

Operating instructions | EN

# EL2904

TwinSAFE Terminal with 4 digital fail-safe outputs





# Table of contents

<b>1</b>	<b>Notes on the documentation</b>	<b>5</b>
1.1	Disclaimer	5
1.1.1	Trademarks	5
1.1.2	Patents	5
1.1.3	Limitation of liability	6
1.1.4	Copyright	6
1.2	Documentation issue status	7
1.3	Staff qualification	8
1.4	Safety and instruction	9
1.4.1	Explanation of symbols	9
1.5	Beckhoff Support and Service	10
<b>2</b>	<b>For your safety</b>	<b>11</b>
2.1	Duty of care	11
2.2	Safety image signs	12
2.3	General safety instructions	13
2.3.1	Before operation	13
2.3.2	During operation	13
2.3.3	After operation	13
<b>3</b>	<b>System description</b>	<b>14</b>
3.1	The Beckhoff Bus Terminal system	14
3.1.1	Bus Coupler	15
3.1.2	Bus Terminals	16
3.1.3	E-bus	16
3.1.4	Power contacts	16
3.2	TwinSAFE	16
3.2.1	The I/O construction kit is extended safely	16
3.2.2	Safety concept	17
3.2.3	EL1904, EL2904 - Bus Terminals with 4 fail-safe inputs or outputs	18
3.2.4	EL6900 - TwinSAFE logic terminal	18
3.2.5	The fail-safe principle (Fail Stop)	18
<b>4</b>	<b>Product description</b>	<b>19</b>
4.1	EL2904 – TwinSAFE terminal with 4 digital fail-safe outputs	19
4.2	Intended use	20
4.3	Technical data	22
4.4	Safety parameters	23
4.5	Dimensions	24
4.6	Block diagram of the EL2904	25
<b>5</b>	<b>Operation</b>	<b>26</b>
5.1	Environmental conditions	26
5.2	Installation	26
5.2.1	Safety instructions	26
5.2.2	Transport / storage	26
5.2.3	Electrical installation	26

5.2.4	Mechanical installation .....	31
5.2.5	TwinSAFE reaction times .....	36
5.2.6	Tested EL2904 devices .....	37
5.3	Operation in potentially explosive atmospheres (ATEX) .....	38
5.3.1	Special conditions .....	38
5.3.2	Identification .....	38
5.3.3	Date code and serial number .....	39
5.3.4	Further ATEX documentation .....	39
5.4	Configuration of the terminal in TwinCAT .....	39
5.4.1	Inserting a Bus Coupler .....	39
5.4.2	Inserting a Bus Terminal .....	39
5.4.3	Inserting an EL2904 .....	39
5.4.4	Address settings on TwinSAFE terminals with 1023 possible addresses .....	41
5.4.5	Entering a TwinSAFE address and parameters in the System Manager .....	42
5.5	Diagnostics .....	44
5.5.1	Diagnostic LEDs .....	44
5.5.2	Diagnostic objects .....	45
5.5.3	Possible causes of diagnostic messages .....	46
<b>6</b>	<b>Service life .....</b>	<b>48</b>
<b>7</b>	<b>Maintenance and cleaning .....</b>	<b>49</b>
<b>8</b>	<b>Decommissioning .....</b>	<b>50</b>
8.1	Disposal .....	50
8.1.1	Returning to the vendor .....	50
<b>9</b>	<b>Appendix .....</b>	<b>51</b>
9.1	Volatility .....	51
9.2	Focus of certificates .....	52
9.3	Certificate .....	53

# 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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The EtherCAT technology is protected by patent rights through the following registrations and patents with corresponding applications and registrations in various other countries:

- EP1590927
- EP1789857
- EP1456722
- EP2137893
- DE102015105702



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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.

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

### 1.1.4 Copyright

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## 1.2 Documentation issue status

Version	Comment
3.1.1	<ul style="list-style-type: none"> <li>• Certificate updated</li> </ul>
3.1.0	<ul style="list-style-type: none"> <li>• In chapter <a href="#">Technical data</a> [► 22] corrosive gas test and footnote for corrosive environment added</li> </ul>
3.0.0	<ul style="list-style-type: none"> <li>• Foreword changed in <a href="#">Notes on the documentation</a> [► 5] and <a href="#">For your safety</a> [► 11]</li> <li>• In chapter <a href="#">Technical data</a> [► 22] link to download page of certificates added</li> <li>• <a href="#">Maintenance and cleaning</a> [► 49] and <a href="#">Decommissioning</a> [► 50] adapted</li> <li>• Appendix adapted and extended</li> </ul>
2.3.0	<ul style="list-style-type: none"> <li>• Specification of overvoltage category added</li> <li>• Protection class III (SELV/PELV) added</li> <li>• Device type "Open equipment" added</li> <li>• Link in chapter <a href="#">Actuality</a> updated</li> <li>• Utilization category DC-13 added</li> </ul>
2.2.0	<ul style="list-style-type: none"> <li>• Notes on heights, fuses and wiring added</li> <li>• Notes on EN 81 added</li> <li>• Notes added in section <i>Intended Use</i></li> <li>• Chapter <i>Identification (ATEX)</i> updated</li> </ul>
2.1.1	<ul style="list-style-type: none"> <li>• Technical data for <i>permissible air pressure</i> extended</li> </ul>
2.1.0	<ul style="list-style-type: none"> <li>• Chapter on <i>Address settings on TwinSAFE terminals with 1023 possible addresses</i> updated</li> <li>• Links in technical data corrected</li> </ul>
2.0.1	<ul style="list-style-type: none"> <li>• Links in the chapter <i>Diagnostic LEDs</i> corrected</li> </ul>
2.0.0	<ul style="list-style-type: none"> <li>• Migration and structural adaptation</li> <li>• Reliability document updated</li> <li>• Safety parameters updated</li> <li>• Foreword revised</li> </ul>
1.6.2	<ul style="list-style-type: none"> <li>• Block diagram updated</li> <li>• Numbering/table of contents changed</li> <li>• Description of the reaction times added</li> <li>• Reliability document updated</li> </ul>
1.6.1	<ul style="list-style-type: none"> <li>• Certificate updated</li> </ul>
1.6.0	<ul style="list-style-type: none"> <li>• Company address changed</li> <li>• Safety parameters extended</li> </ul>
1.5.0	<ul style="list-style-type: none"> <li>• Extended temperature range added</li> <li>• Notes regarding temperature measurement and EMC added</li> <li>• Description of date code extended</li> </ul>
1.4.1	<ul style="list-style-type: none"> <li>• Document origin added</li> </ul>
1.4.0	<ul style="list-style-type: none"> <li>• Note regarding cable length and signal routing extended</li> <li>• Table listing causes for diagnosis messages added</li> </ul>
1.3.0	<ul style="list-style-type: none"> <li>• Block diagram for EL2904 added</li> </ul>
1.2.1	<ul style="list-style-type: none"> <li>• Reference to EN 60068-2-29 removed</li> </ul>
1.2.0	<ul style="list-style-type: none"> <li>• ATEX notes added</li> <li>• Installation position / minimum distances extended</li> <li>• Notes regarding overvoltage protection added</li> <li>• Notes regarding cable length and clocked signals extended</li> <li>• EN954 wiring example removed</li> </ul>

Version	Comment
	<ul style="list-style-type: none"> <li>• Diagnostics for CoE object 0x800E described</li> </ul>
1.1.0	<ul style="list-style-type: none"> <li>• Minor amendments for EtherCAT</li> <li>• Copyright / disclaimer modified</li> <li>• Support / service addresses updated</li> </ul>
1.0.0	<ul style="list-style-type: none"> <li>• First released version</li> </ul>

### 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.de/twinsafe>. In case of doubt, please contact Technical Support (see [Beckhoff Support and Service \[► 10\]](#)).

### 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 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.



## 1.4 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 \[▶ 11\]](#) in the operating instructions.

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

### 1.4.1 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.

#### 1.4.1.1 Signal words

The signal words used in the documentation are classified below.

##### 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.

## 1.5 Beckhoff Support and Service

### Support

Beckhoff Support offers technical advice on the use of individual Beckhoff products and system planning. The employees support you in the programming and commissioning of sophisticated automation systems.

Hotline: +49 5246/963-157  
E-mail: [support@beckhoff.com](mailto:support@beckhoff.com)  
Web: [www.beckhoff.com/support](http://www.beckhoff.com/support)

### Training

Training in Germany takes place in our training center at the Beckhoff headquarters in Verl, at subsidiaries or, by arrangement, at the customer's premises.

Hotline: +49 5246/963-5000  
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### Download area

In the download area you can obtain product information, software updates, the TwinCAT automation software, documentation and much more.

Web: [www.beckhoff.com/download](http://www.beckhoff.com/download)

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For the addresses of our worldwide locations, please visit our website at [Global Presence](#).

## 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.

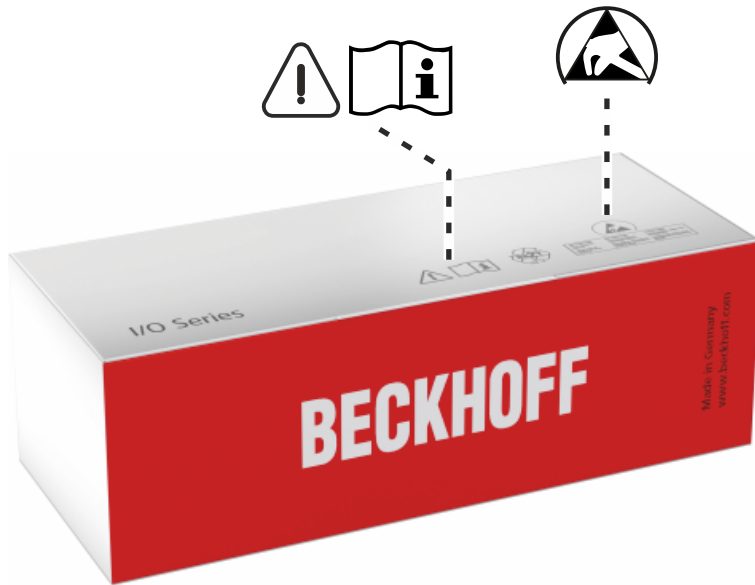


#### No disposal in domestic waste

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 Directive

Only use the TwinSAFE component in machines that comply with the Machinery Directive. This is how you ensure safe operation.

#### 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.

### 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](#) [► 50].

## 3 System description

### 3.1 The Beckhoff Bus Terminal system

The Beckhoff Bus Terminal system is used for decentralized connection of sensors and actuators to a control system. The Beckhoff Bus Terminal system components are mainly used in industrial automation and building management applications. In its minimum configuration, a bus station consists of a Bus Coupler or a Bus Terminal Controller and Bus Terminals connected to it. The Bus Coupler forms the communication interface to the higher-level controller, and the terminals are the interface to sensors and actuators. The whole bus station is clipped onto a 35 mm DIN mounting rail (EN 60715). The mechanical cross connection of the bus station is established via a slot and key system at the Bus Coupler and the Bus Terminals.

