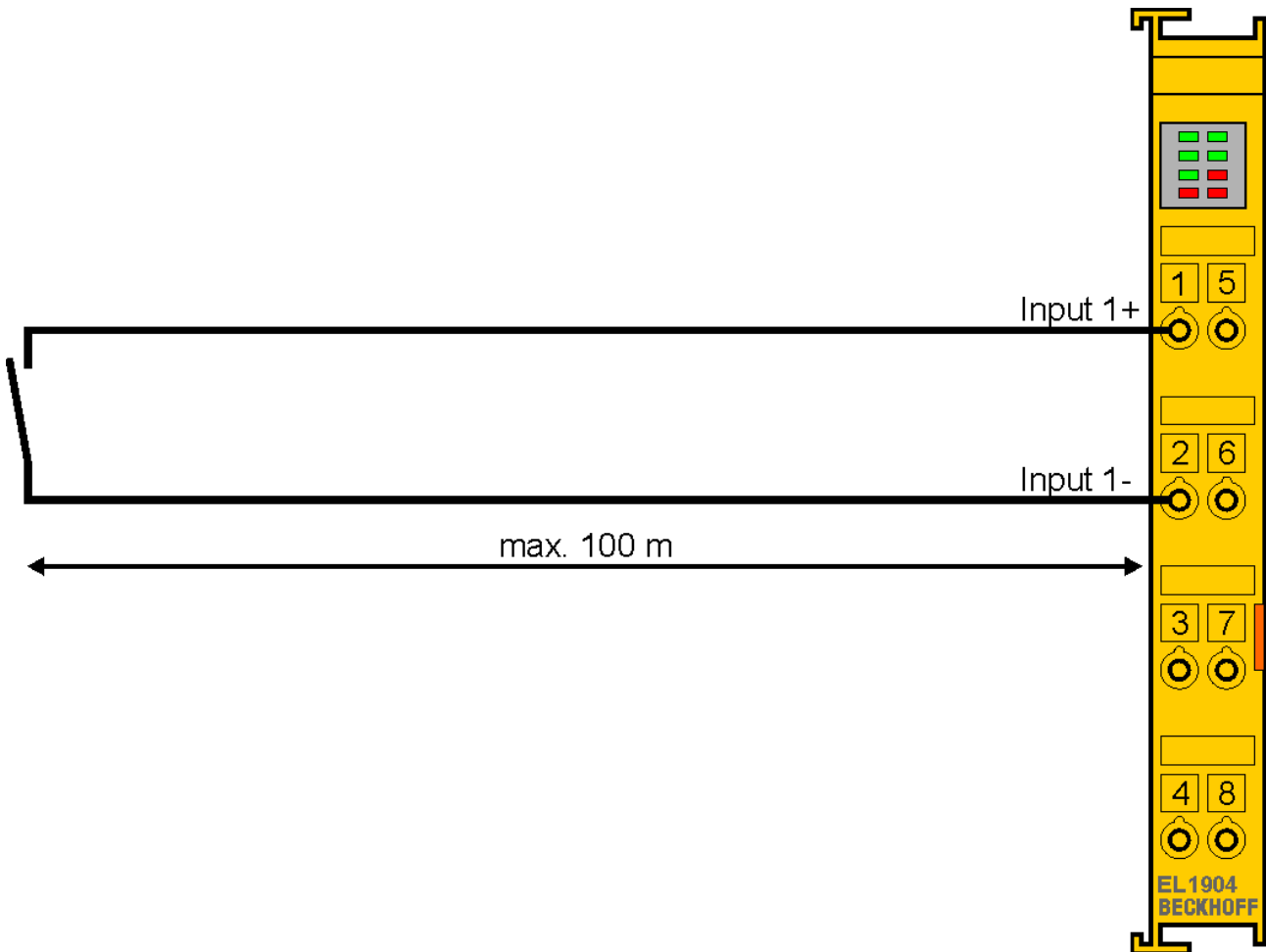## 6.3.5 Signal cables

Permitted cable length

Fig. 13: Permitted cable length

When connecting a single switching contact via its own continuous cabling (or via a non-metallic sheathed cable), the maximum permitted cable length is 100 m.

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

The test pulses can be switched off (*sensor test* parameter) if the connection of a common cable is unavoidable. However, this then leads to a reduction in the degree of diagnostic cover when calculating the performance level.

Test pulses

The typical length of a test pulse (switching from 24 V to 0 V and back to 24 V) is 350 µs and takes place approx. 250 times per second.

