

Operating Instructions | EN

EP2911-0001

Head station for pneumatic valves with safe shut-off

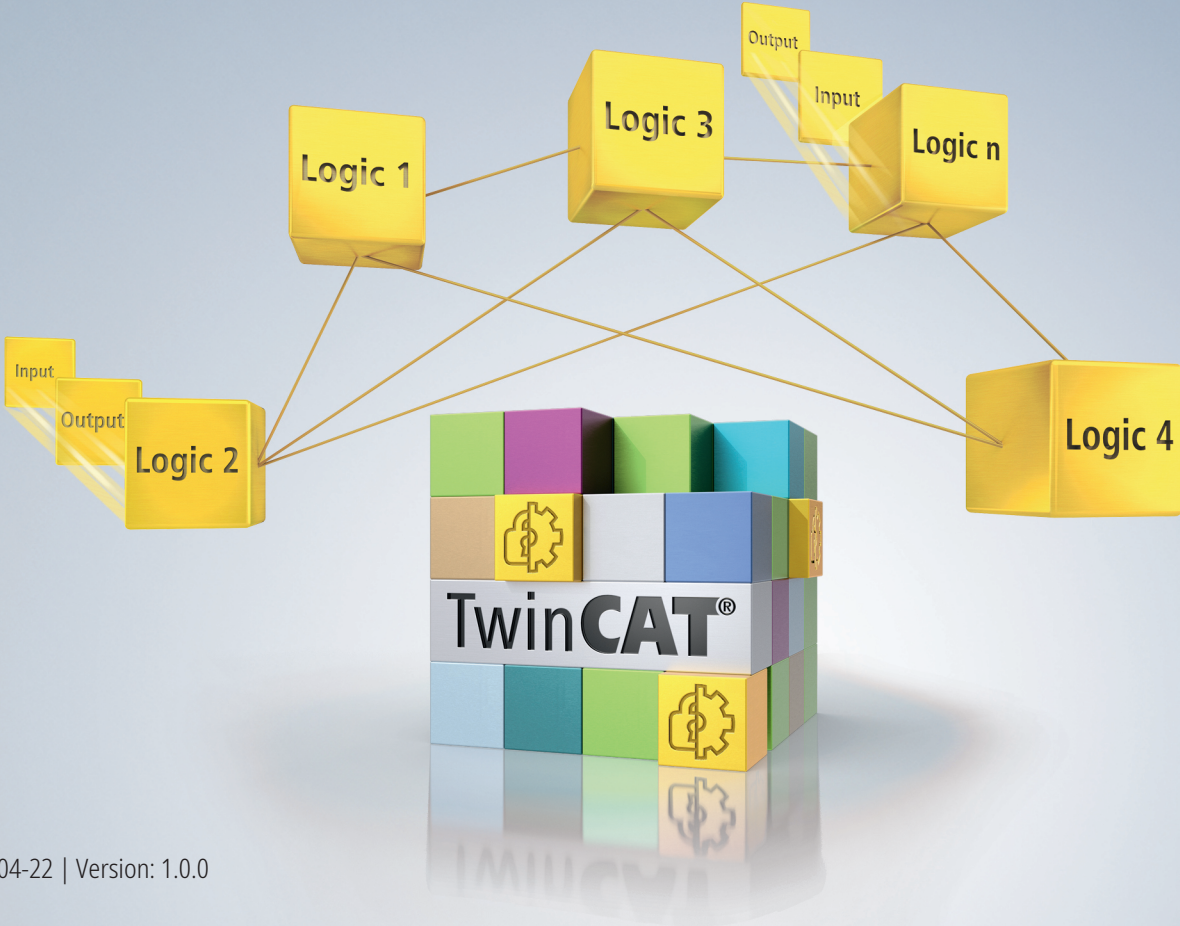


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1 Notes on the documentation

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.

1.1.1 Trademarks

Beckhoff®, TwinCAT®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered and licensed trademarks of Beckhoff Automation GmbH.

The use of other brand names or designations by third parties may lead to an infringement of the rights of the owners of the corresponding designations.

1.1.2 Patents

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



EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH.



Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH.

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

1.1.4 Copyright

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The distribution and reproduction of this document as well as the use and communication of its contents without express authorization are prohibited.

Offenders will be held liable for the payment of damages. All rights reserved in the event of the grant of a patent, utility model or design.

1.2 Version numbers

Output	Comment
1.0.0	• First released version
0.0.1	• Preliminary (internal only)

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 References

No.	Output	Title / description
[1]	/	Not in use.
[2]	/	Not in use.
[3]	1.4.1 or newer	Operating instructions for EL6910 TwinSAFE Logic module The document contains a description of the Logic functions of the EL6910, and thus also of the TwinSAFE component, and their programming
[4]	3.1.0 or newer	Documentation for TwinSAFE Logic FB The document describes the safety function blocks that are available in the EL6910, and thus also in the TwinSAFE component, and form the safety application.
[5]	1.8.0 or newer	TwinSAFE Application Guide The Application Guide provides the user with examples for the calculation of target failure measures for safety functions according to the standards DIN EN ISO 13849-1 and EN 62061 or EN 61508:2010, such as are typically used on machines.
[6]	2006/42/EC	Directive 2006/42/EC of the European Parliament and of the Council of 17. May 2006 on machinery and amending Directive 95/16-7/EC (revised) of 29 June 2006 This directive, also known as the Machinery Directive, defines requirements for the placing on the market of machines and machine-like components, such as safety components.
[7]	/	Not in use.

1.4 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.

1.5 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](#) [▶ 12] 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.

1.6 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
Web: 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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Web: www.beckhoff.com/training

Service

The Beckhoff Service Center supports you with after-sales services such as on-site service, repair service or spare parts service.

Hotline: +49 5246/963-460
E-mail: service@beckhoff.com
Web: www.beckhoff.com/service

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

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

1.7 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

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 General safety instructions

This chapter contains safety instructions for handling the product. This product is a safety component as defined by the Machinery Directive. The product must be installed in a machine or system by the machine builder and is used to ensure the safety function. Safety components are not required for the functioning of a machine. However, a failure or malfunction of safety components will result in a hazard to personal safety. Read the documentation prepared by the machine builder.

2.2.1 Before operation

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 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.

For more information, see the document [6] at [References](#) |► 7|.

Traceability

Ensure the traceability of the head station via the serial number.

Using the SELV/PELV power supply unit

Use a SELV/PELV Class 2 power supply with an output-side voltage limitation of $U_{\max} = 36 V_{DC}$ in accordance with UL1310, Limited Energy in accordance with UL61010-1 or an equivalent source for the power supply of the head station with $24 V_{DC}$ and for all connected circuits.

Failure to do so may jeopardize the safety function of the product. Depending on the machine, death and danger to life, serious bodily injury and damage to the machine may result.

Use UL-compliant cables

Supply cables and communication cables must be UL-certified: CYJV2/8, CYJV/7 or PVVA/7.

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.

2.2.2 During operation

Impairment due to interference emissions

Do not operate the following devices in the vicinity of the head station: for example, mobile phones, radio equipment, transmitters or high-frequency systems.

The TwinSAFE products comply with the current standards on electromagnetic compatibility with regard to spurious radiation and immunity to interference. If you exceed the limits for interference emissions specified in the standards, the function of the head station may be impaired.