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

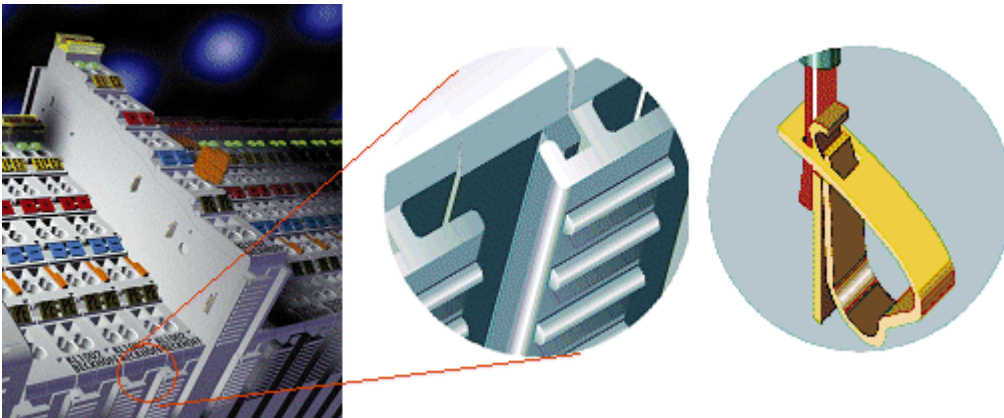


Fig. 1: Slot and key system and screwless (spring-loaded) connection system.

In order to accommodate the wide range of different communication standards encountered in industrial automation, Beckhoff offers Bus Couplers for a number of common bus systems (e.g. EK1100 for EtherCAT).

### 3.1.1 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

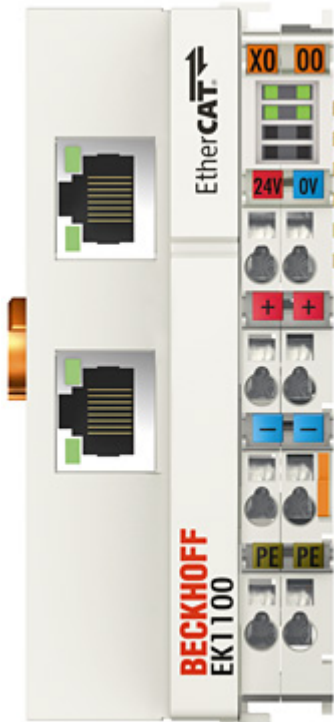


Fig. 2: Bus Coupler (EtherCAT)

Connection technology	Bus Coupler
Wiring	spring-loaded system
Connection cross-section	0.08 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> , stranded wire, solid wire
Fieldbus connection	depending on fieldbus
Power contacts	3 spring contacts
Current load	10 A
Rated voltage	24 V <sub>DC</sub>

### 3.1.2 Bus 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

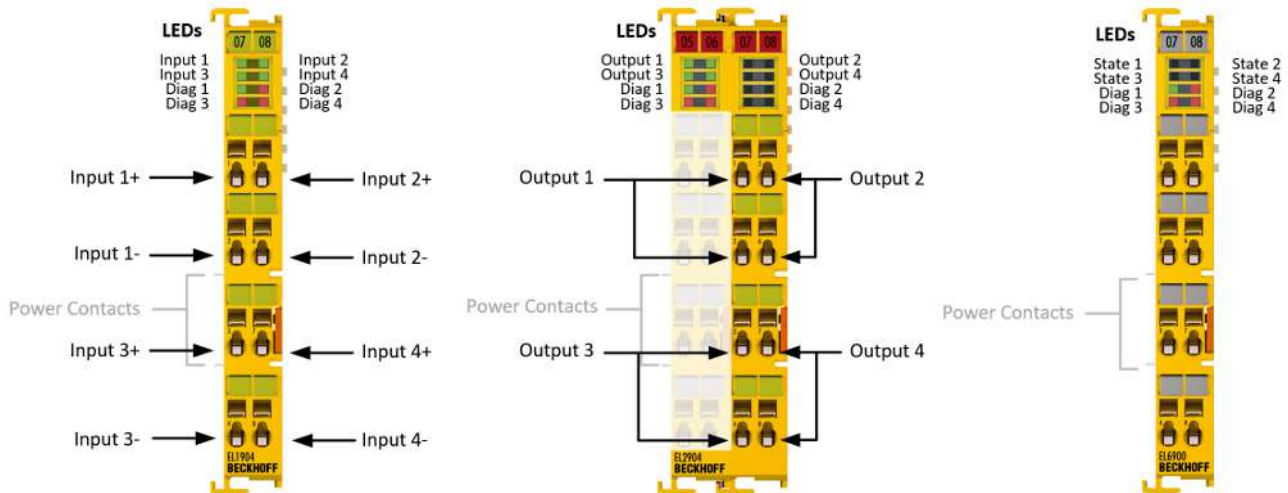


Fig. 3: TwinSAFE Terminals (EtherCAT)

Connection technology	Bus Terminal
Wiring	spring-loaded system
Connection cross-section	0.08 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> , stranded wire, solid wire
Fieldbus connection	E-bus
Power contacts	up to 3 blade/spring contacts
Current load	10 A
Rated voltage	depends on Bus Terminal type

### 3.1.3 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.

### 3.1.4 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 feed terminals as required. The power feed terminals play no part in the control of the terminals, and can be inserted at any locations within the terminal strip.

## 3.2 TwinSAFE

### 3.2.1 The I/O construction kit is extended safely

With the TwinSAFE Terminals, Beckhoff offers the option of simply expanding the proven Bus Terminal system, and to transfer the complete cabling for the safety circuit into the already existing fieldbus cable. Safe signals can be mixed with standard signals without restriction. This saves design effort, installation and material. Maintenance is simplified significantly through faster diagnosis and simple replacement of only a few components.



The new ELx9xx series Bus Terminals only include three basic functionalities: digital inputs EL19xx, digital outputs EL29xx and a logic unit EL6900. For a large number of applications, all sensors and actuators can be wired on these Bus Terminals. The required logical link of the inputs and the outputs is handled by the EL6900. For small to medium-sized configurations, the tasks of a fail-safe PLC can thus be handled within the Bus Terminal system.

### 3.2.2 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
- Logical link of the I/Os in the EL6900 TwinSAFE logic terminal
- Safety-relevant networking of machines via bus systems

#### **TwinSAFE protocol (FSoE)**

- 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

#### **Configuring instead of wiring: the TwinSAFE configurator**

- Configuration of the TwinSAFE system via the TwinCAT System Manager
- System Manager for editing and displaying all bus parameters
- Certified function blocks such as emergency stop, operation mode, etc.
- Simple handling
- Typical function blocks for machine safety
- any bus connection with the EL6900 TwinSAFE logic terminal

#### **TwinSAFE logic Bus Terminal EL6900**

- Link unit between TwinSAFE input and output terminals
- Configuration of a simple, flexible, cost-effective, decentralized safety controller
- No safety requirements for higher-level control system
- TwinSAFE enables networks with up to 65535 TwinSAFE devices.
- TwinSAFE Logic Terminal can establish up to 128 connections (TwinSAFE connections).
- Several TwinSAFE Logic Terminals are cascadable in a network
- Safety functions such as emergency stop, protective door, etc. are already included
- Suitable for applications up to SIL 3 according to IEC 61508:2010 and DIN EN ISO 13849-1:2015 (Cat 4, PL e).

#### **TwinSAFE digital input (EL1904) and output terminal (EL2904)**

- All current safety sensors can be connected
- Operation with a TwinSAFE logic terminal
- EL1904 with 4 fail-safe inputs for sensors (24 VDC) with potential-free contacts
- EL2904 with four safe channels for actuators (24 VDC, 0.5 A per channel)
- Conforming to IEC 61508:2010 SIL 3 and EN ISO 13849-1:2015 (Cat 4, PL e) requirements.

### **3.2.3 EL1904, EL2904 - Bus Terminals with 4 fail-safe inputs or outputs**

The EL1904 and EL2904 Bus Terminals enable connection of common safety sensors and actuators. They are operated with the EL6900 TwinSAFE logic terminal. The TwinSAFE logic terminal is the link unit between the TwinSAFE input and output terminals. It enables the configuration of a simple, flexible and cost-effective decentralized safety control system.

Therefore, there are no safety requirements for the higher-level controller! The typical safety functions required for the automation of machines, such as emergency stop, protective door, two-hand etc., are already permanently programmed in the EL6900. The user configures the EL6900 terminal according to the safety requirements of his application.

### **3.2.4 EL6900 - TwinSAFE logic terminal**

The TwinSAFE Logic Terminal is the link unit between the TwinSAFE input and output terminals. The EL6900 meets the requirements of IEC 61508:2010 SIL 3 and EN ISO 13849-1:2015 (Cat 4, PL e).

### **3.2.5 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. The safe state is always the switched off and wattless state.

## 4 Product description

### 4.1 EL2904 – TwinSAFE terminal with 4 digital fail-safe outputs

The EL2904 is a safe output terminal with digital outputs for connecting actuators (contactors, relays, etc.) with a maximum current 0.5 A (24 V<sub>DC</sub>). The Bus Terminal has 4 fail-safe outputs.

The EL2904 meets the requirements of IEC 61508:2010 SIL 3, EN ISO 13849-1:2015 (Cat 4, PL e), NRTL, UL508, UL1998 and UL991.

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

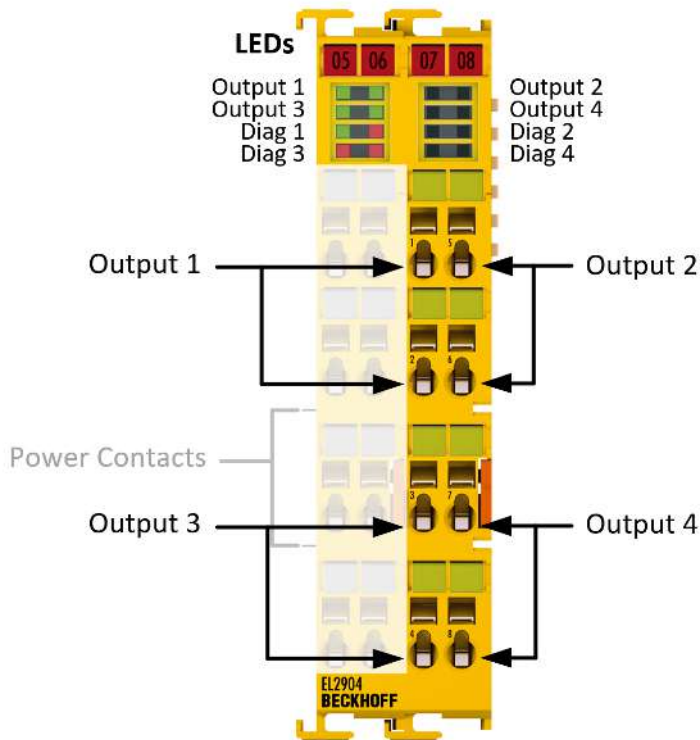


Fig. 4: EL2904 – TwinSAFE terminal with 4 digital fail-safe outputs

## 4.2 Intended use

### WARNING

#### Caution - Risk of injury!

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

The TwinSAFE terminals expand the application range 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 wattless state. Fail-safety according to the relevant standards is required.

The TwinSAFE Terminals enable connection of:

- 24  $V_{DC}$  sensors (EL1904) such as emergency off pushbutton switches, pull cord switches, position switches, two-hand switches, safety mats, light curtains, light barriers, laser scanner, etc.
- 24  $V_{DC}$  actuators (EL2904) such as contactors, protection door switches with tumbler, signal lamps, servo drives, etc.