The test pulses at the **outputs** Input 1+ to Input 4+ are generated separately for each channel in order to be able to detect cross-circuits between the individual channels of a terminal and also between channels of different terminals. In order to generate test pulses as shown in the diagram, the *sensor test active* safety parameter must be set to true for the respective channels. The test cycle for all four channels is typically 4 ms. The times between the test pulses of different channels vary, thus allowing better diagnostic detection.
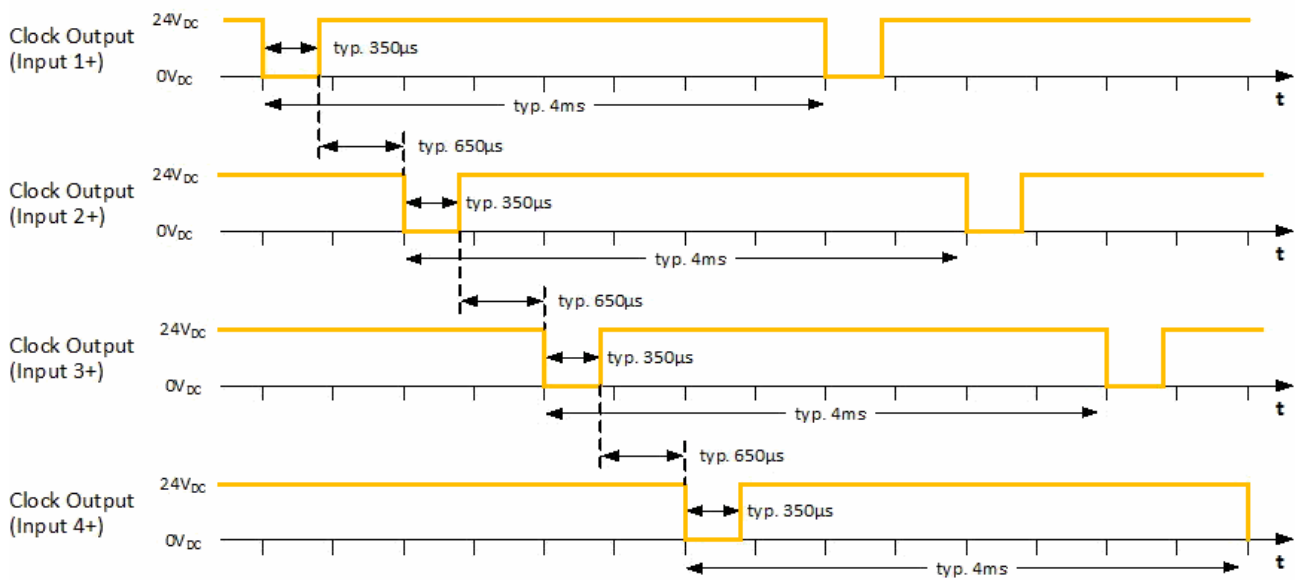
Fig. 14: Typical course of test pulses of the inputs

If self-testing sensors are to be used on the safe inputs, please refer to chapter Configuration for light barriers, light grids, light curtains etc [▶ 55].

6.4 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 response time

The typical response time is the time required for transferring a piece of information from the sensor to the actuator, when the whole system operates normally, without error.
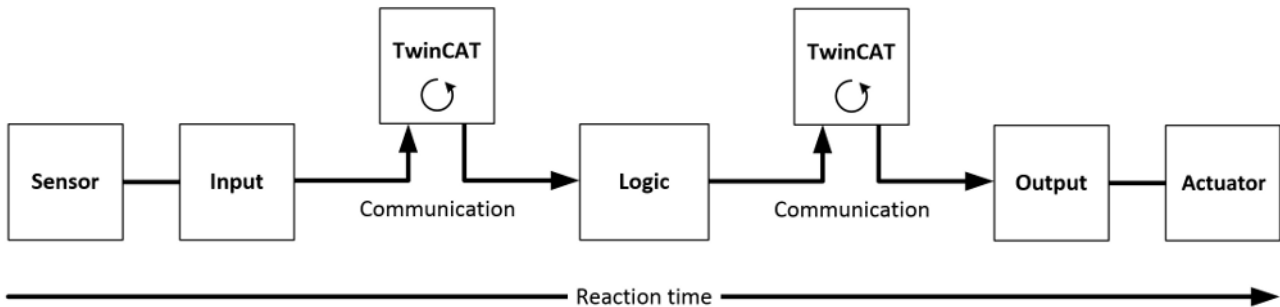

Fig. 15: Typical response time

Definition	Description
RT$_{Sensor}$	Response time of the sensor, until the signal is made available at the interface. Typically provided by the sensor manufacturer.
RT$_{Input}$	Response time of the safe input, e.g. EL1904 or EP1908. This time can be found in the technical data. In the case of the EL1904 it is 4 ms.
RT$_{Comm}$	Response time of the communication. This is typically 3 times the EtherCAT cycle time, since a new Safety-over-EtherCAT telegram has to be generated before new data can be sent. These times depend directly on the higher-level standard controller (cycle time of the PLC/NC).
RT$_{Logic}$	Response 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.
RT$_{Output}$	Response time of the output terminal. This is typically between 2 and 3 ms.
RT$_{Actuator}$	Response time of the actuator. This information is typically provided by the actuator manufacturer
WD$_{Comm}$	Watchdog time of the communication

The typical response time is based on the following formula:

$$ReactionTime_{typ} = RT_{Sensor} + RT_{Input} + 3*RT_{Comm} + RT_{Logic} + 3*RT_{Comm} + RT_{Output} + RT_{Actuator}$$

with

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

Worst case response time

The worst-case response time is the maximum time required for switching off the actuator in the event of an error.
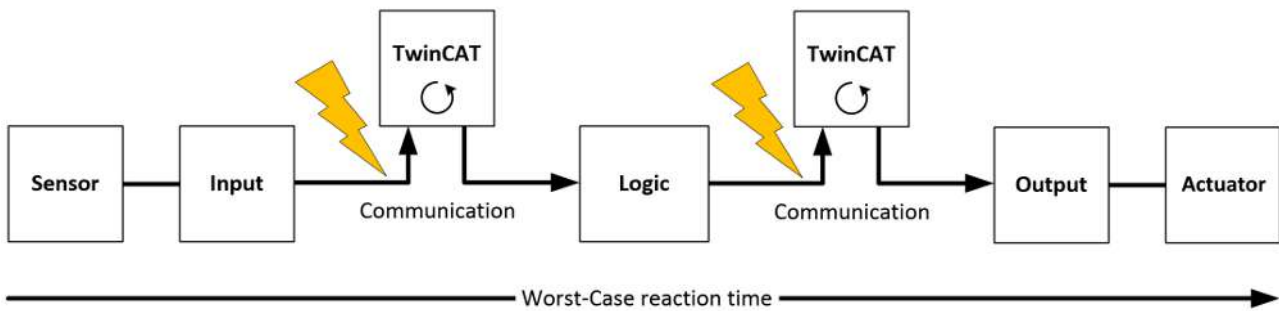
Fig. 16: Worst case response time

It is assumed that a signal change takes place at the sensor, and that this is passed to the input. A communication error occurs just at the moment when the signal is to be passed to the communication interface. This is detected by the logic once the watchdog time of the communication link has elapsed. This information should then be passed on to the output, resulting in a further communication error. This fault is detected at the output once the watchdog time has elapsed, resulting in shutdown.