Observe the GND concept

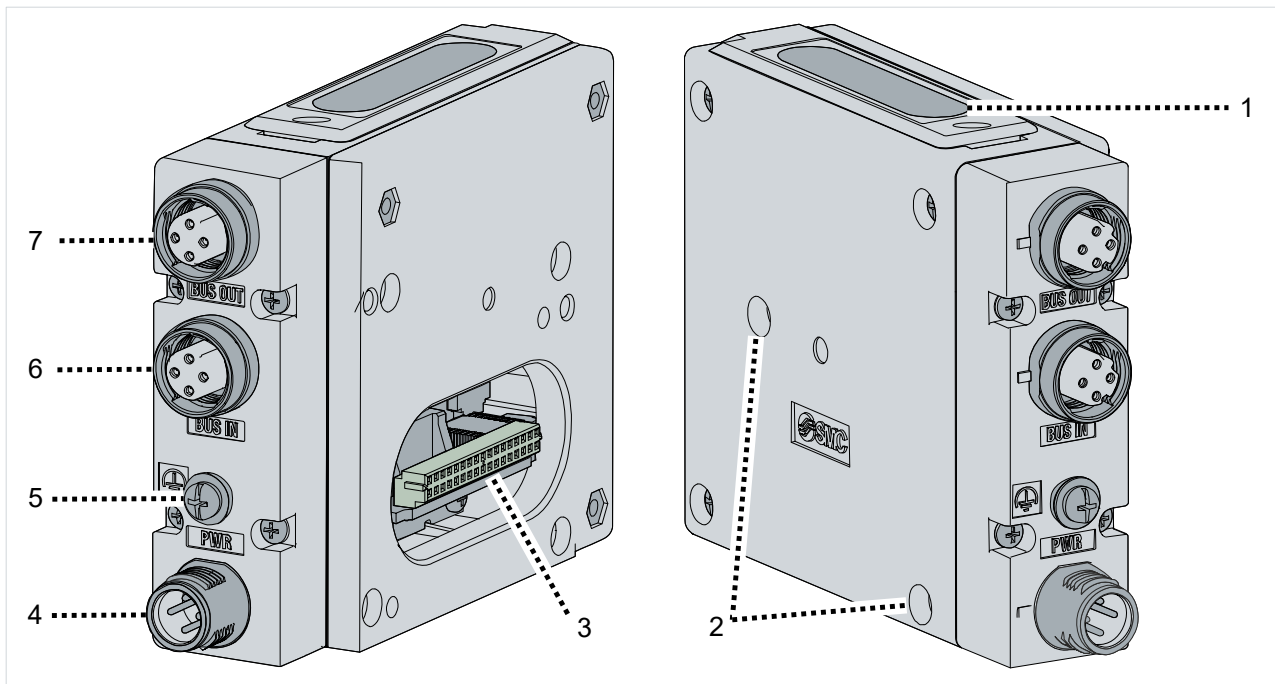
When grounding the TwinSAFE component, observe special conditions. In every case, read the chapter [Grounding](#) [▶ 42].

2.2.3 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](#) [▶ 47].

3 Product overview



Item number	Component	Explanation
1	LEDs and address switch	LED display to indicate the status of SI Unit A 10-bit DIP-Switch is provided for the safety address setting
2	Mounting hole	Mounting hole for connection to the valve manifold
3	Output signal interface	Output connection for valve manifold
4	Connector for the power supply	Power supply for valves and power supply for logic of the SI Unit M12 4-pin plug, A-coded For more information, see the chapter PWR [▶ 40].
5	FE terminal screw	Functional earth terminal M3 screw For more information, see the chapter Grounding [▶ 42].
6	EtherCAT connector BUS IN	EtherCAT connection for Port 1 M12 4-pin socket, D-coded For more information, see the chapter BUS OUT and BUS IN [▶ 40].
7	EtherCAT connector BUS OUT	EtherCAT connection for Port 2 M12 4-pin socket, D-coded For more information, see the chapter BUS OUT and BUS IN [▶ 40].

3.1 Product description

Integrated TwinSAFE safety technology

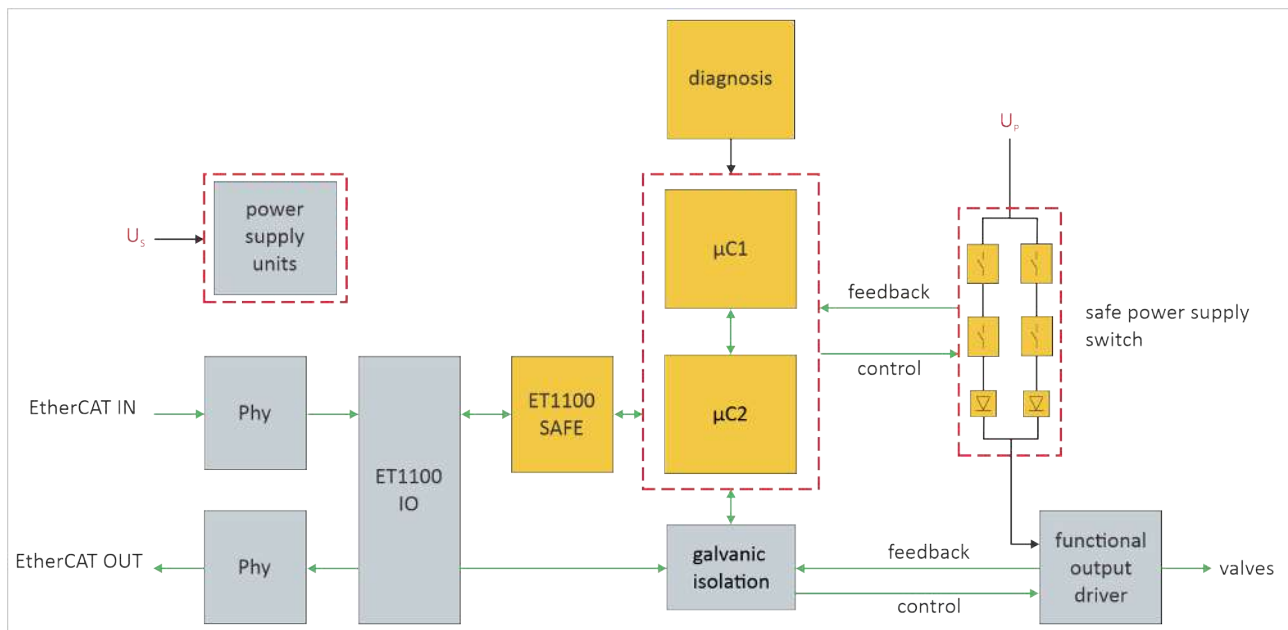
This Serial Interface Unit (SI Unit) is a TwinSAFE product for SMC pneumatic valves. TwinSAFE Logic allows you to implement safety applications directly in the SI Unit and realize them on up to 32 connected valves.

3.2 Block diagram

The block diagram describes the internal structure of the TwinSAFE component.

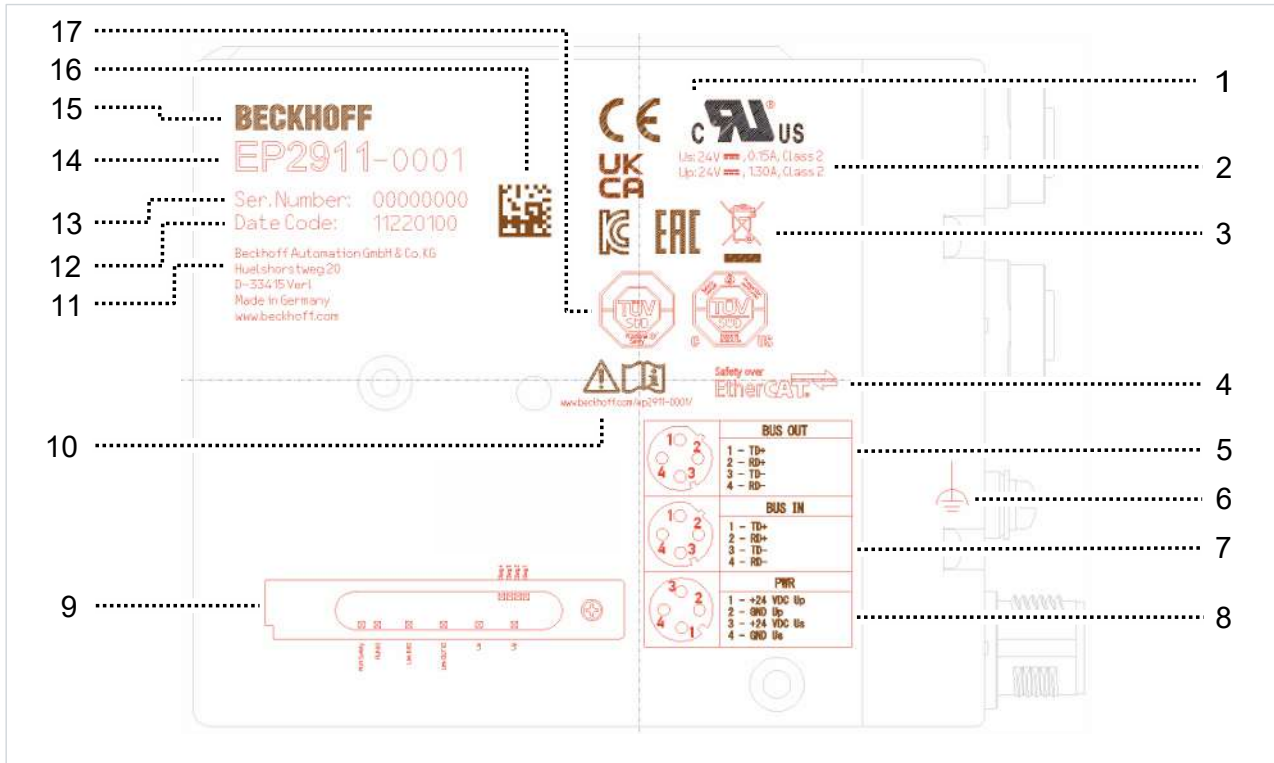
A distinction is made between a functional and a higher-level, safe part in the component:

- The functional part controls up to 32 downstream pneumatic valves.
- The higher-level, safety-related part safely shuts down the power supply to up to 32 valves.



The TwinSAFE component has an internal two-channel structure based on a 1oo2 structure.

3.3 Laser image



Item number	Explanation
1	Mark of conformity <ul style="list-style-type: none"> • CE • cRUus • UKCA • KC • EAC • NRTL
2	Current and voltage specification for U_s and U_p
3	Labeling of products that must not be disposed of with domestic waste in accordance with Directive 2012/19/EU
4	Safety over EtherCAT® logo
5, 7, 8	Illustration of the connector pin assignment
6	Labeling of the functional earth connection
9	Labeling the LEDs
10	Product label "Read operating instructions", website
11	Address, country of manufacture
12	Date Code WW = calendar week of manufacture JJ = year of manufacture SW = software version HW = hardware version
13	Serial number
14	Product designation
15	Vendor's logo
16	QR code to read out the serial number
17	TÜV-SÜD test mark for functional safety

3.4 Intended use

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

The TwinSAFE products are designed for machine safety functions and directly associated industrial automation tasks.

This product is intended for use in applications requiring safe disconnection of electrical power of pneumatic valves. It is the user's responsibility to determine if this product is suitable for the intended application and to specify the pneumatic valve arrangement accordingly to achieve the required safety function.

TwinSAFE products are therefore only approved for applications with a defined fail-safe state. This safe state is the wattless state.

WARNING

Improper use

Any use which exceeds the permissible written values from the chapter [Technical data \[► 19\]](#) 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/>.

4.1.1 Hardware

Hardware data		Explanation
Electrical data		
• Supply voltage U_S	24 V _{DC} (-15 % / +20 %) SELV/PELV with maximum 36 V _{DC}	The supply voltage U_S supplies the internal logic (control voltage).
• Supply voltage U_P	24 V _{DC} (-15 % / +20 %) SELV/PELV with maximum 36 V _{DC}	The supply voltage U_P supplies the valves (peripheral voltage).
• Number of functional output drivers	32	
• Simultaneity factor of the outputs	100 %	
• Output power	0.975 W	
• Output current U_P	1.3 A	The head station can only be activated if there is no overvoltage or undervoltage on U_P .
• Current consumption of U_S	0.15 A	
• Detection of external power supply	≥ 2 V _{DC} active 1 seconds after switching off the safe output	
• Undervoltage detection of U_P	≤ 16 V _{DC} (+10 %)	If undervoltage is detected, the TwinSAFE component switches to the state <u>Global Shutdown</u> [▶ 25].
• Overvoltage detection of U_P	≥ 36 V _{DC} (-10 %)	If overvoltage is detected, the TwinSAFE component switches to the state <u>Global Shutdown</u> [▶ 25].
• Overcurrent detection of U_P	267 mA \pm 20% per output	If overcurrent is detected, the TwinSAFE component switches to the state <u>Module Shutdown</u> [▶ 25].
Mechanical data		
• Dimensions	28.2 x 76.5 x 102.4	Width x height x length All dimensions in mm. See chapter <u>Dimensional drawing</u> [▶ 24].
• LEDs	Division and number: 10 LEDs • 6 status LEDs • 4 diagnostic LEDs	See chapter <u>LEDs</u> [▶ 28].
• Number of connectable valves	max. 32	
• Weight	approx. 200 g	

4.1.2 Software

Software data		Explanation
Reaction times		
• Reaction time	Typically 4 ms maximum see fault reaction time	Time between the request of a safety function until the output is switched off.
• Fault reaction time	≤ watchdog time	
Process image		
• Input	6 – 255 bytes (1 – 126 bytes Safe Data)	For more information, see the chapter Local process image [▶ 45] .
• Output	6 – 255 bytes (1 – 126 bytes Safe Data)	
General		
• Number of downloads	max. 10,000	When 90% of this value is reached, a Diag message is issued as a warning for each further write access. When 100% is reached, no further write access is possible and the device goes into the Global Shutdown state as soon as another write access occurs. For further information, please refer to the chapter Global Shutdown [▶ 25] .
• Protocol	TwinSAFE SC	

4.2 Target failure measures

● 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 13849-1:2015; table K.1.

The TwinSAFE component is intended for use in safety-related applications. It meets the following standards:

- IEC 61508:2010 up to SIL 3
- EN ISO 13849-1:2015 up to PL e, category 4

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	5.04E-09	
PFD_{avg}	9.54E-06	
$MTTF_D$	High	
DC	High, 99 %	
SFF	>99 %	
SIL	3	Conforms to IEC 61508:2010.
Performance Level	e	Conforms to EN ISO 13849-1:2015.
Category	4	Conforms to EN ISO 13849-1:2015.
HFT	1	
Element classification	Type B	In accordance with 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 the product under the following operating conditions:

- under the influence of ionizing radiation (exceeding the natural background radiation)
- in corrosive environments¹
- in an environment that leads to impermissible contamination of the product

¹ A corrosive environment exists when corrosion damage becomes apparent.

Permissible requirements for the environment		Explanation
Environmental conditions		
• Class for climatic environmental conditions	3K22	Conforms to EN IEC 60721-3-3:2019. The deviation from 3K22 is only possible under optimum environmental conditions and also applies only to the technical data which are specified differently in this documentation.
• Application	indoors	
• Pollution degree	2	Conforms to EN IEC 60664-1:2020.
• Overvoltage category	II	
• Protection class	III	By using a SELV/PELV power supply unit.
• Utilization category	DC-13	Conforms to EN 60947-5-1:2017.
Operating conditions		
• Fieldbus	EtherCAT	
• EMC requirements	Severity level conforms to SIL 3 Zone B	Conforms to EN 61326-3-1:2017 and IEC 61131-2:2017.
• Vibration resistance	5 Hz ≤ f < 8.4 Hz; 3.5 mm _{peak} 8.4 Hz ≤ f < 500 Hz; 10 m/s ² _{peak}	Conforms to DIN EN 60068-2-6:2008-10.
• Shock resistance	15 g with a pulse duration 11 ms in all three axes	Conforms to DIN EN 60068-2-27:2010-02.
• Protection rating	IP67	Conforms to EN 60529-2014:09. Only with connected valves.
• Correct installation position	Variable	
Temperatures		
Tested in accordance with EN 60068-2-1:2007, EN 60068-2-2:2007 and EN 60068-2-14:2009. <i>The measuring device has a tolerance range of ± 3 °C for the minimum temperature and ± 2 °C for the maximum temperature.</i>		
• during operation	-10 °C to +50 °C	See chapter Sample configuration for temperature measurement in document [5] in References. For altitudes above 2450 m, the derating factors in the following table apply.
• in storage	-20 °C to +60 °C	

Permissible requirements for the environment		Explanation
• internal switch-off temperature	110 °C	If this value is exceeded, the TwinSAFE component switches to the state Global Shutdown [► 25].
Ambient air		
• Air humidity	5% to 85%	Non-condensing.
• Air pressure operation	750 hPa to 1100 hPa	Up to an altitude of approx. 2450 m above sea level, assuming an international standard atmosphere.