#### Test pulses

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

The following TwinSAFE components have been 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

#### 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.

### CAUTION

#### Follow the machinery directive!

The TwinSAFE components shall 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.

### WARNING

#### Commissioning test

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

### CAUTION

#### Use ferrules with plastic collars

When using fine-wire cables for 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.

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

- The release does **not** apply to the EL1918-2200, EL2911-2200 and EP1957-2222 variants.
- 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. A direct switch-off occurs 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 degree of pollution 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  $U_{\max} \leq 36 \text{ V}_{\text{DC}}$ .

## 4.3 Technical 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/>.

Product designation	EL2904
Number of outputs	4
Status display	4 (one green LED per output)
Fault reaction time	≤ watchdog times
Output current per channel	max. 500 mA, min. 20 mA with <i>Current Measurement Active</i> parameter enabled
Utilization category according to EN 60947-5-1	DC-13
Actuators	When selecting actuators please ensure that the EL2904 test pulses do not lead to actuator switching.
Cable length between actuator and terminal	unshielded max. 100 m shielded max. 100 m
Wire cross-section	min. 0.75 mm <sup>2</sup>
Input process image	6 bytes
Output process image	6 bytes
EL2904 supply voltage (PELV)	24 V <sub>DC</sub> (-15% / +20%) (A 10 A fuse should be provided for the potential group)
Protection class	III (by using a SELV/PELV power supply unit)
Overvoltage category	II
Current consumption via E-bus	approx. 221 mA
Power loss of the terminal	typically 2 W
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 <sub>DC</sub>
Dimensions (W x H x D)	24 mm x 100 mm x 68 mm
Weight	approx. 100 g
Permissible ambient temperature (operation) up to SW 03	0 °C ... +55 °C (see chapter Example configuration for temperature measurement)
Permissible ambient temperature (operation) from SW 04 (CW 02/2014)	-25 °C ... +55 °C (see chapter Example configuration for temperature measurement)
Permissible ambient temperature (transport/storage)	-40 °C ... +70 °C
Permissible air humidity	5% to 95%, non-condensing
Permissible air pressure (operation/storage/transport)	750 hPa ... 1100 hPa (this is equivalent 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 degree of pollution according to EN 60664-1	2 (see chapter Maintenance)
Inadmissible operating conditions	TwinSAFE terminals must not be used under the following operating conditions: <ul style="list-style-type: none"> <li>• under the influence of ionizing radiation (exceeding the natural background radiation)</li> <li>• in corrosive environments<sup>1</sup></li> <li>• in an environment that leads to unacceptable soiling of the bus terminal</li> </ul>
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
Corrosive gas test	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 <ul style="list-style-type: none"> <li>• Test duration: 21 days</li> <li>• Hydrogen sulfide: (50 ± 5) ppb</li> <li>• Nitrogen dioxide: (1250 ± 20) ppb</li> <li>• Chlorine: (10 ± 5) ppb</li> </ul>

Product designation	EL2904
	• Sulfur dioxide: (300 ± 20) ppb
Protection rating	IP20
Device type according to EN 61010-2-201	Open equipment
Permitted operating environment	In the control cabinet or terminal box, with minimum protection rating IP54 according to IEC 60529
Permissible installation position	see chapter Installation position and minimum distances
Approvals	CE, cULus, ATEX, TÜV SÜD

<sup>1</sup> A corrosive environment exists when corrosion damage becomes apparent.

**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 <sup>1</sup>
0 to 2000 <sup>2</sup>	1.0
3000	0.9
4000	0.8
5000	0.7

Note: Linear interpolation is permissible between the altitudes

<sup>1</sup>) Ambient temperature of the device at an altitude of 2000 m

<sup>2</sup>) 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 Safety parameters**

Characteristic numbers	EL2904
Lifetime [a]	20
Proof test Interval [a]	not required <sup>1</sup>
PFH <sub>D</sub>	1.25E-09
%SIL3	1.25 %
PFD	8.45E-05
%SIL3	8.45 %
MTTF <sub>d</sub>	high
DC	high
Performance level	PL e
Category	4
HFT	1

Characteristic numbers	EL2904
Element classification <sup>2</sup>	Type B

1. Special proof tests are not required during the entire service life of the EL2904 EtherCAT terminal.
2. Classification according to IEC 61508-2:2010 (chapter 7.4.4.1.2 and 7.4.4.1.3)

The EL2904 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 (Cat4).

For the calculation or estimation of the  $MTTF_d$  value from the  $PFH_D$  value, further information can be found in the TwinSAFE Application Guide or in ISO 13849-1:2015 Table K.1.

## 4.5 Dimensions

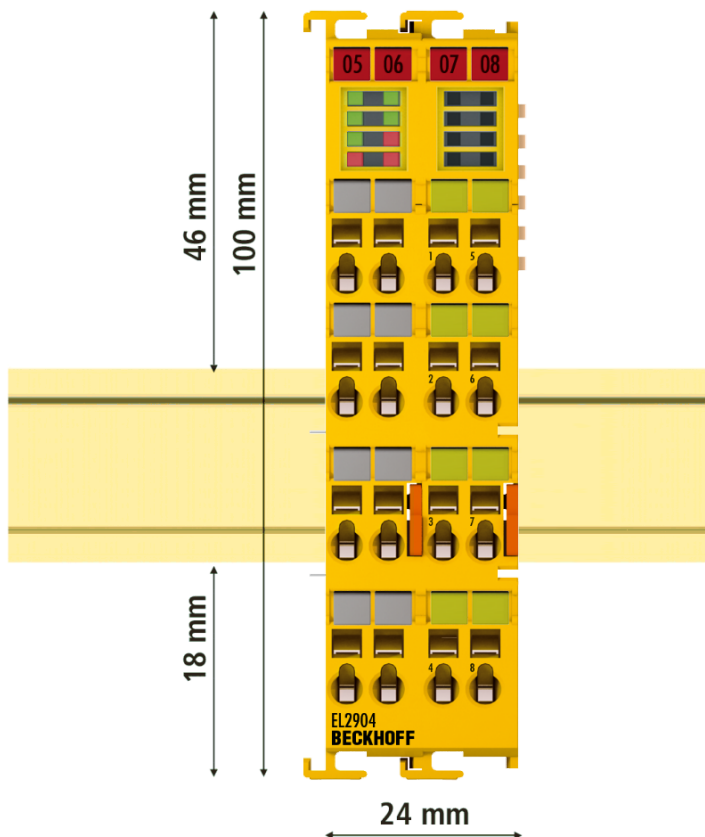


Fig. 5: Dimensions of the EL2904

Width: 24 mm (side-by-side installation)

Height: 100 mm

Depth: 68 mm



### 4.6 Block diagram of the EL2904

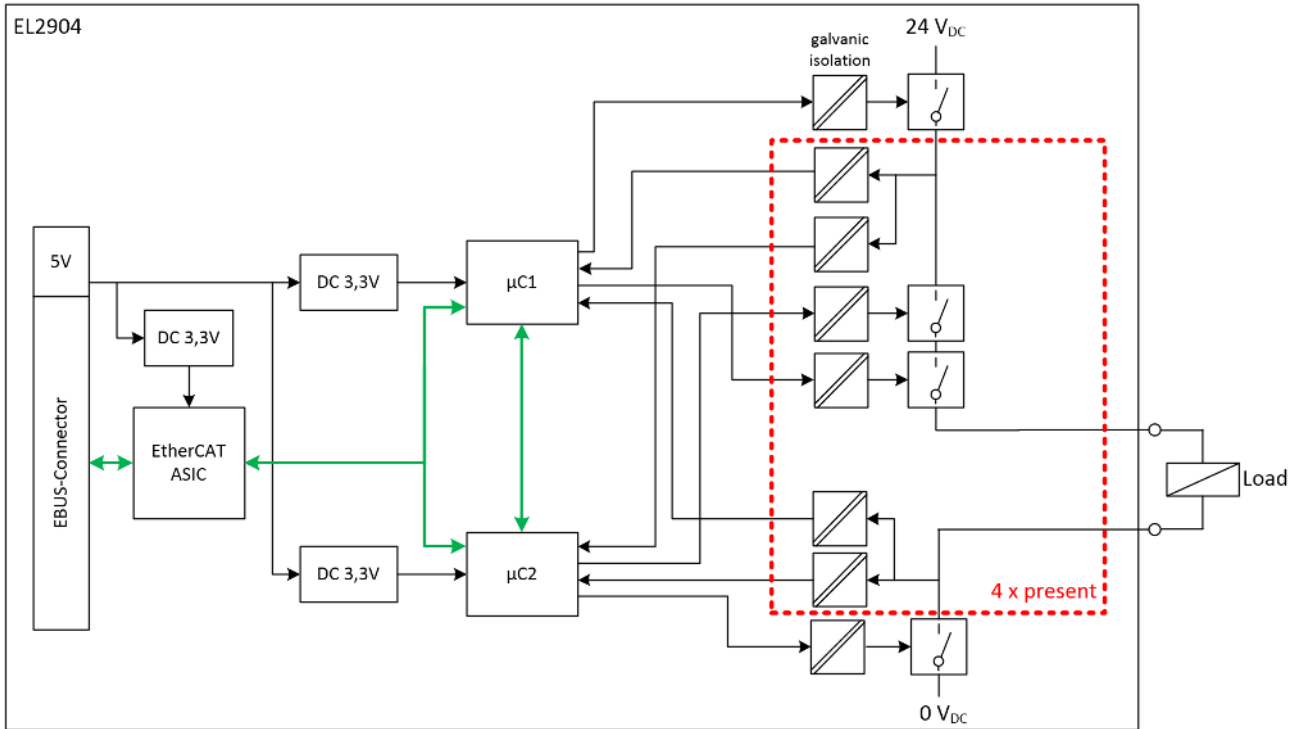


Fig. 6: Block diagram of the EL2904

The block diagram shows the basic configuration of a channel in the EL2904. The part with a red border is present four times in the terminal. The high-side and low-side switches only exist once for all channels. This means that each channel has a total of four stop paths.