This results in the following formula for the worst-case response time:

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

with

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

6.5   Tested EL1904 devices

The following list contains devices that were tested together with the EL1904 TwinSAFE terminal. The results only apply for the current device hardware version at the time of testing. The tests were carried out in a laboratory environment. Modifications of these products cannot be considered here. If you are unsure please test the hardware together with the TwinSAFE terminal.

Manufacturer	Type	Comment
SICK	C4000	Safety light curtain
SICK	S3000	Safety laser scanner
Wenglor	SG2-14ISO45C1	Safety light grids
Leuze	lumiflex ROBUST 42/43/44	Safety light barriers
Schmersal	BNS250-11ZG	Safety switch
ifm	GM701S	Inductive safety sensor
Keyence	SL-V (with PNP cable set)	Safety light curtain

The tests were carried out as function tests only. The information provided in the respective manufacturer documentation remains valid.

7   Operation

7.1   Environmental conditions

Ensure that the TwinSAFE components are only transported, stored and operated under the specified conditions according to the 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[1]
• in an environment that leads to unacceptable soiling of the TwinSAFE component

[1] *A corrosive environment exists when corrosion damage becomes apparent.*

NOTICE
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.

7.2   Operation in potentially explosive atmospheres (ATEX)

7.2.1   Special conditions

⚠ WARNING
Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas (directive 94/9/EU)!
The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60529! The environmental conditions during use are thereby to be taken into account!
If the temperatures during rated operation are higher than 70 °C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
Observe the permissible ambient temperature range of 0 to 55 °C when using Beckhoff fieldbus components in potentially explosive atmospheres!
Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
The fuses of the EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

  • EN 60079-0: 2006

- EN 60079-15: 2005

7.2.2 Identification

Beckhoff fieldbus components that are certified for use in potentially explosive atmospheres bear one of the following markings:

II 3 G Ex nA IIC T4 Gc KEMA 10ATEX0075 X
Ta: 0 … 55 °C

or

II 3 G Ex nA nC IIC T4 Gc KEMA 10ATEX0075 X
Ta: 0 … 55 °C

7.2.3 Further ATEX documentation

ℹ **Please also refer to the further documentation**

Notes regarding application of the Bus Terminal system in areas potentially explosive atmosphere are available in the <u>Download</u> section of the Beckhoff website at <u>http://www.beckhoff.de</u>.

7.3 Configuration of the terminal in TwinCAT

ℹ **Identical configuration**

The configuration of the terminal in TwinCAT is identical for the variant.

⚠ **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!

7.3.1 Inserting a Bus Coupler

See TwinCAT automation software documentation.

7.3.2 Inserting a Bus Terminal

See TwinCAT automation software documentation.

7.3.3 Inserting an EL1904

An EL1904 is inserted in the same way as any other Beckhoff Bus Terminal. In the list open *Safety Terminals (ELx9xx)* and select the EL1904.
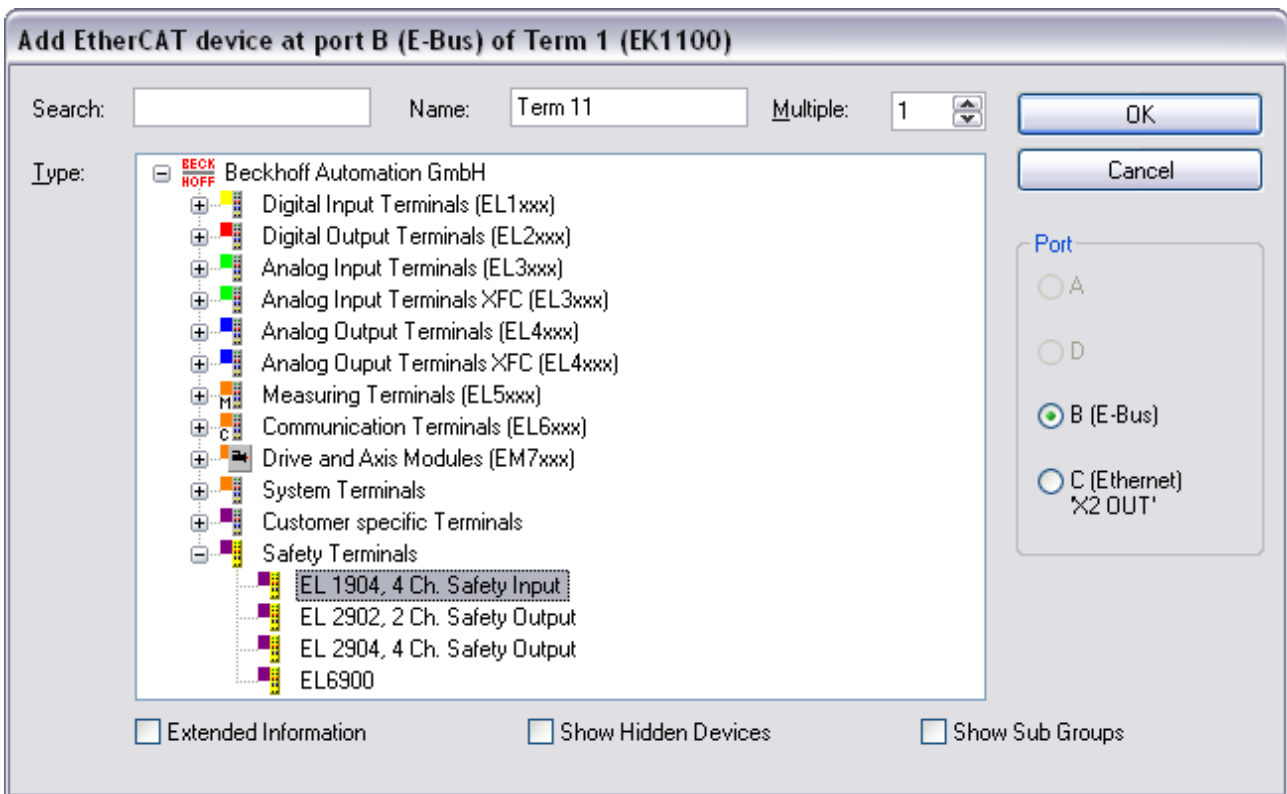
Fig. 17: Inserting an EL1904