Derating table for altitudes above 2450 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
-690 to 2450 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 2450 m

²⁾ The air pressure and air density increase as the altitude decreases. Therefore the derating factor for 0 to 2450 m (1.0) is used for altitudes below sea level.

Calculation example

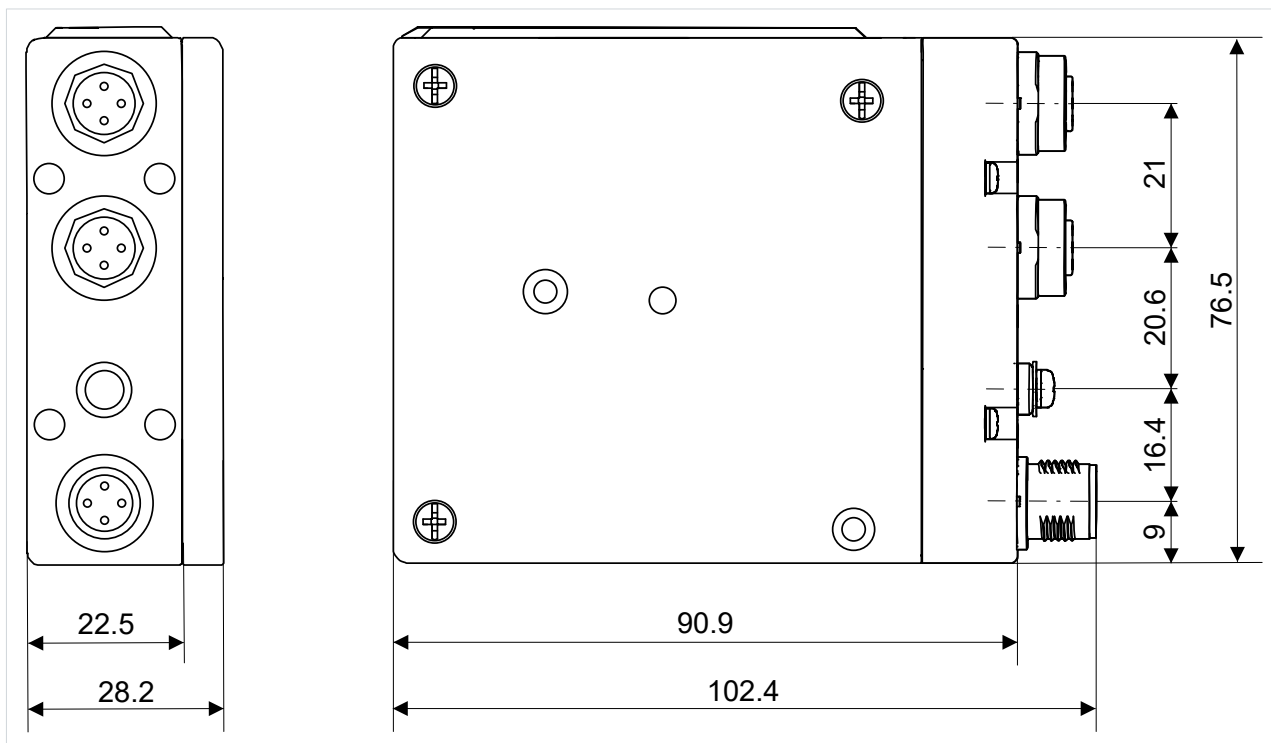
The following example shows the calculation for a TwinSAFE component at an operating altitude of 4000 m.

Permissible maximum ambient temperature up to 2450 m above sea level = 50 °C

Permissible maximum ambient temperature up to 4000 m above sea level = 50°C * 0.8 = **40 °C**

4.4 Dimensional drawing

All dimensions in mm.



4.5 Project design limits

● Project design limits

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

Process image size	maximum 1486 bytes per data direction (Maximum memory size 0x1E00 for 3 buffers, i.e. with the same size of input and output process data, this results in a maximum size of 1280 bytes per data direction. Only even start addresses are possible, therefore fill bytes may have to be considered).
TwinSAFE connections	maximum 212 (A maximum of 255 CRCs in total - 1 CRC is required for a TwinSAFE connection with 1 or 2 bytes of secure data).
Safe data per TwinSAFE connection	maximum 255 bytes (telegram length 126 bytes)
TwinSAFE function blocks	maximum 512 (When using ESTOP blocks with complete input and output mapping. Other blocks may result in a lower maximum number.)
TwinSAFE groups	maximum 128
TwinSAFE users	maximum 40
Standard PLC inputs	dynamic (memory-dependent) maximum 1483 bytes
Standard PLC outputs	dynamic (memory-dependent) maximum 1483 bytes

4.6 Lifetime

TwinSAFE components have a lifetime of 20 years, during which the target failure measures are guaranteed. For more information, see the chapter [Target failure measures](#) [▶ 21].

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.

4.7 Error reaction

The product performs a permanent self-diagnosis. In the event of a detected malfunction, the product switches to the safe state according to the fail-safe principle.

Depending on the severity of the cause of the error, the system enters one of the following error states:

- Global Shutdown
- Global Fault
- Module Shutdown

4.7.1 Global Shutdown

If transient faults are detected, such as overvoltage, undervoltage or EMC influences, the head station switches to the "Global Shutdown" state.

This operating state is a safe state and temporarily shuts down the head station.

Disconnecting and reconnecting the 24 V DC power supply (U_s) to the head station resets the operating state.

4.7.2 Global Fault

When errors are detected that affect the integrity of the safety logic, such as memory errors, the head station switches to the "Global Fault" state.

This operating state permanently shuts down the head station.

Replace the head station.

4.7.3 Module Shutdown

If software errors are detected, the affected software module switches to the "Module Shutdown" state.

This operating state is a safe state and temporarily shuts down the software module.

An Error Acknowledge resets the operating state.

4.8 Voltage ratios with functional outputs switched off

In the operating state with the functional outputs switched off, there are two special circuit-related features, which are described below.

4.8.1 Switch-on pulses

When the safe supply switch is switched on, a short switch-on pulse with a pulse width of approx. 120 μs occurs due to capacitive overcoupling.

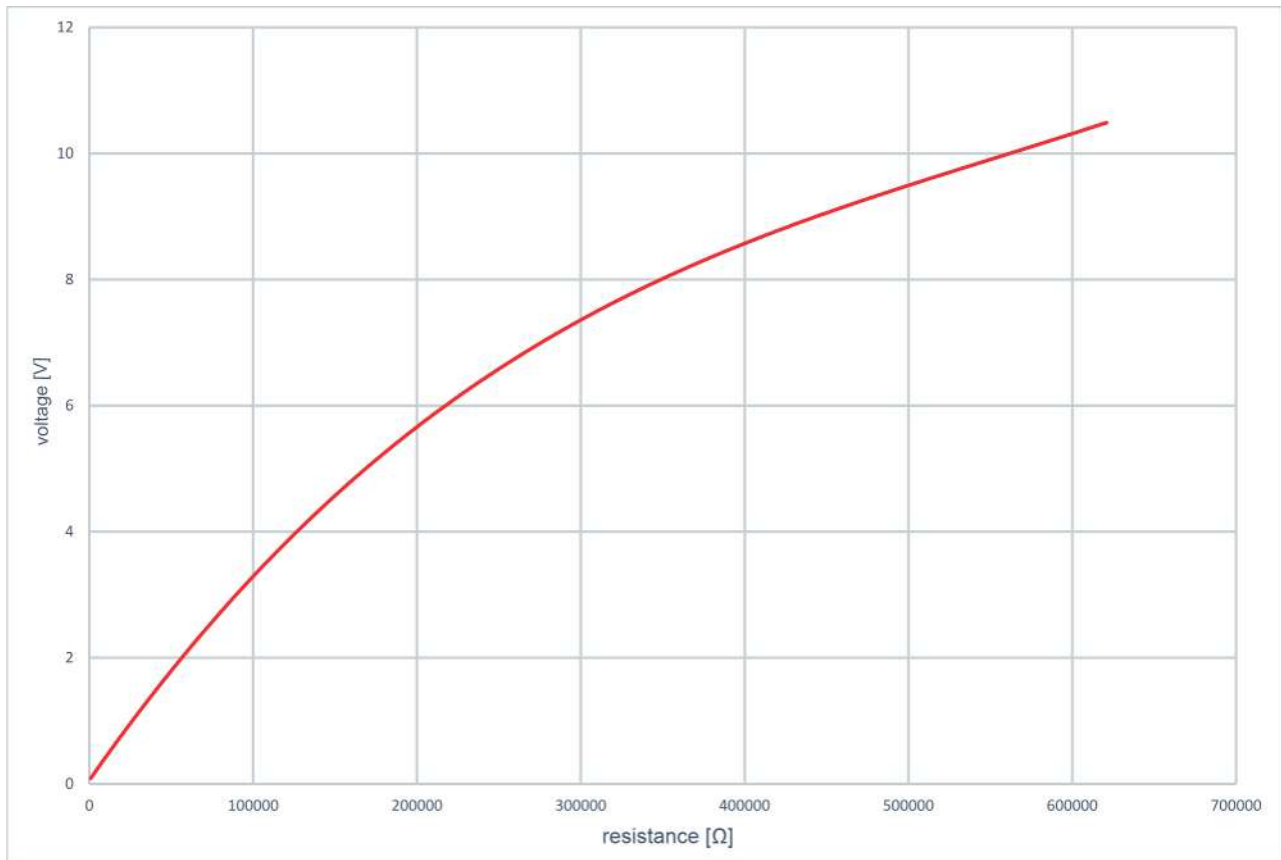
The height of this voltage level depends on the resistance of the connected loads and can be found in the following table.