## 5 Operation

### 5.1 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

#### **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.

### 5.2 Installation

#### 5.2.1 Safety instructions

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

#### 5.2.2 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).

#### 5.2.3 Electrical installation

##### 5.2.3.1 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.

**NOTICE****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**

**i** 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.

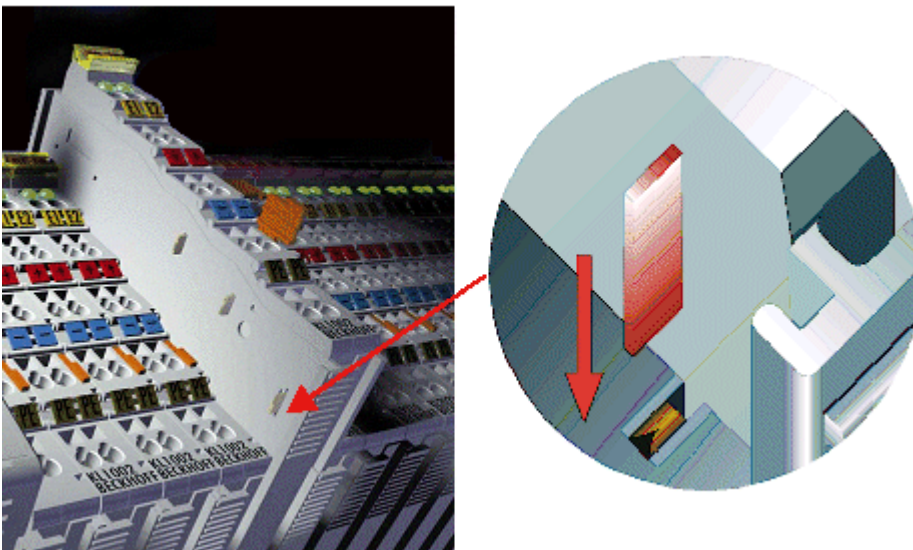


Fig. 7: PE power contact

**⚠ 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!

### 5.2.3.2 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.

### 5.2.3.3 Wiring

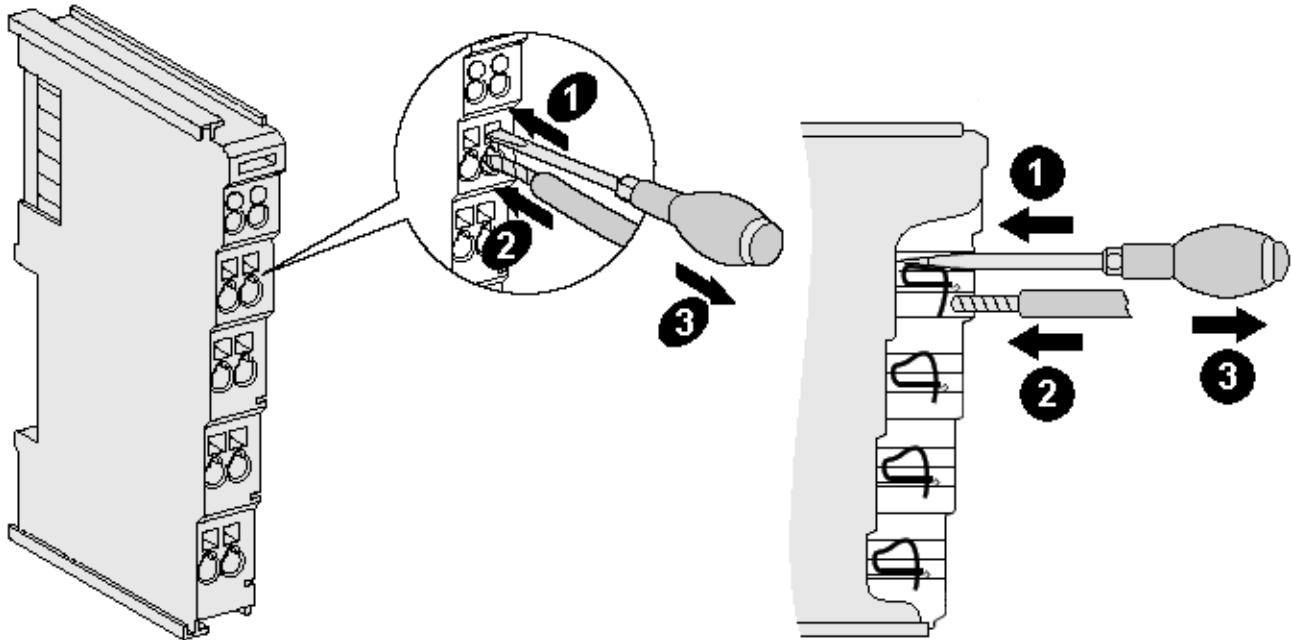


Fig. 8: Connection of a cable to a terminal point

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.

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

5.2.3.4 EL2904 pin assignment

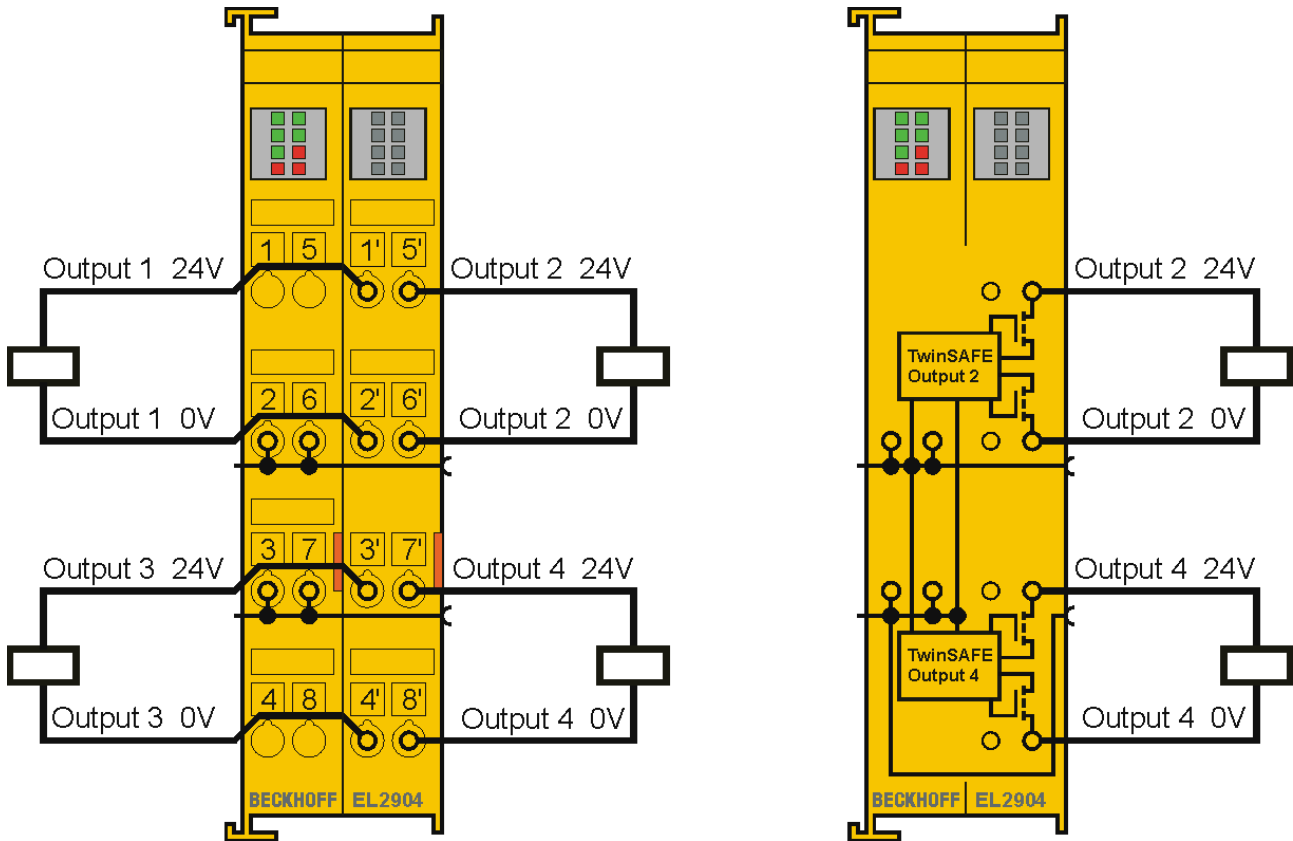


Fig. 9: EL2904 pin assignment

Terminal point	Output	Signal
1	-	not used, no function
2	-	positive power contact
3	-	negative power contact
4	-	not used, no function
5	-	not used, no function
6	-	positive power contact
7	-	negative power contact
8	-	not used, no function
1'	1	Output 1+
2'		Output 1-
3'	3	Output 3+
4'		Output 3-
5'	2	Output 2+
6'		Output 2-
7'	4	Output 4+
8'		Output 4-

**i** Test pulses

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

### 5.2.3.5 Signal cables

#### Permitted cable length

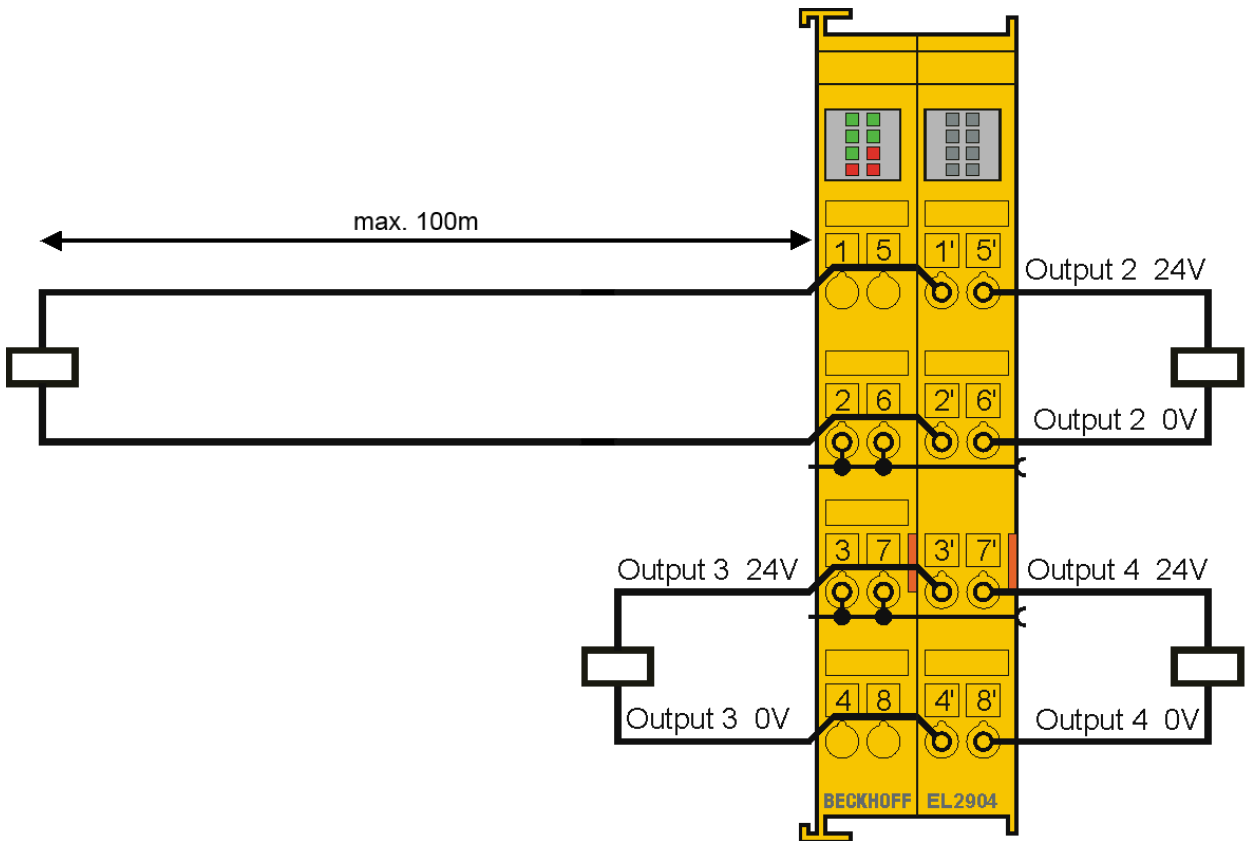


Fig. 10: Permitted cable length

When connecting a single actuator via its own continuous cabling (or via a sheathed cable), the maximum permitted cable length is 100 m.