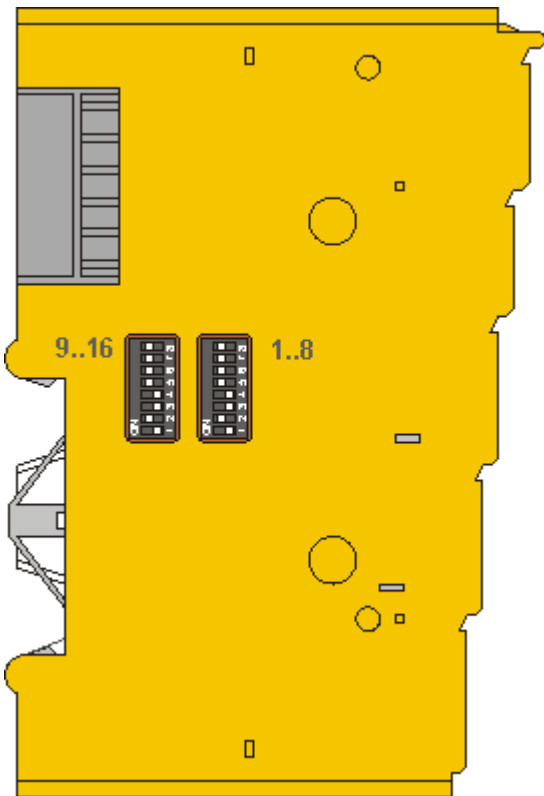## 7.3.4 Address settings on TwinSAFE terminals with 65535 possible addresses

Fig. 18: Address settings on TwinSAFE terminals with 65535 possible addresses

Set the TwinSAFE address for the terminal using the two dip switches (with 8 setting options) on the left-hand side of the EL1904 TwinSAFE terminal. TwinSAFE addresses between 1 and 65535 are available.

DIP switches																Ad-dress
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1
OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	4
ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	5
OFF	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	6
ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	7
OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	8
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	65535

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

7.3.5   Entering a TwinSAFE address and parameters in the System Manager

The TwinSAFE address set at the DIP switch must also be entered in tab *FSoE* (under *FSoE address*) under the EL1904.
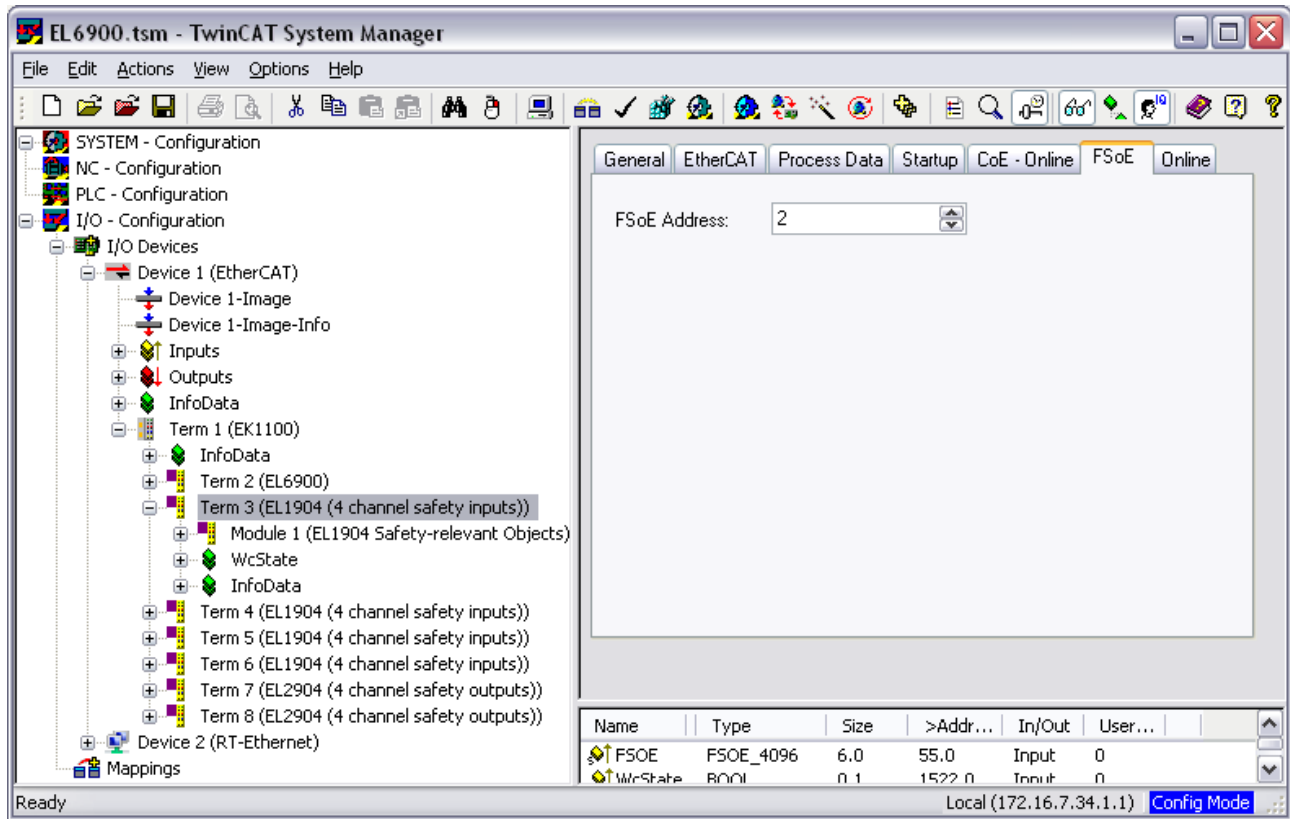