Resistance [k Ω]	Pulse [V]
33	14.6
23.5	14.4
18.8	14.4
14.1	14.1
9.4	13.7
4.7	13.2
2	12.8
1	12.3
0.5	11.9
0.2	11.4
0.1	11.4

4.8.2 Open-circuit voltage/residual voltage

When the safe supply switch is switched on, an open-circuit voltage of approx. 19 V is generated at the outputs when the functional outputs are switched off.

As the ohmic load on the outputs increases, this residual voltage is reduced according to the following curve.

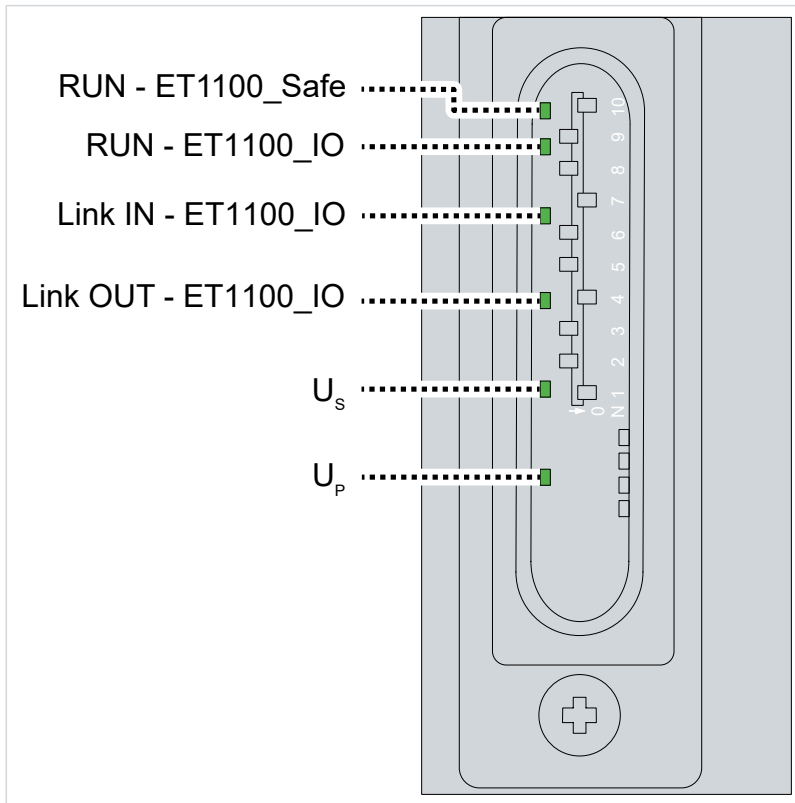


This residual voltage drops when the safe supply switch is shutdown.

5 Diagnosis

5.1 LEDs

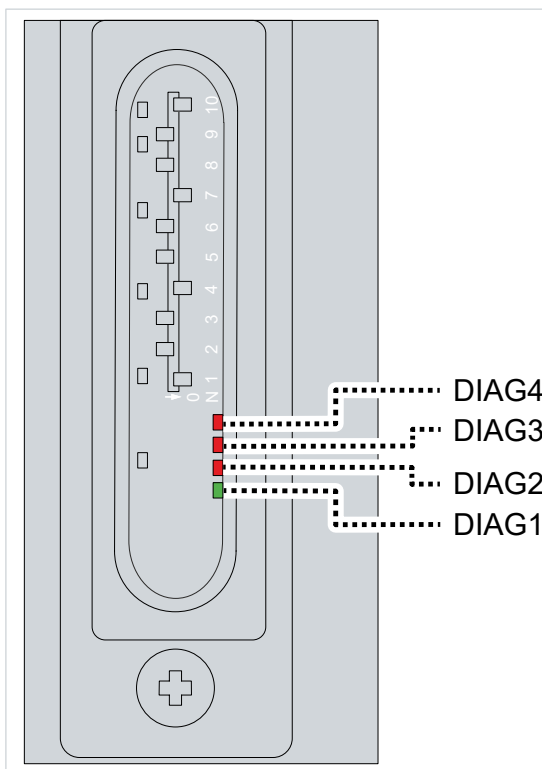
5.1.1 Status LEDs



Status LED	Function
RUN – ET1100_Safe	Indicates the status of the Safety. LED on: EtherCAT module in Operational status LED flickers: EtherCAT module in Pre-Operational status LED flashes: EtherCAT module in Safe-Operational status LED off: EtherCAT module in Init status
RUN – ET1100_IO	Indicates the status of the I/O. LED on: EtherCAT module in Operational status LED flickers: EtherCAT module in Pre-Operational status LED flashes: EtherCAT module in Safe-Operational status LED off: EtherCAT module in Init status
Link IN – ET1100_IO	Indicates the status of BUS IN. LED on: connection to previous EtherCAT module LED flashes: communication with previous EtherCAT module LED off: no connection to previous EtherCAT module
Link OUT – ET1100_IO	Indicates the status of BUS OUT. LED on: connection to the following EtherCAT module LED flashes: communication with following EtherCAT module LED off: no connection to the following EtherCAT module
U _s	Indicates the status of the control voltage U _s which supplies the internal logic.

Status LED	Function
	LED on: Operating voltage is present LED off: No operating voltage
U _p	Indicates the status of the voltage U _p which supplies the valves. LED on: U _p is in the permitted range, safe output is switched on LED flickers: U _p is in the permitted range, safe output is switched off LED flashes (flash – break – [REPEAT]): Overcurrent detected LED flashes (flash – flash – break – [REPEAT]): Overvoltage detected LED off: Undervoltage or no operating voltage detected

5.1.2 Diagnostic LEDs



DIAG1	DIAG2	DIAG3	DIAG4	Meaning
off	off	off	off	The device has no power supply.
lit	off	- ¹	-	The environmental conditions, operating voltage and internal tests are in the valid range.
lit	flashes	-	-	Internal tests are out of valid range. DIAG2 outputs a Logic error code. For more information see chapter Logic error codes [▶ 31].
off	flashes	-	-	Environmental conditions or electrical parameters are out of valid range. DIAG2 outputs an environment error code. For more information see chapter Environment error codes [▶ 31].
-	lit	lit	off	A global shutdown is present on μC1. For more information, see the chapter Global Shutdown [▶ 25].
-	lit	off	lit	A global shutdown is present on μC2. For more information, see the chapter Global Shutdown [▶ 25].