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

#### Cable routing

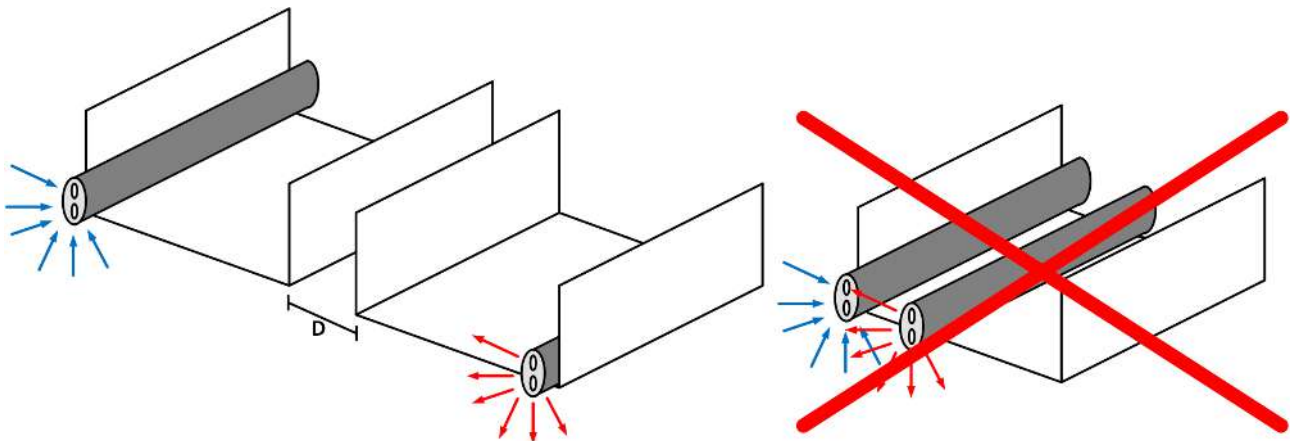


Fig. 11: Cable routing

**NOTICE**

**Route the signal cable separately**

The signal cable must be routed separately from potential sources of interference, such as motor supply cables, 230 V<sub>AC</sub> 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.

If connection via a bus cable is unavoidable, the test pulses can be switched off (parameters *Testing of outputs active* and *Current measurement active*). However, this then leads to a reduction in the degree of diagnostic cover when calculating the performance level.

**Test pulses**

The typical length of test pulse (switching from 24 V to 0 V and back to 24 V) is 300 µs to 800 µs. Testing usually takes place 5 to 7 times per second.

**● Test pulses for the outputs**

**i** The following diagram shows a typical test pulse curve for the four outputs of an EL2904. The parameters *Current measurement active* and *Testing of outputs active* are enabled.

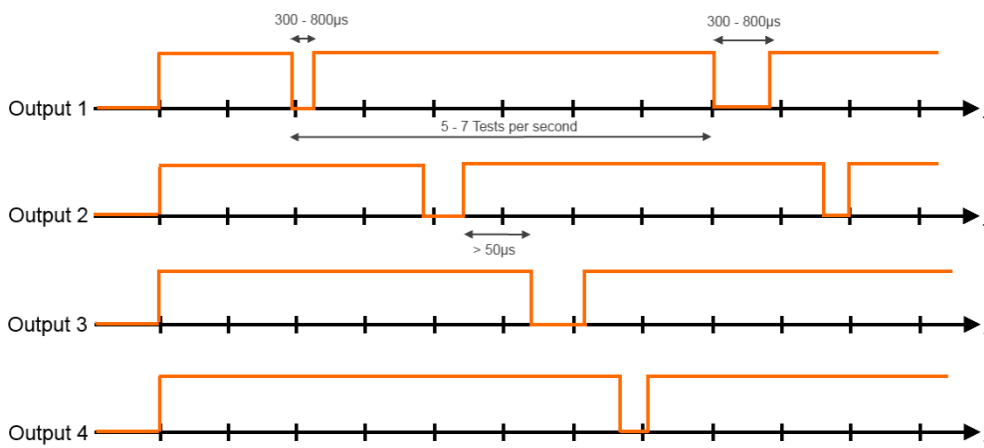


Fig. 12: Typical course of test pulses of the outputs

**5.2.4 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!

### 5.2.4.1 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.

### 5.2.4.2 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.

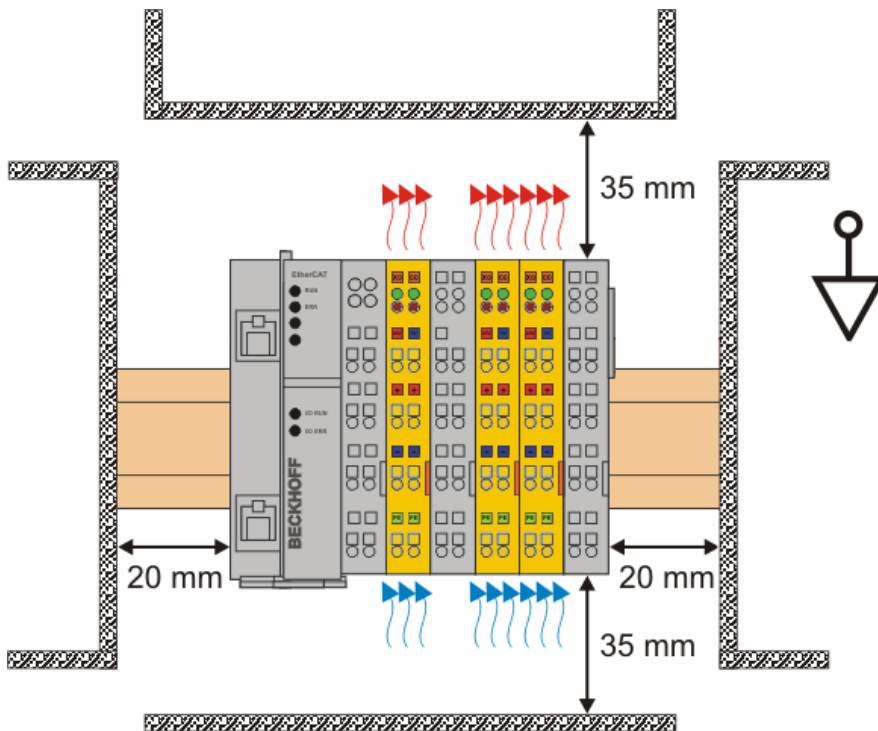


Fig. 13: Installation position and minimum distances

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.



5.2.4.3 Example configuration for temperature measurement

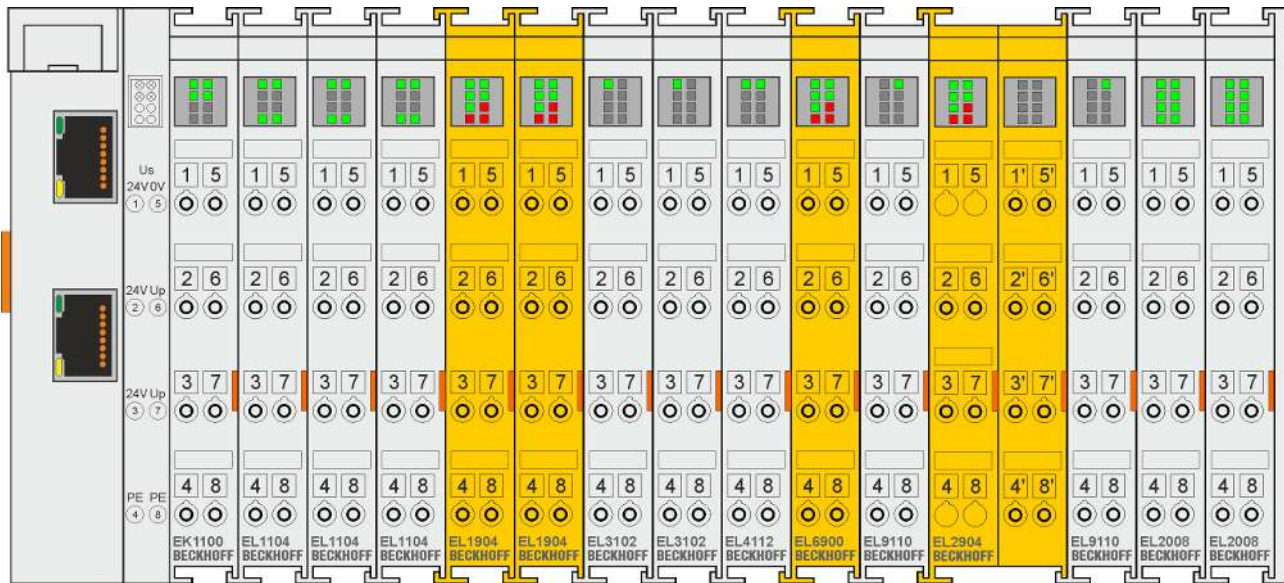


Fig. 14: Example configuration for temperature measurement

The example configuration for the temperature measurement consists of an EK1100 EtherCAT coupler with connected terminals that match the typical distribution of digital and analog signal types at a machine. On the EL6900 a safety project is active, which reads safe inputs and enables all 4 safe outputs during the measurement.

**i External heat sources / radiant heat / impaired convection**

The maximum permissible ambient temperature of 55°C was checked with the above example configuration. Impaired convection, an unfavorable location near heat sources or an unfavorable configuration of the EtherCAT Terminals may result in overheating of the terminals. 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 chapter Diagnose).

### 5.2.4.4 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:

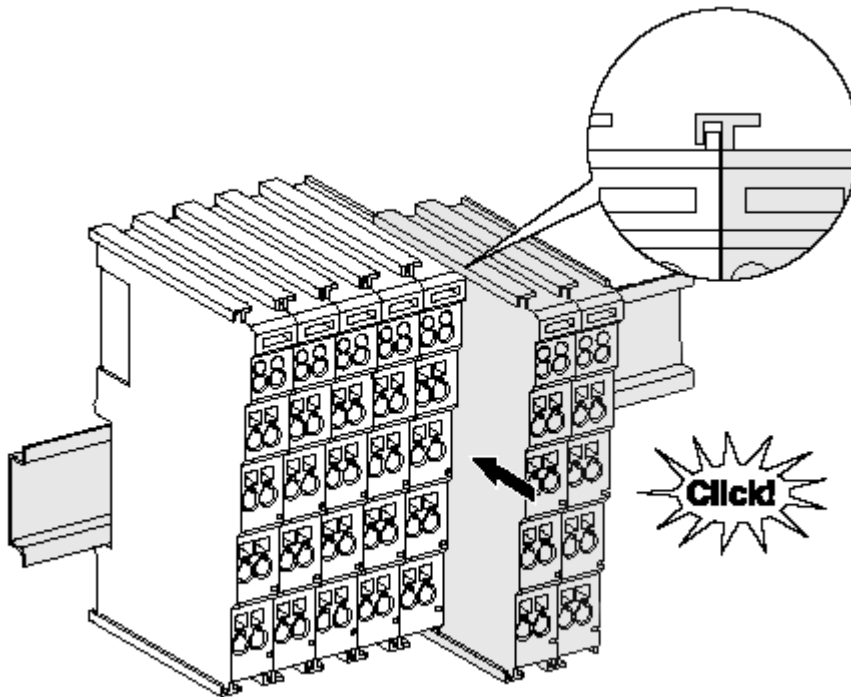


Fig. 15: Installation on the mounting rail

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.