Fig. 19: Entering the FSoE address

The EL1904 parameters are set under the respective TwinSAFE connection in the Connection and Parameter tabs.
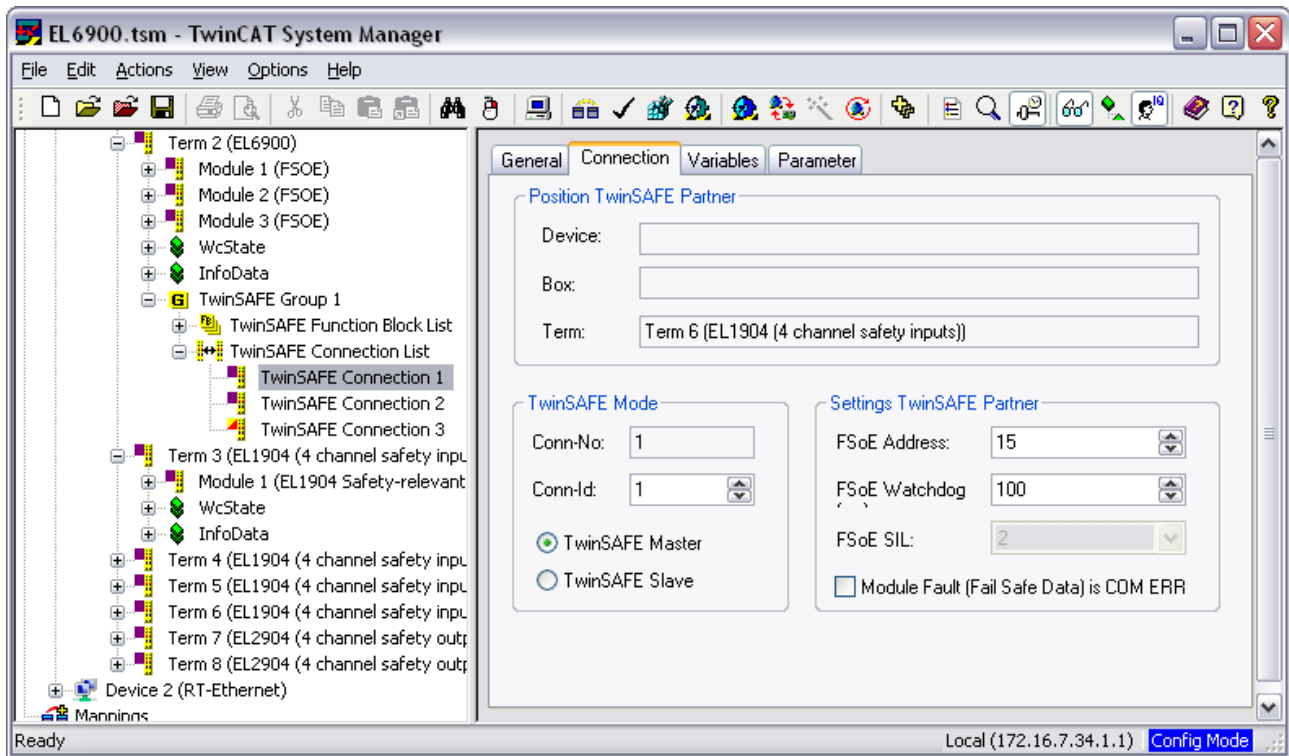
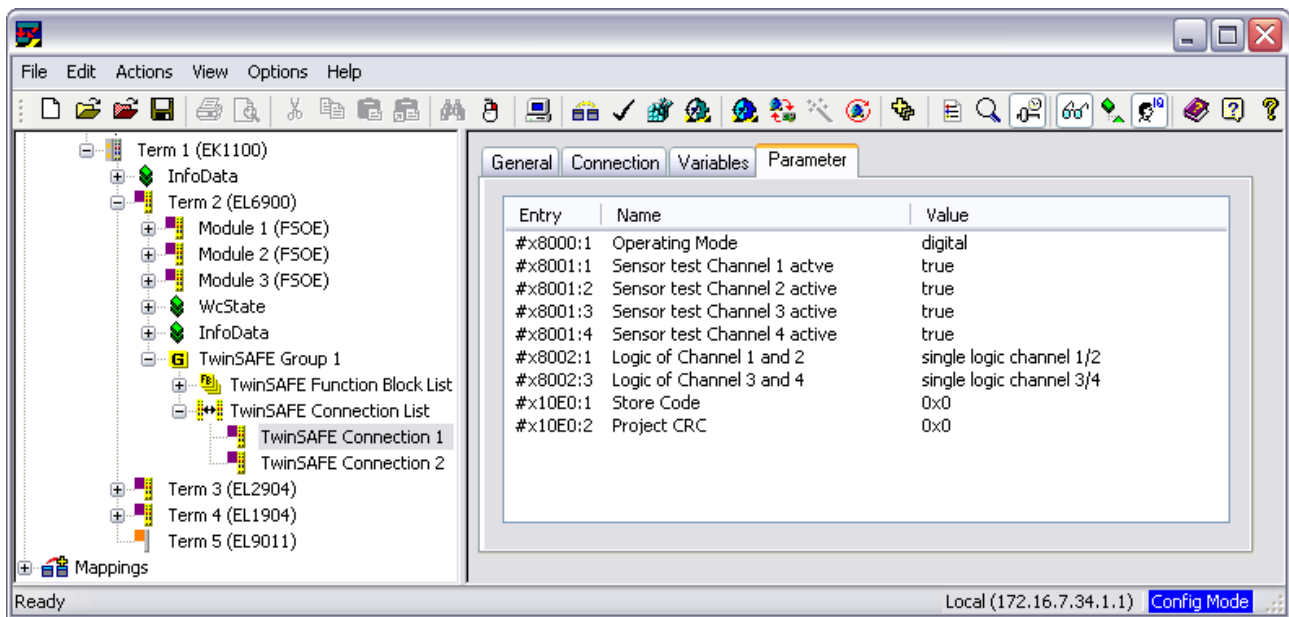Fig. 20: Setting the connection of the TwinSAFE connection