DIAG1	DIAG2	DIAG3	DIAG4	Meaning
-	off	lit	off	A global fault is present on μ C1. For more information, see the chapter Global Fault [▶ 25] .
-	off	off	lit	A global fault is present on μ C2. For more information, see the chapter Global Fault [▶ 25] .
-	flickers	-	-	An error of a safe input or output module is present.

¹ The dashes indicate a Don't-Care state.

5.1.2.1 Logic error codes

If Diag1 is on and Diag2 is flashing, Diag2 outputs a Logic error code.

The error code is introduced as follows:

1. Diag2 flickers 20 times
2. Diag2 is off for 1 s
3. Diag2 flashes according to one of the error codes in the table

Flashing Code	Description
1	Function block error in a TwinSAFE group
2	Communication error in a TwinSAFE group
3	Error combination: function block and communication
4	General error in one of the TwinSAFE groups
5	Error combination: general and function block
6	Error combination: general and communication
7	Error combination: general, function block and communication
8	not used
9	not used
10	not used

5.1.2.2 Environment error codes

If Diag1 is not on and Diag2 is flashing, Diag2 outputs a Logic error code.

The error code is introduced as follows:

1. Diag2 flickers 20 times
2. Diag2 is off for 1 s
3. Diag2 flashes according to one of the error codes in the table

Flashing Code	Description
1	Maximum supply voltage μ C1 exceeded
2	Supply voltage μ C1 below minimum value
3	Maximum supply voltage μ C2 exceeded
4	Supply voltage μ C2 below minimum value
5	Maximum internal temperature exceeded
6	Internal temperature below minimum value
7	Valid temperature difference between μ C1 and μ C2 exceeded
8	Not used
9	Not used
10	General error

5.1.3 Flashing Codes



LED flashes

Intervals:

- 400 ms ON
- 400 ms OFF
- 1 second pause between the flashing codes



LED flickers

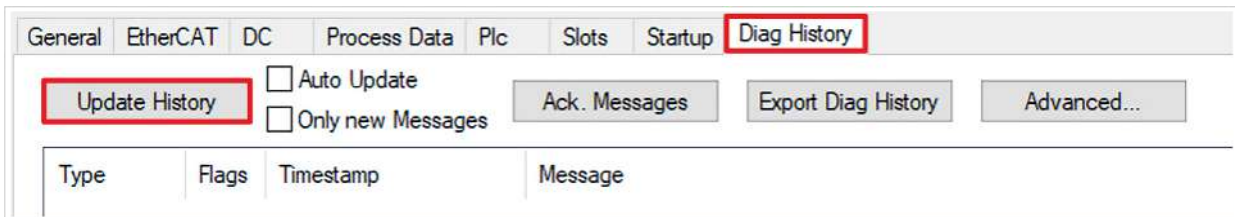
Intervals:

- 50 ms ON
- 50 ms OFF

5.2 Diagnostic history

The diagnostic history of the TwinSAFE components that support this function is implemented in accordance with the ETG guideline ETG.1020 Chapter 13 "Diagnosis Handling".

The CoE object 0x10F3_{hex}, displays current diagnosis messages and stores them in the object. They can be read out by the application or by TwinCAT and viewed in the "Diag History" tab.



If you want to retrieve the current data:

1. Click on "Update History"

Information on the parameters can be found in the table below:

Index	Name	Function	Data type	Flags	Default
10F3:0	Diagnosis History	---	---	---	---
10F3:01	Maximum Messages	Maximum number of stored messages 64 messages can be stored. The oldest messages are overwritten.	UINT8	RO	0x40; 64 _{dec}
10F3:02	Newest Message	Subindex of the latest message		RO	0x00; 0 _{dec}
10F3:03	Newest Acknowledged Message	Subindex of the last confirmed message		RW	
10F3:04	New Messages Available	Display of new messages	BOOL	RO	0x00; 0 _{dec}
10F3:05	Flags	Is set via the StartUp list: at 0x0001 the diagnosis messages are sent to the EtherCAT master via Emergency.	UINT 16	RW	0x000; 0 _{dec}
10F3:06	Diagnosis Message 001	Diagnosis message 1	BYTE 32	RO	0
---	---	---	---	---	---
10F3:45	Diagnosis Message 064	Diagnosis message 64	BYTE 32	RO	0

5.3 Structure of diagnosis messages

Component	Number of bytes	Description
DiagCode	4	The DiagCode is in this case always 0x0000 E000.
Flags	2	Contains the diagnostic type information, warning or error Contains the timestamp and the number of parameters contained
Text ID	2	ID of the diagnosis message as a reference to the message text from the SCI/XML file
Timestamp	8	Local slave time [in ns] since switching on the TwinSAFE component
Dynamic parameters	16	Parameters that can be inserted in the message text

Flags

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

Dynamic parameters

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

Diagnostic messages are stored as text format in the ESI/XML file of the TwinSAFE component. You can find the corresponding message in all available languages via the text ID in the diagnostic message. You can insert the parameters at the appropriate places in the ESI/SML file.

i Example

In the following example, %x will be used for a hexadecimal representation of the parameters:

620	#x6032	MessageText	Lcid	1031
			Abc Text	SAFEOUT:The Feedback of the active Channel Switch is wrong. Module:0x%x / Channel:0x%x

5.4 Startup

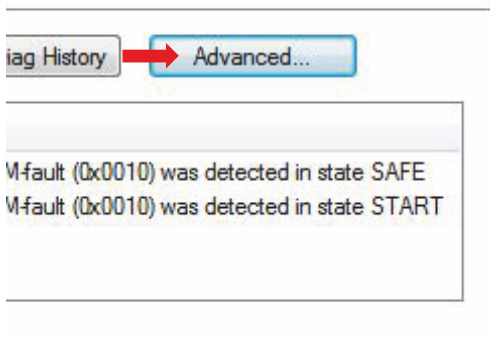
The "New Messages Available" entry indicates that new messages are available. You read the messages via CompleteAccess. CompleteAccess is a CoE read command for the complete CoE object 0x10F3. The "New Messages Available" bit is reset after reading the messages.

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

General	EtherCAT	Process Data	Slots	Startup	CoE - Online	Diag History	Online
Transition	Protocol	Index	Data	Comment			
IP	CoE	0x10F3:05	0x0001 (1)				