#### **i** 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

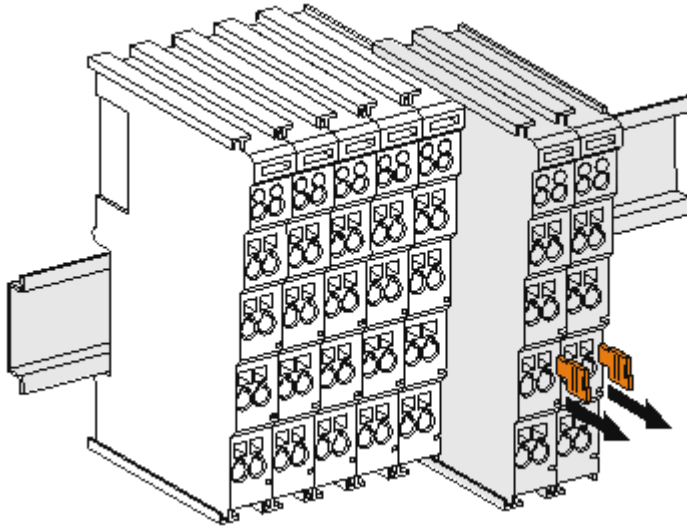


Fig. 16: Removal of mounting rails

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.

## 5.2.5 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.

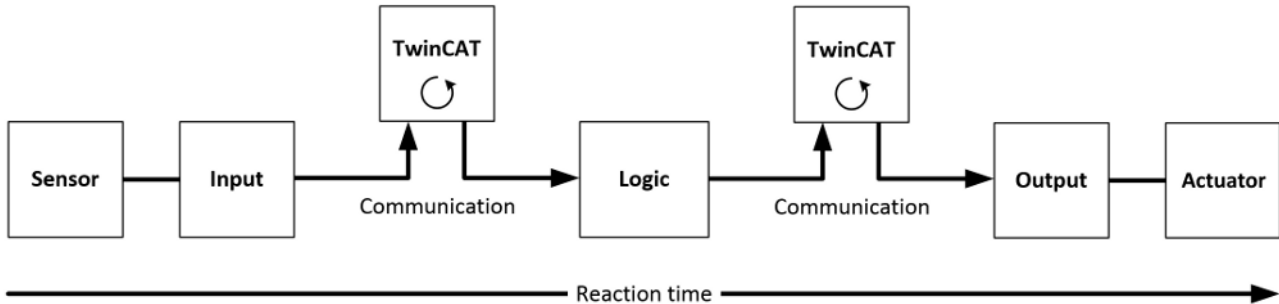


Fig. 17: Typical response time

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 $\mu$ s 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.

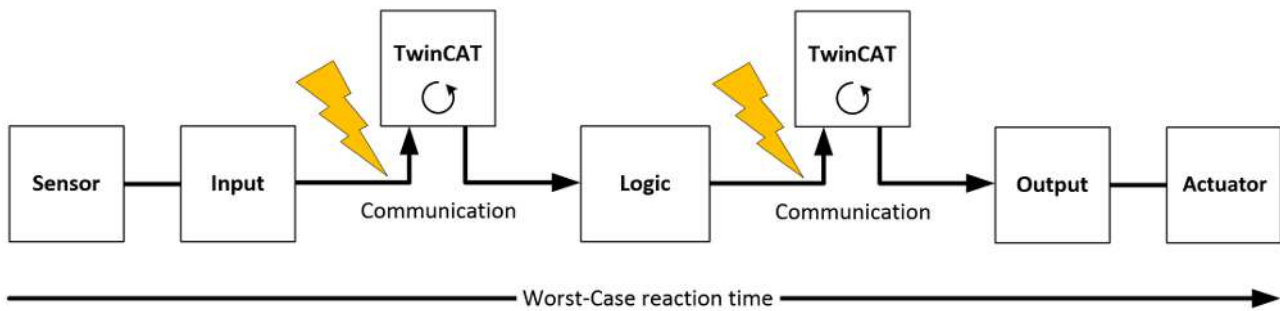


Fig. 18: Worst case response time

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

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

## 5.2.6 Tested EL2904 devices

The following list contains devices that were tested together with the EL2904 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
Beckhoff	AX5801	TwinSAFE Drive option card: safe restart lock
Beckhoff	AX2000 AS option	safe restart lock
Siemens	SIRIUS series S00 3RT1016-1BB42	Contactora
Telemecanique	LP1K09	Contactora

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

### **i** Recommended protective circuits

We recommend R/C or diode-based protective circuits for these devices. Varistor-based protective circuits should not be used.

## 5.3 Operation in potentially explosive atmospheres (ATEX)

### 5.3.1 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

### 5.3.2 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

### 5.3.3 Date code and serial number

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

Date code: CW YY SW HW

Legend:	Sample: Date code 29 10 02 01
CW: Calendar week of manufacture	Calendar week: 29
YY: Year of manufacture	Year: 2010
SW: Software version	Software version: 02
HW: Hardware version	Hardware version: 01

In addition the TwinSAFE terminals bear a unique serial number.

### 5.3.4 Further ATEX documentation

#### Please also refer to the further documentation



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

## 5.4 Configuration of the terminal in TwinCAT

#### 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!

### 5.4.1 Inserting a Bus Coupler

See TwinCAT automation software documentation.

### 5.4.2 Inserting a Bus Terminal

See TwinCAT automation software documentation.

### 5.4.3 Inserting an EL2904

An EL2904 is inserted in the same way as any other Beckhoff Bus Terminal. In the list open *Safety Terminals (ELx9xx)* and select the EL2904.

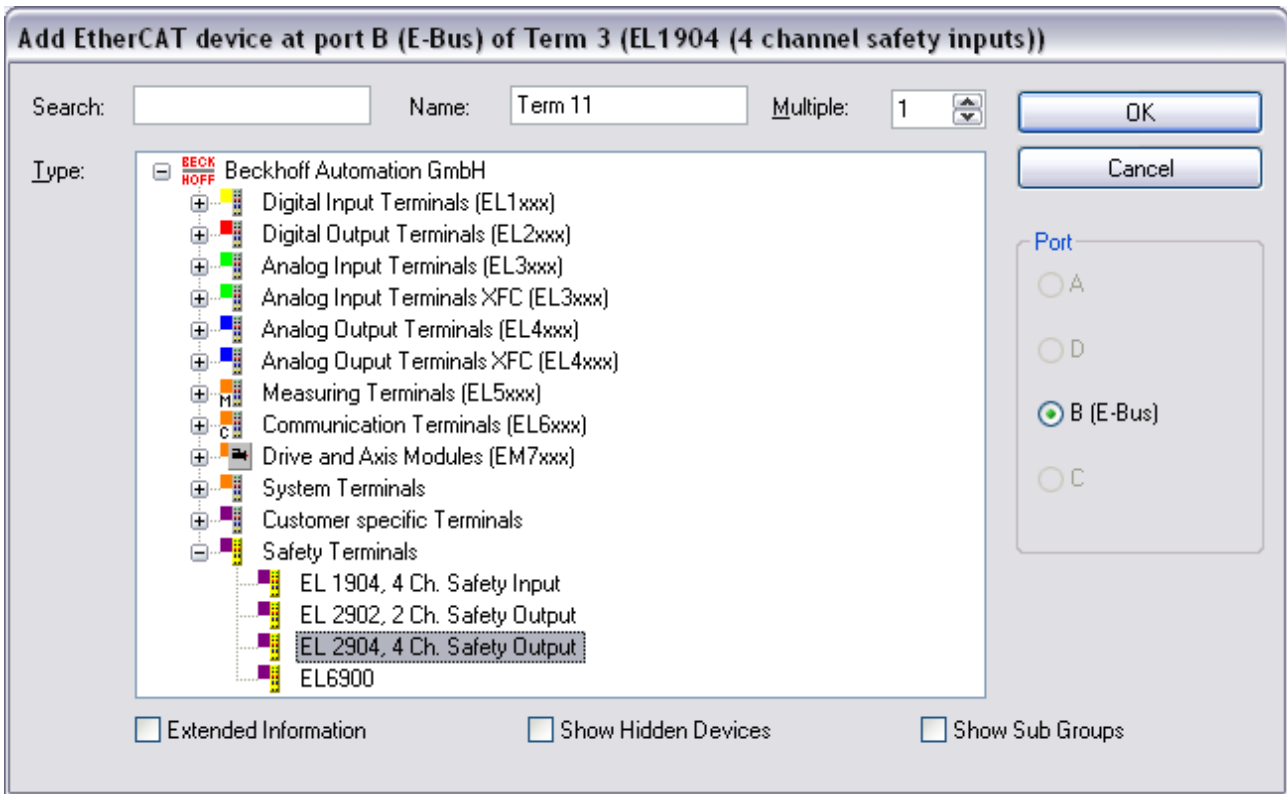


Fig. 19: Inserting an EL2904



### 5.4.4 Address settings on TwinSAFE terminals with 1023 possible addresses

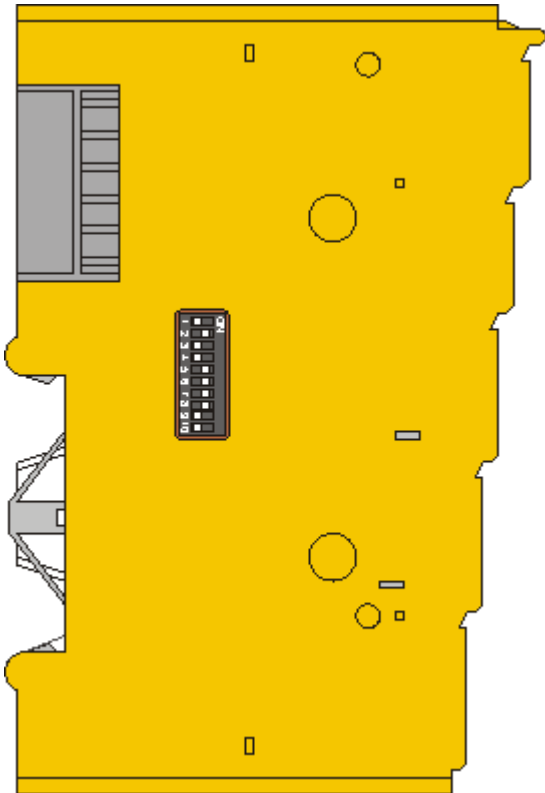


Fig. 20: Address settings on TwinSAFE terminals with 1023 possible addresses

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!

### 5.4.5 Entering a TwinSAFE address and parameters in the System Manager

The FSoE address set at the DIP switch must also be entered under the *FSoE* tab (*FSoE Address* entry).