Fig. 21: Setting the parameters of the TwinSAFE connection

Parameter overview

PrmName	Meaning	Values
FSoE_Address	DIP switch address	1 to 65535
Operating Mode	Digital / standstill monitoring 1 and 2	Digital / standstill 1 and 2 (Standstill monitoring is not supported)
Sensor test channel 1 active	The clock signal for connection Input1+ is checked at connection Input1-.	true / false
Sensor test channel 2 active	The clock signal for connection Input2+ is checked at connection Input2-.	true / false

PrmName	Meaning	Values
Sensor test channel 3 active	The clock signal for connection Input3+ is checked at connection Input3-.	true / false
Sensor test channel 4 active	The clock signal for connection Input4+ is checked at connection Input4-.	true / false
Logic channel 1 and 2	Logic of channels 1 and 2	• single logic • asynchronous repetition OSSD (sensor test must be switched off) • any pulse repetition OSSD (sensor test must be switched off) • short cut is no module fault
Logic channel 3 and 4	Logic of channels 3 and 4	• single logic • asynchronous repetition OSSD (sensor test must be switched off) • any pulse repetition OSSD (sensor test must be switched off) • short cut is no module fault
Store Code	This parameter is required for the TwinSAFE Restore Mode	0x0000
Project CRC	This parameter is required for the TwinSAFE Restore Mode	0x0000

7.3.5.1 EL1904 configuration for light barriers, light grids, light curtains etc.

The EL1904 also supports direct connection of contact-free protective devices with two self-testing outputs such as light barriers, light grids, light curtains, laser scanners, etc.

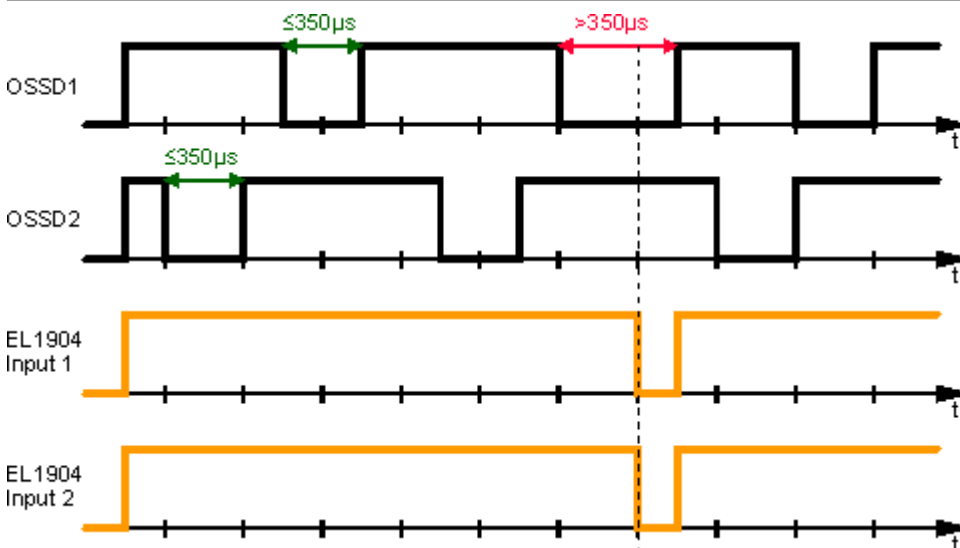| ⚠ CAUTION |
|---|
| **Sensors with self-testing outputs!**
Only sensors with self-testing outputs and a maximum sensor self-test duration of 350 µs may be connected to the EL1904 (see illustration below). |

Fig. 22: Maximum permissible sensor self-test duration of 350 µs

Parameter

To connect these sensors please set the following parameters for the EL1904 in the TwinCAT System Manager:

Connect the two sensor signals either to channels 1 and 2 or channels 3 and 4 and activate *asynchronous repetition OSSD* or *any pulse repetition* for the two inputs used under parameter *Logic for channel x and y*. The difference between these settings is that with *any pulse repetition* simultaneous tests of the OSSD signals up to 350 µs are allowed.

For the two inputs used set the sensor test for the EL1904 to *false*.

7.3.5.2 Configuration of the EL1904 for safety switching mats

The EL1904 also supports direct connection of safety switching mats.

Parameter

To connect these switching mats please set the following parameters for the EL1904 in the TwinCAT System Manager:

Connect the two sensor signals either to channels 1 and 2 or channels 3 and 4 and activate *short cut channel x/y is no module fault* for the two inputs used under parameter *Logic for channel x and y*.