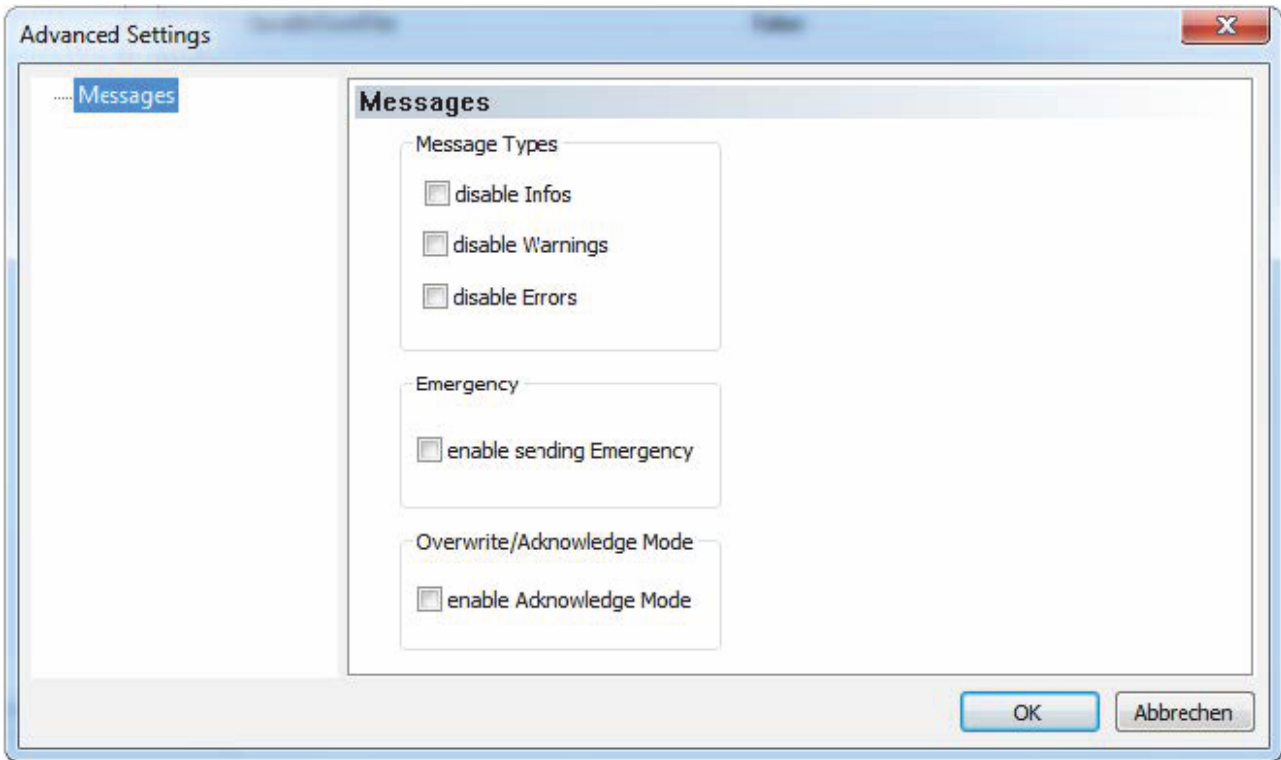
5.5 Advanced Settings

If you want to adjust the behavior of the history:



1. Select "Advanced Settings"

The dialog box "Advanced Settings" opens.



The following table contains information on the possible settings:

Setting	Explanation
Message Types	Disable Info <i>No saving of "Messages" with status "Info" in the "Diag history".</i> Disable Warnings <i>No saving of "Messages" with "Warning" status in the "Diag history".</i> Disable Errors <i>No saving of "Messages" with "Error" status in the "Diag history".</i>
Emergency	Additional sending of an emergency object, which is displayed in the "TwinCAT Logger window"
Overwrite / Acknowledge Mode	This setting is currently not supported.

6 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

Check the barcode sticker used to seal the outer packaging for damage. If the sticker is missing, opened or damaged, please contact [Beckhoff Support and Service](#) [[▶ 10](#)].

7 Installation

⚠ WARNING

Only work on TwinSAFE components in a de-energized state

The system is under tension. Bring the system into a safe, de-energized state before starting mounting, disassembly or wiring of the TwinSAFE components.

If you work on the TwinSAFE components while the system is live, you could be injured by an electric shock. The device may also be damaged.

7.1 Mechanical installation

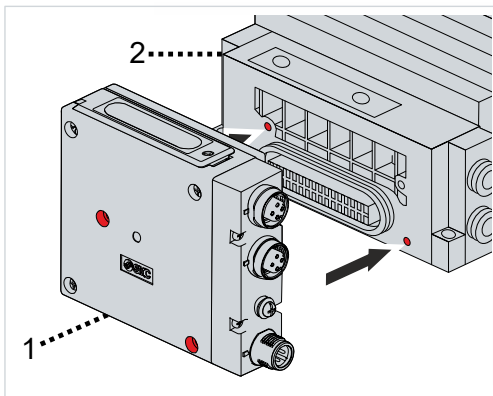
Proceed as follows to mount the head station on valves:

⚠ WARNING

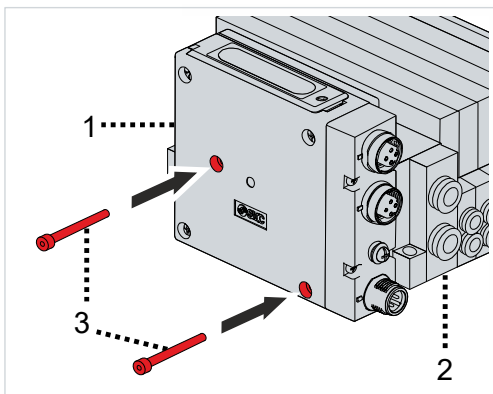
Observe the tightening torque

Observe the tightening torque to ensure a protection rating of IP67.

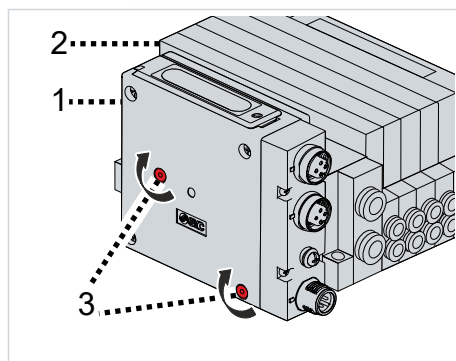
Failure to comply may endanger safety.



1. Push the head station [1] sideways against the valves [2]
2. Ensure that the holes [marked in red] of the head station [1] and the valves [2] are aligned with each other



3. Turn the screws [3] into the holes in the head station [1] to screw the head station [1] and the valves [2] together



4. Tighten the screws [3] to the defined tightening torque
The tightening torque is 0.6 Nm.

The head station has no additional holes for mounting. Details on further installation can be found in the corresponding catalog for valves.

7.1.1 Address settings

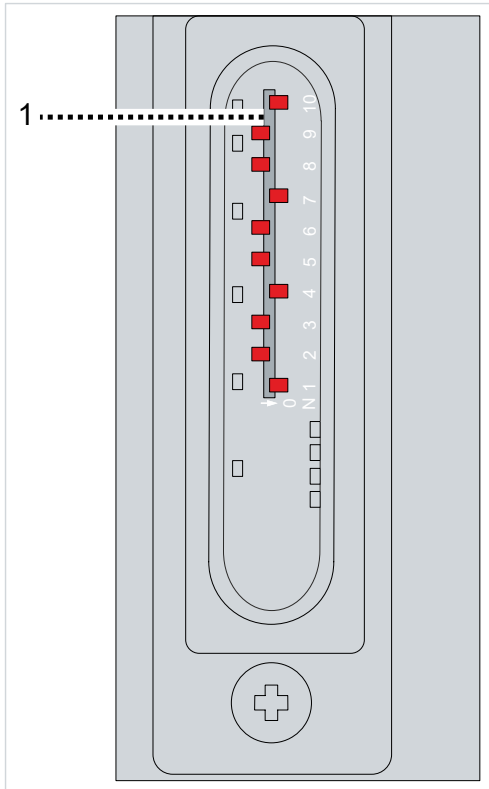
⚠ WARNING

Use TwinSAFE address only once

Each TwinSAFE address set may only occur once within a network or configuration. Use the set TwinSAFE addresses only once within your configuration.

The address 0 is not a valid TwinSAFE address.

Failure to observe this may result in malfunctions.



The 10-position DIP switch [1] for address setting is located under the housing cover on the top of the component.

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

As an alternative to setting the address with the DIP switch, you also have the option of defining the safer address as a 16-bit value in the software and saving it in the logic project. You can load the safe address separately from the logic project. When the safe address is downloaded, the address of the DIP switch is ignored. You can also delete the secure address by downloading and entering the user data.

- i Loading the safe address**
After deleting the secure address, the address is not 0.

7.2 Electrical installation

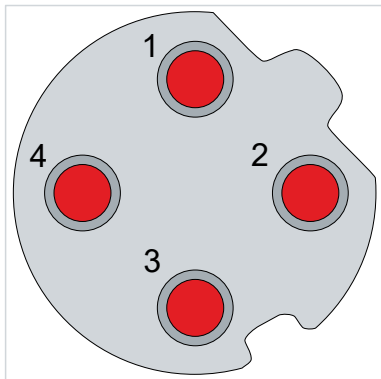
7.2.1 Connection

This chapter describes the EtherCAT connections and the connection for the power supply. Information on positioning the connections on the housing can be found in the chapter [Product overview](#) [► 15].

7.2.1.1 BUS OUT and BUS IN

The connection of the BUS OUT and BUS IN EtherCAT interfaces is identical.

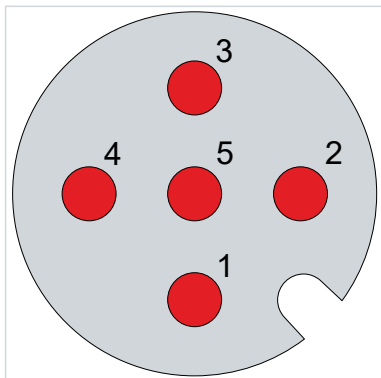
BUS OUT and BUS IN are each a 4-pin M12 D-coded socket.