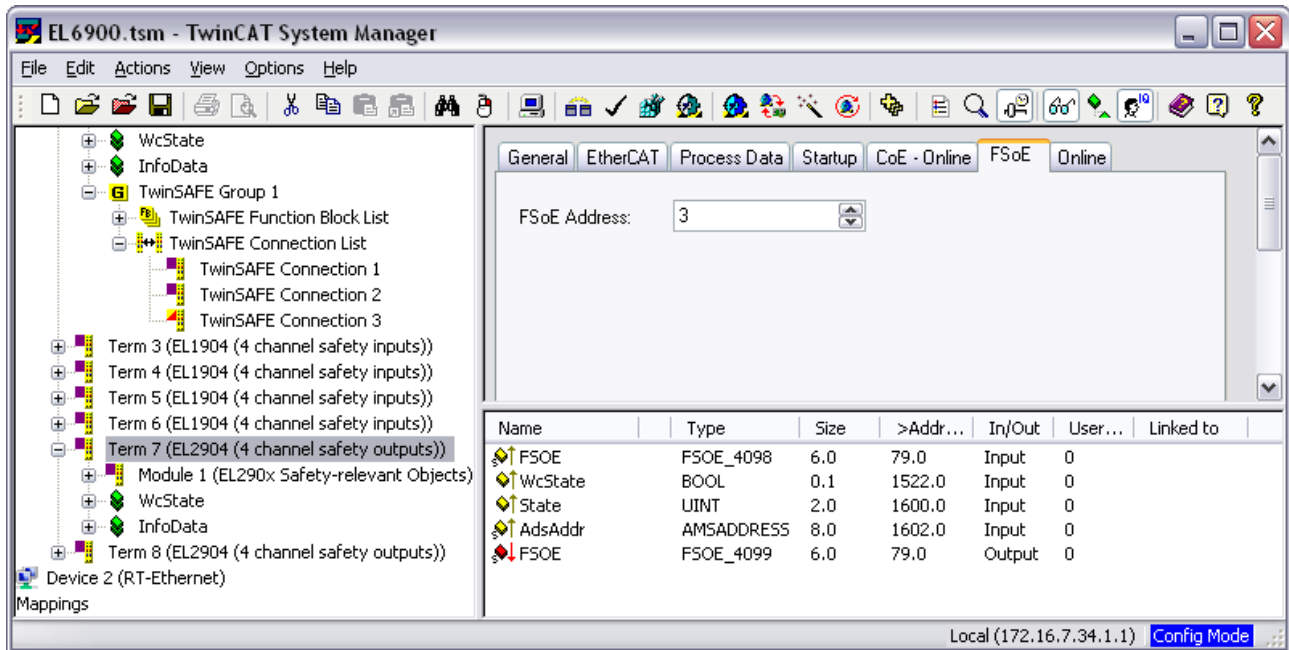


Fig. 21: Entering the FSoE address

The EL2904 parameters are set under the respective TwinSAFE connection in the *Connection* and *Parameter* tabs.

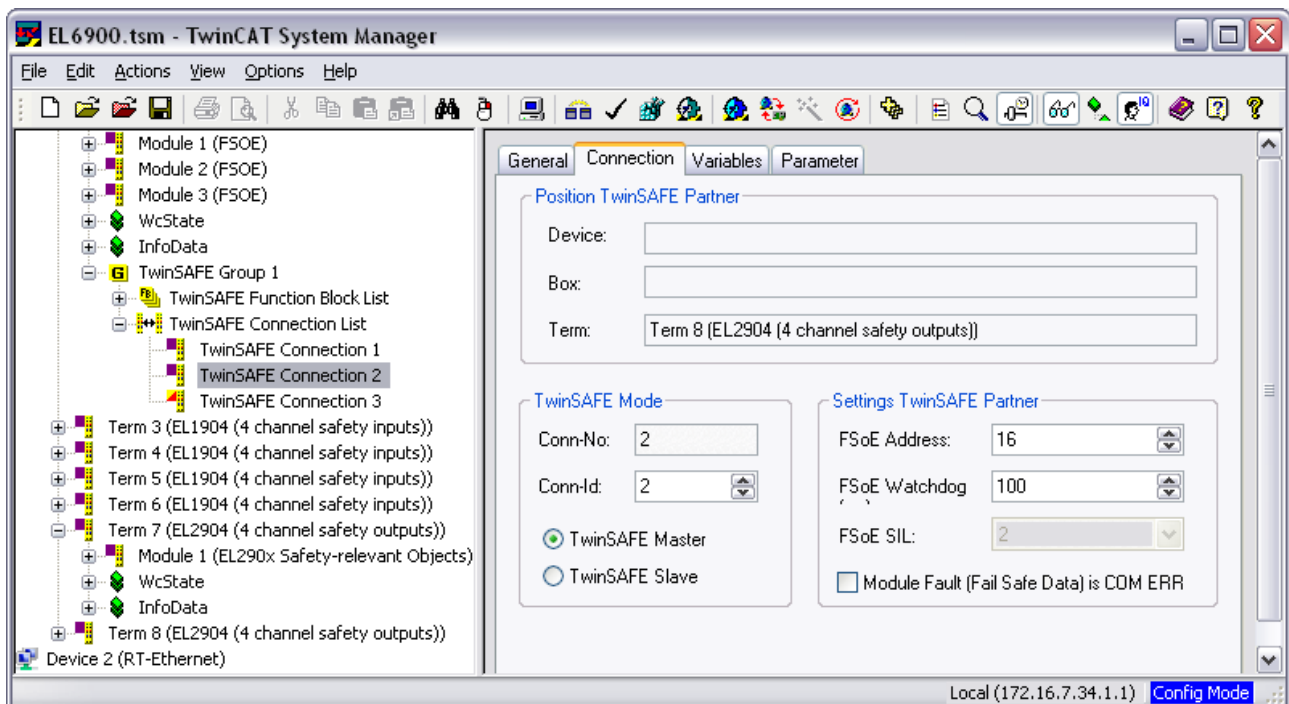


Fig. 22: Setting the connection of the TwinSAFE connection

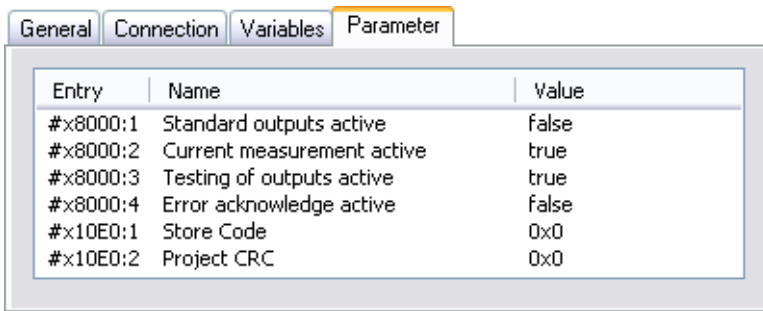


Fig. 23: Setting the parameters of the TwinSAFE connection

**Parameter overview**

PrmName	Meaning	Values
Standard outputs active	In addition the output can be switched off from the standard PLC. The safe output is linked with the standard logic signal AND.	true / false
Current measurement active	Current measurement for the outputs is activated	true / false
Testing of outputs active	Test pulses for the outputs are activated	true / false
Error acknowledge active	True: Terminal errors lead to a reset of the TwinSAFE Connection (error code 14 (0x0E)). This error code is shown in the diagnostic data for the connection until the user acknowledges it via ErrAck in the TwinSAFE group.  False (Default): Terminal errors can only be reset by switching the power supply off and back on again.	true / false
Store Code	This parameter is required for the TwinSAFE Restore Mode	0x0000
Project CRC	This parameter is required for the TwinSAFE Restore Mode	0x0000

**Use the TwinSAFE component in the permitted operation modes**

**i** The TwinSAFE component has been designed for specific operation modes. Refer to the following table for the permissible operation modes. Only use the TwinSAFE component in these operation modes.

Operation mode	Current Measurement active	Testing of outputs active	Explanation
Short circuit and load current monitoring	TRUE	TRUE	Test pulses at output Current measurement active Performance Level see Application Guide.
Short circuit monitoring	FALSE	TRUE	Test pulses at output Current measurement inactive Performance Level see Application Guide.
No monitoring	FALSE	FALSE	No test pulses at the output Current measurement inactive Performance Level see Application Guide.

## 5.5 Diagnostics

### 5.5.1 Diagnostic LEDs

The LEDs Diag 1 to Diag 4 display diagnostic information for the EL2904.

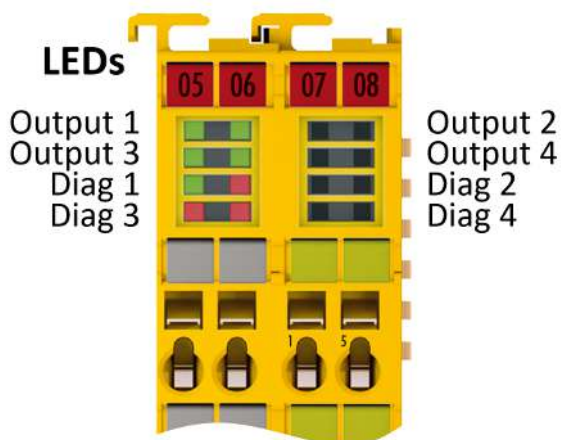


Fig. 24: Diagnostic LEDs

#### Diag 1 (green)

The *Diag 1* LED indicates the state of the TwinSAFE interface (in preparation).

Flashing Code	Meaning
LED illuminated continuously	Diagnostic flashing code in preparation

#### Diag 2 (red)

The *Diag 2* LED indicates the state of the digital outputs.

Flashing Code	Meaning (see chapter <a href="#">Possible causes of diagnostic messages [▶ 46]</a> )
rapid flickering, alternating with 1 flash pulse	Error at output 1
rapid flickering, alternating with 2 flash pulses	Error at output 2
rapid flickering, alternating with 3 flash pulses	Error at output 3
rapid flickering, alternating with 4 flash pulses	Error at output 4
rapid flickering, alternating with 5 flash pulses	Field voltage too low
rapid flickering, alternating with 6 flash pulses	Field voltage too high
rapid flickering, alternating with 7 flash pulses	Internal terminal temperature too low
rapid flickering, alternating with 8 flash pulses	Internal terminal temperature too high
rapid flickering, alternating with 9 flash pulses	Temperature difference error
rapid flickering, alternating with 10 flash pulses	Error in output circuit

These errors can only be reset by switching the power supply for the TwinSAFE terminal off and back on again.

#### Diag 3 (red) and Diag 4 (red)

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

These errors lead to shutdown of the terminal. The terminal must be checked by Beckhoff Automation GmbH & Co. KG.

### Flashing Code

In the case of such an error, the *Diag 4* LED on the EL2904 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.

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

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

## 5.5.2 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<sub>hex</sub>: Internal temperature values

The CoE objects FA80<sub>hex</sub> indicate the current internal temperature values of the EL2904.

Index	Name	Meaning	Flags	Default
FA80:01	Temperature 1	Temperature measurement 1 (left board)	RO	0 <sub>bin</sub>
FA80:02	Temperature 2	Temperature measurement 2 (left board)	RO	0 <sub>bin</sub>
FA80:03	Temperature Outputs	Temperature measurement (right board)	RO	0 <sub>bin</sub>

### Index 800E<sub>hex</sub>: Diagnostic objects

The CoE objects 800E<sub>hex</sub> display further diagnostic information.