8 Diagnostics

8.1 Diagnostic LEDs

The LEDs Diag 1 to Diag 4 display diagnostic information for the EL1904.
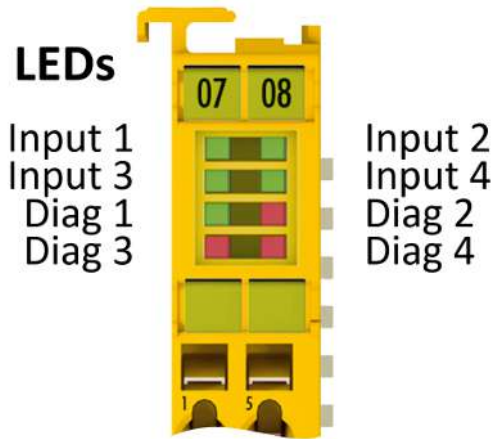
8.1.1 Diag 1 (green)

The *Diag 1* LED indicates the state of the TwinSAFE interface.

Flashing Code	Meaning
LED illuminated continuously	normal operation: TwinSAFE communication OK
rapid flickering, alternating with 1 flash pulse	Error in S parameter (Twin**S**AFE parameter)
rapid flickering, alternating with 2 flash pulses	Error in I parameter (**I**ndividual parameter)
rapid flickering, alternating with 3 flash pulses	Waiting for S and I parameter
rapid flickering, alternating with 4 flash pulses	S- and I-parameter correct: waiting for first host message
rapid flickering, alternating with 5 flash pulses	Watchdog error
rapid flickering, alternating with 6 flash pulses	CRC error
rapid flickering, alternating with 7 flash pulses	Sequence number error
rapid flickering, alternating with 8 flash pulses	Communication error in the TwinSAFE protocol

8.1.2 Diag 2 (red)

The *Diag 2* LED illuminates red if the terminal detects an external supply or cross-circuit. The LED extinguishes once the error is rectified.

8.1.3 Diag 3 (red) and Diag 4 (red)

If the Diag 3 LED is lit, the Diag 4 LED indicates internal terminal errors.

Flashing Codes

In the case of such an error, the *Diag 4* LED on the EL1904 displays flashing codes that describe the error in more detail.

A flashing code consists of four sequences, which are interrupted in each case by a short break. After the four sequences there is a long break, following which the flashing code is displayed again.

Count the individual sequences of the flashing code.

The errors indicated by the following flashing codes are reversible. After successful troubleshooting the terminal can be restarted.

Diag 3 LED	Diag 4 LED			
	Flashing Code	**Meaning**	**Remedy**	
lit	6-1-1-1	max. internal temperature exceeded	Ensure that the permissible ambient temperature is adhered to.	
	7-1-1-1	internal temperature below min. value		
	2-1-2-1	max. supply voltage µC1 exceeded	Check the supply voltage.	
	3-1-2-1	max. supply voltage µC2 exceeded		
	4-1-2-1	voltage fell below min. supply voltage µC1		
	5-1-2-1	voltage fell below min. supply voltage µC2		
	8-1-1-1	Temperature difference between the measuring points exceeded	Check the installation position and the ambient temperature.	

If another flashing code is displayed, this means that there is an internal terminal error that has stopped the terminal. In this case the terminal must be checked by Beckhoff Automation GmbH & Co. KG.

ℹ **Note the flashing codes and return the terminal**

Note the flashing code displayed and include this information with the terminal when you return it.

8.2 Diagnostic objects

⚠ CAUTION
Do not change CoE objects!
Do not make any modifications to the CoE objects in the TwinSAFE components! Any modifications (e.g. using TwinCAT) of the CoE objects will permanently set the TwinSAFE components to the Fail-Stop state.

Index FA80$_{hex}$: Internal temperature values

The CoE object FA80$_{hex}$ indicates the current internal temperature values of the EL1904.

Index	Name	Meaning	Flags	Default
FA80:01	Temperature 1	Temperature measurement 1	RO	0_{bin}
FA80:02	Temperature 2	Temperature measurement 2	RO	0_{bin}

Index 800E$_{hex}$: diagnostic information

The CoE object 800E$_{hex}$ displays further diagnostic information.

Index	Name	Meaning			Flags	Default
800E:0	Diag	The following sub-indices contain detailed diagnostic information.			RO	
800E:0A	Sensor test error	**Bit**	Error during the sensor test		RO	
		0	1_{bin}	Error at input 1		0_{bin}
		1	1_{bin}	Error at input 2		0_{bin}
		2	1_{bin}	Error at input 3		0_{bin}
		3	1_{bin}	Error at input 4		0_{bin}

Index	Name	Meaning			Flags	Default
800E:0B	Error during two-channel evaluation	**Bit**	Error during the contiguous evaluation of two channels, i.e. the two channels contradict each other.		RO	
		0	1_{bin}	Error in the first input pair		0_{bin}
		1	1_{bin}	Error in the second input pair		0_{bin}
800E:0C	Error in the safety mat operation mode: input pair disagree	**Bits**	Error in the input pair		RO	
		1, 0	11_{bin}	Error in the first input pair		00_{bin}
		3, 2	11_{bin}	Error in the second input pair		00_{bin}
800E:0D	Error in the safety mat operation mode: external supply	**Bit**	Error in the test pulses in the safety mat operating mode; i.e. the terminal has detected an external supply.		RO	
		0	1_{bin}	Error at input 1		0_{bin}
		1	1_{bin}	Error at input 2		0_{bin}
		2	1_{bin}	Error at input 3		0_{bin}
		3	1_{bin}	Error at input 4		0_{bin}

● **Differing diagnostic messages possible**

i Due to the variable order or execution of the test series, diagnostic messages differing from those given in the table above are possible.