Pos.	Designation	Description
1	TD+	Transfer data +
2	RD+	Receiving data +
3	TD-	Transfer data -
4	RD-	Receiving data -

7.2.1.2 PWR

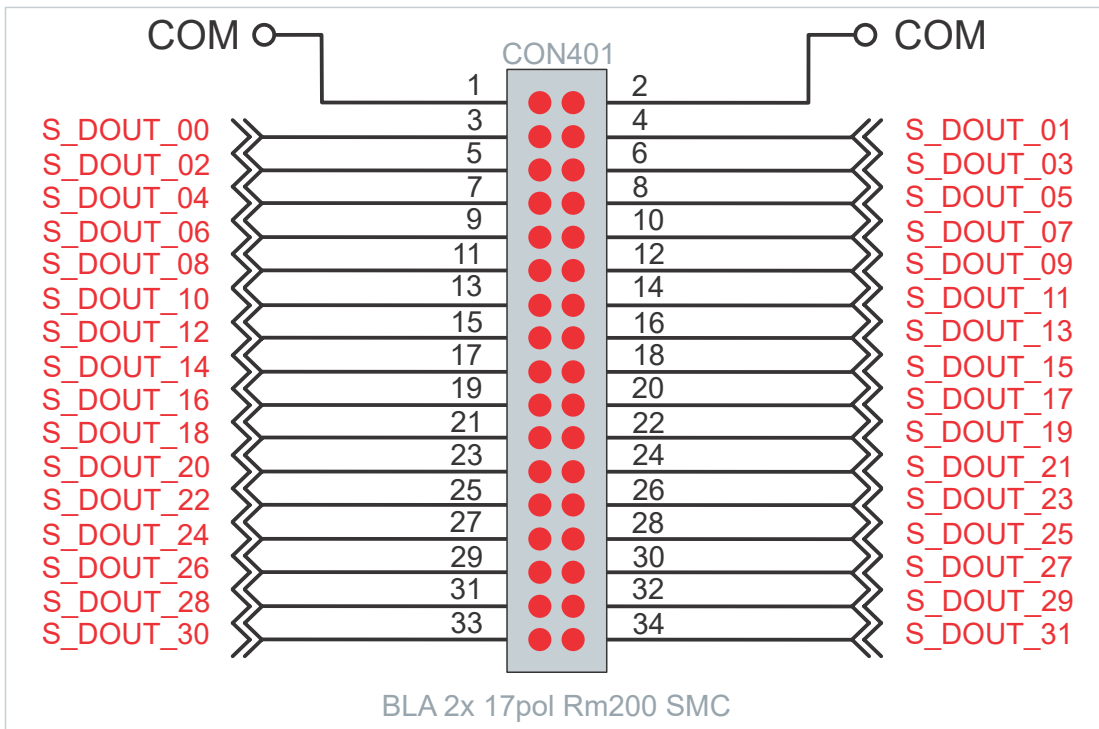
The power supply plug is a 5-pin M12 A-coded plug.



Pos.	Designation	Description
1	U_p	+24 V for solenoid valves
2	Ground (U_p)	0 V for solenoid valves
3	U_s	+24 V for operation of the head station
4	Ground (U_s)	0 V for operation of the head station
5	/	Not used

7.2.1.3 Valve connection

The connection to the valve block is connector P5032-13-2.



7.2.2 Grounding

The head station must be connected to FE (functional earth) in order to dissipate electromagnetic interference. Connect a ground cable from the FE terminal screw on the head station to the nearest functional earthing point.

The position of the FE terminal screw on the housing can be found in the chapter [Product overview \[► 15\]](#).

7.2.3 Connectable loads

The following conditions apply to connectable loads:

- Only valve blocks that do not allow a valve to be connected using a cable extension may be used.
- Connection lines between the head station and valve block should run completely in the protected housing (consisting of head station and valve block) in order to prevent a short circuit on the 24 V lines.
- The 24 V and ground connections of the loads (valve block) should only be routed to the corresponding connections of the head station.
- The loads (valve block) should not allow any further external power supply.
- The valve blocks to be connected should have at least the same IP protection class as the head station.

8 Factory setting project

8.1 Description

The head station with integrated safety technology is supplied with a factory setting project as an example, which enables simple commissioning.

● No safety functions when deleting the factory setting project

i If you delete the factory setting project and do not load a customer-specific safety application on the head station, the PLC of the head station is empty and the outputs are switched off. The device is in a safe state.

Make sure that a safety project is always active on the head station before using it for safety purposes.

● Address setting

i In the delivery state, a safe address of "1" is set.

If you want to use more than one head station, change the addresses of the additional head stations to ensure specific addressing. Then download the project again.

For further information on address setting, please refer to the chapter [Address settings \[► 39\]](#).

8.2 Process image

⚠ WARNING

Use non-safe signals only functionally

For each signal in the process image, the column "Group" indicates whether it is a safety-related or a standard signal. Non-safe signals must not be used for safety-related evaluation or shutdown without additional measures.

● Process image valid for the factory setting project

i Note that the process image depends on the active project and the implemented safety functions. The process image listed in this document applies exclusively to the factory setting project. For customer-specific projects, the process image may differ from the process image shown here. For further information on customer-specific projects, please refer to the chapter Customized safety application.

The process image of the EP2911-0001 consists of the input and output process image. Detailed information can be found in the following tables.

8.2.1 Input

The process image of the input signals consists of 6 bytes of data, 1 byte of which are usage data.

Offset	Name	Data type	Group	Description
0.0	Safe Power Supply Enable	BOOL	Safety	True: Power supply active False: Power supply inactive, safe state
0.1	Safe Power Supply ErrAck	BOOL	Safety	True: Reset error in the power supply False: Do not reset error in the power supply

8.2.2 Output

The process image of the output signals consists of 6 bytes of data, 1 byte of which are usage data.

Offset	Name	Data type	Group	Description
0.0	Safe Power Supply Error	BOOL	Safety	True: Error in the power supply False: No error

9 Local process image

The process image is composed of the input process image and the output process image. The following local process image is available for your customer-specific safety application.

9.1 Input

The local process image of the input signals consists of a maximum of 512 bytes of data.

Offset	Name	Data type	Group	Description
0.0	Safe Power Supply Error	BOOL	Safety	True: Error in the power supply False: No error

9.2 Output

The local process image of the input signals consists of a maximum of 512 bytes of data.

Offset	Name	Data type	Group	Description
0.0	Safe Power Supply Enable	BOOL	Safety	True: Power Supply active False: Power supply inactive; safe state
0.1	Safe Power Supply ErrAck	BOOL	Safety	Resetting a power supply error

10 Maintenance and cleaning

● **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.

TwinSAFE components are basically maintenance-free.

11 Decommissioning

11.1 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.

11.1.1 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.

12 Appendix

12.1 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.


12.2 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.

CERTIFICADO ◆ CERTIFICADO ◆ CERTIFICADO ◆ CERTIFICADO ◆



EC-Type Examination Certificate


No. M6A 062386 0055 Rev. 01

Holder of Certificate:	Beckhoff Automation GmbH & Co. KG Hülshorstweg 20 33415 Verl GERMANY
Product:	Safety components
Model(s):	EL1918
Parameters:	Supply voltage: 24VDC (-15%/+20%) Ambient temperature: -25°C...+55°C Protection class: IP20

This EC Type Examination Certificate is issued according to Article 12(3) b or 12(4) a of Council Directive 2006/42/EC relating to machinery. It confirms that the listed Annex-IV equipment complies with the principal protection requirements of the directive. It refers only to the sample submitted to TÜV SÜD Product Service GmbH for testing and certification. For details see: www.tuvsud.com/ps-cert

Test report no.:	BV99670C
-------------------------	-----------------

◆ CERTИФИКАТ ◆ CERTИФИКАТ ◆ CERTИФИКАТ ◆



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

More Information:
www.beckhoff.com/twinsafe

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