Index	Name	Meaning	Flags	Default
800E:0	Diag	The following sub-indices contain detailed diagnostic information.	RO	
800E:0C	Error at the output	Bit External supply or cross-circuit*	RO	
		0 1 <sub>bin</sub> : Output 1		0 <sub>bin</sub>
		1 1 <sub>bin</sub> : Output 2		0 <sub>bin</sub>
		2 1 <sub>bin</sub> : Output 3		0 <sub>bin</sub>
		3 1 <sub>bin</sub> : Output 4		0 <sub>bin</sub>
		Bit Open load or current below minimum value of 20 mA or current above maximum value of 500 mA**		0 <sub>bin</sub>
		4 1 <sub>bin</sub> : Output 1		
		5 1 <sub>bin</sub> : Output 2		0 <sub>bin</sub>
800E:0D	Supply error	Bit Field voltage (power contacts) outside the specification	RO	
		0 1 <sub>bin</sub> : Field voltage too high		0 <sub>bin</sub>
		1 1 <sub>bin</sub> : Field voltage too low		0 <sub>bin</sub>
800E:0E	Temperature error	Bit Terminal temperature outside the specification.	RO	
		0 1 <sub>bin</sub> : Overtemperature µC1		0 <sub>bin</sub>
		1 1 <sub>bin</sub> : Overtemperature µC2		0 <sub>bin</sub>
		2 1 <sub>bin</sub> : Overtemperature of the output board		0 <sub>bin</sub>

Index	Name	Meaning	Flags	Default
		3 1 <sub>bin</sub> : Temperature too low $\mu$ C1		0 <sub>bin</sub>
		4 1 <sub>bin</sub> : Temperature too low $\mu$ C2		0 <sub>bin</sub>
		5 1 <sub>bin</sub> : Temperature of the output board too low		0 <sub>bin</sub>
		6 1 <sub>bin</sub> : Temperature difference on the processor board too large		0 <sub>bin</sub>
		7 1 <sub>bin</sub> : Temperature difference between the boards is too large		0 <sub>bin</sub>

\*) These diagnostic messages are displayed only if Current Measurement active = false.

\*\*\*) These diagnostic messages are displayed only if Current Measurement active = true. If no channel-specific diagnostic is possible, all bits (4...7) are set. This is independent of the parameter settings.

**● 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.

### 5.5.3 Possible causes of diagnostic messages

Diagnostics	Possible cause	Remedial actions
<i>Diag 2</i> LED Flash code 1 to 4 or 10	If parameters "Testing of outputs active" and/or "Current measurement active" are enabled:	
	Faulty test pulses. Cause: external supply or cross-circuit.	Eliminate cross-circuit or external supply.
	Faulty test pulses. Cause: parallel routed cables with high capacitive coupling and dynamized signals, possibly also in common cables	Isolate lines and lay in separate non-metallic sheathed cable. Create a distance between the non-metallic sheathed cables.
	Cause: Current is below the limit of 20 mA or above the limit of 500 mA.	Select actuator accordingly. Current > 20mA and < 500mA
	Regardless of whether the parameters "Testing of outputs active" and/or "Current measurement active" are enabled:	
	The output voltage lies below the permissible voltage range (24V -15%/+20%). A possible cause is a short-circuit at the output or e.g. a voltage drop at the instant of switching.	Eliminate short-circuit. Design power supply accordingly. Check supply lines for voltage drop.
	EMC faults Internal defect	Take suitable EMC measures Replace terminal
<i>Diag 2</i> LED Flash code 5	Voltage at the power contacts not switched on.	Switch on voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	Voltage at the power contacts was switched on after the terminal supply	Switch on voltage at the power contacts before or at the same time as the terminal supply and reset the error display through PowerOn Reset of the terminal
	Voltage on the power contacts too low.	Increase the voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
<i>Diag 2</i> LED Flash code 6	Field voltage too high. Voltage on the power contacts too high.	Reduce the voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	Voltage briefly too high due to external influences, such as switching contactors off.	Use an R/C or diode-based protective circuit on the actuators
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
<i>Diag 2</i> LED Flash code 7	Terminal temperature too low	Comply with the specified temperature range
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
<i>Diag 2</i> LED Flash code 8	Terminal temperature too high	Comply with the specified temperature range
	EMC faults	Take suitable EMC measures

Diagnostics	Possible cause	Remedial actions
	Internal defect	Replace terminal
<i>Diag 2</i> LED Flash code 9	Terminal temperature difference too large: one of the 3 internal measuring points is faulty	Replace terminal
	Terminal temperature difference too large: An internal measuring point shows an elevated temperature due to inadequate convection.	Check the installation position of the terminal and modify it according to the specifications in section <i>Mechanical installation</i> , if required
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal

## 6 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:

CW: Calendar week of manufacture

YY: Year of manufacture

SW: Software version

HW: Hardware version

Sample: Date Code 17 11 05 00

Calendar week: 17

Year: 2011

Software version: 05

Hardware version: 00

In addition the TwinSAFE terminals bear a unique serial number.

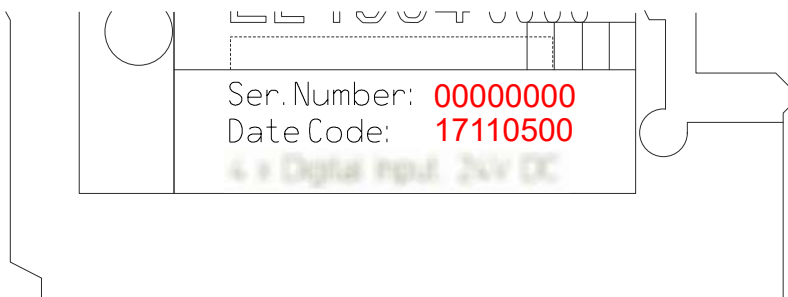


Fig. 25: Unique serial number of a TwinSAFE terminal



## 7 Maintenance and cleaning

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### ● Cleaning by the manufacturer only

**i** 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.

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TwinSAFE components are basically maintenance-free.

## 8 Decommissioning

### 8.1 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.

#### 8.1.1 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.

## 9 Appendix

### 9.1 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.



### 9.3 Certificate

**BECKHOFF** New Automation Technology

**EG-Konformitätserklärung**  
*EC Declaration of Conformity*

Nummer: 2013019EL2904-3, Datum: 06.09.2023  
*Number, Date*

**Originalerklärung**  
*Original declaration*

<b>Hersteller</b> <i>Manufacturer</i>	<b>Beckhoff Automation GmbH &amp; Co. KG</b> Hülshorstweg 20, 33415 Verl, Germany
<b>erklärt, dass das Produkt</b> <i>declares that the product</i>	<b>TwinSAFE EL2904</b> 4-Kanal-Digital-Ausgangsklemme, TwinSAFE, 24 V <sub>DC</sub> <i>4-Channel-Digital-Output-Terminal, TwinSAFE, 24 V<sub>DC</sub></i>

den Bestimmungen der folgenden EG-Richtlinien entspricht:  
*complies with the relevant requirements of the following EC directives:*

<b>2006/42/EG</b> <i>2006/42/EC</i>	<b>Richtlinie 2006/42/EG des Europäischen Parlaments und des Rates vom 17. Mai 2006 über Maschinen und zur Änderung der Richtlinie 95/16/EG (Neufassung)</b> <i>Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)</i>
<b>2014/33/EU</b> <i>2014/33/EU</i>	<b>Richtlinie 2014/33/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über Aufzüge und Sicherheitsbauteile für Aufzüge</b> <i>Directive 2014/33/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to lifts and safety components for lifts</i>
<b>2014/30/EU</b> <i>2014/30/EU</i>	<b>Richtlinie 2014/30/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit (Neufassung)</b> <i>Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast)</i>
<b>2014/34/EU</b> <i>2014/34/EU</i>	<b>Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten für Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen (Neufassung)</b> <i>Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast)</i>
<b>2011/65/EU</b> <i>2011/65/EU</i>	<b>Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates vom 8. Juni 2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten</b> <i>Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)</i>

Die Konformität mit den Bestimmungen der genannten Richtlinien wird durch Einhaltung der folgenden Normen nachgewiesen:  
*The conformity with the listed directives is proved by compliance with the following standards:*

<b>EN ISO 13849-1:2015</b>	<b>EN IEC 63000:2018</b>	<b>EN 61131-2:2007</b>	<b>EN 81-20:2020</b>
<b>EN 62061:2005/A2:2015</b>	<b>EN IEC 60079-0:2018</b>	<b>EN 61000-6-2:2011</b>	<b>EN 81-22:2014</b>
	<b>EN 60079-15:2010</b>	<b>EN 61000-6-4:2011</b>	<b>EN 81-50:2020</b>

Die Übereinstimmung eines Baumusters des bezeichneten Produkts mit den EU-Richtlinien wurde bescheinigt von  
*The accordance of a production sample of the designated product with the EC directives is certified by*

<b>Richtlinie</b> <i>Directive</i>	<b>Benannte Stelle</b> <i>Notified Body</i>	<b>Baumusterprüfbescheinigung</b> <i>type examination certificate</i>
<b>2006/42/EG</b> <i>2006/42/EC</i>	<b>TÜV SÜD Product Service GmbH</b> Ridlerstraße 65, 80339 München, Germany	<b>M6A 062386 0096 Rev. 00</b> 2023-09-01
<b>2014/33/EU</b> <i>2014/33/EU</i>	<b>TÜV SÜD Industrie Service GmbH (NB 0036)</b> Westendstraße 199, 80686 München, Germany	<b>EU-ESD 044 + Module C2 Random Check</b> 2021-05-06
<b>2014/34/EU</b> <i>2014/34/EU</i>	<b>DEKRA Certification B.V.</b> Meander 1051, 6825 MJ Arnhem, Netherlands	<b>KEMA 10ATEX0075 X</b> 2018-06-08

Verantwortlich für die Zusammenstellung der technischen Unterlagen  
*Responsible for the compilation of technical documentation*

<b>Bevollmächtigter</b> <i>Authorised person</i>	<b>Beckhoff Automation GmbH &amp; Co. KG</b> Hülshorstweg 20, 33415 Verl, Germany
---	--

Verl, 22.9.2023

Ort / Datum  
*Place / Date*

**Dipl.-Phys. Hans Beckhoff, Geschäftsführer**  
*Dipl.-Phys. Hans Beckhoff, CEO*

Fig. 26: EL2904 EC declaration of conformity

## List of illustrations

Fig. 1	Slot and key system and screwless (spring-loaded) connection system. ....	14
Fig. 2	Bus Coupler (EtherCAT) .....	15
Fig. 3	TwinSAFE Terminals (EtherCAT) .....	16
Fig. 4	EL2904 – TwinSAFE terminal with 4 digital fail-safe outputs .....	19
Fig. 5	Dimensions of the EL2904 .....	24
Fig. 6	Block diagram of the EL2904 .....	25
Fig. 7	PE power contact .....	27
Fig. 8	Connection of a cable to a terminal point .....	28
Fig. 9	EL2904 pin assignment .....	29
Fig. 10	Permitted cable length .....	30
Fig. 11	Cable routing .....	30
Fig. 12	Typical course of test pulses of the outputs .....	31
Fig. 13	Installation position and minimum distances .....	32
Fig. 14	Example configuration for temperature measurement .....	33
Fig. 15	Installation on the mounting rail .....	34
Fig. 16	Removal of mounting rails .....	35
Fig. 17	Typical response time .....	36
Fig. 18	Worst case response time .....	37
Fig. 19	Inserting an EL2904 .....	40
Fig. 20	Address settings on TwinSAFE terminals with 1023 possible addresses .....	41
Fig. 21	Entering the FSoE address .....	42
Fig. 22	Setting the connection of the TwinSAFE connection .....	42
Fig. 23	Setting the parameters of the TwinSAFE connection .....	43
Fig. 24	Diagnostic LEDs .....	44
Fig. 25	Unique serial number of a TwinSAFE terminal .....	48
Fig. 26	EL2904 EC declaration of conformity .....	53



More Information:  
[www.beckhoff.com/EL2904](http://www.beckhoff.com/EL2904)

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