9 Maintenance and cleaning

ⓘ **Cleaning by the manufacturer only**

Do not operate the TwinSAFE component if it is unacceptably dirty. Refer to the technical data for the protection class.

Send unacceptably dirty TwinSAFE component to the manufacturer for cleaning.

TwinSAFE components are basically maintenance-free.

9.1 Disassembly

Each TwinSAFE component is secured by a lock on the mounting rail.
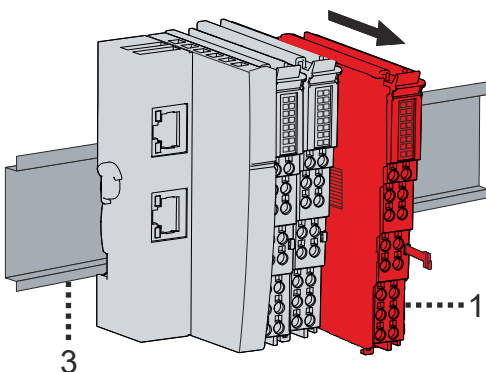
To remove the TwinSAFE component, release the lock as follows:
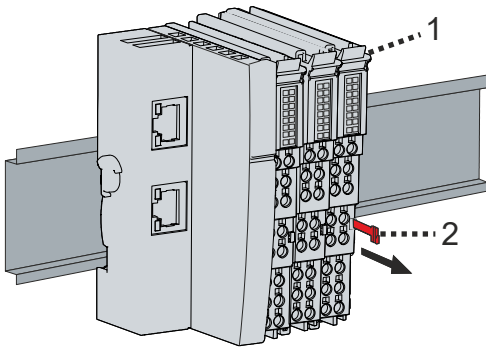
1. Pull the orange strap [2] approx. 1 cm out of the TwinSAFE component [1]

The mounting rail lock of the TwinSAFE component releases automatically.
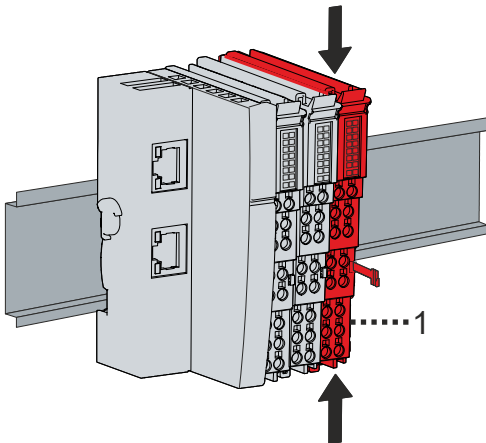
2. Use your thumb and index finger to grip the unlocked TwinSAFE component [1] simultaneously at the top and bottom of the housing surfaces

3. Pull the TwinSAFE component [1] out of the bus terminal block from the mounting rail [3] with little effort

10 Decommissioning

10.1 Disposal

NOTICE
Correct disposal
Observe the applicable national laws and guidelines for disposal.
Incorrect disposal may result in environmental damage.

Remove the TwinSAFE component for disposal.

Depending on your application and the products used, make sure that the respective components are disposed of properly:

Cast iron and metal

Hand over cast iron and metal parts to scrap metal recycling.

Cardboard, wood and polystyrene

Dispose of packaging materials made of cardboard, wood or Styrofoam in accordance with regulations.

Plastic and hard plastic

You can recycle parts made of plastic and hard plastic via the waste management center or reuse them in accordance with the component regulations and markings.

Oils and lubricants

Dispose of oils and lubricants in separate containers. Hand over containers to the waste oil collection point.

Batteries and accumulators

Batteries and accumulators may also be marked with the crossed-out wheeled garbage can symbol. You must separate these components from waste. You are legally obliged to return used batteries and accumulators within the EU. Outside the validity of the EU Directive 2006/66/EC, observe the respective regulations.

10.1.1 Returning to the vendor

In accordance with the WEEE-2012/19/EU directives, you can return used devices and accessories for professional disposal. The transport costs are borne by the sender.

Send the used devices with the note "For disposal" to:

Beckhoff Automation GmbH & Co. KG
Gebäude „Service"
Stahlstraße 31
D-33415 Verl

In addition, you have the option to contact a local certified specialist company for the disposal of used electrical and electronic appliances. Dispose of the old components in accordance with the regulations applicable in your country.

11 Appendix

11.1 Volatility

If there are requirements concerning the volatility of products in your application, for example of the U.S. Department of Defense or similar authorities or security organizations, the following process applies:

The product has both volatile and non-volatile components. Volatile components lose their data immediately after removing power. Non-volatile components keep the data even after loss of power.

If there is customer specific data saved on the product, it cannot be ensured that this data might not be restored through for example forensic measures, even after the data is deleted through the provided tool chain. If this data is confidential, the scrapping of the product after usage is recommended to protect this data.

11.2   Focus of certificates

The most decisive document for certified components of the TwinSAFE department is the EC type examination certificate. The document contains both the test coverage and the regarded component and component family.

The current certificates of all TwinSAFE components with the underlying standards and directives can be found at https://www.beckhoff.com/en-en/support/download-finder/certificates-approvals/.

If the document refers only to the first four figures of a product (ELxxxx), the certificate is valid for all available variants of the component (ELxxxx-abcd). This is applicable for all components like EtherCAT Terminals, EtherCAT Boxes, EtherCAT plug-in modules and Bus Terminals.

If you regard the example EL1918 in the picture, the certificate is valid for both the EL1918 and the available variant EL1918-2200.

11.3   Declarations of conformity and certificates

The EC Declaration of Conformity can be found at EC Declaration of Conformity.

The UKCA Declaration of Conformity can be found at (website link to UKCA Declaration of Conformity).

Further certificates can be found under EL1904 certificates.

Table of figures

More Information:
www.beckhoff.com/EL1904