# BECKHOFF New Automation Technology

Safety Manual | EN

# EJ19xx-0001

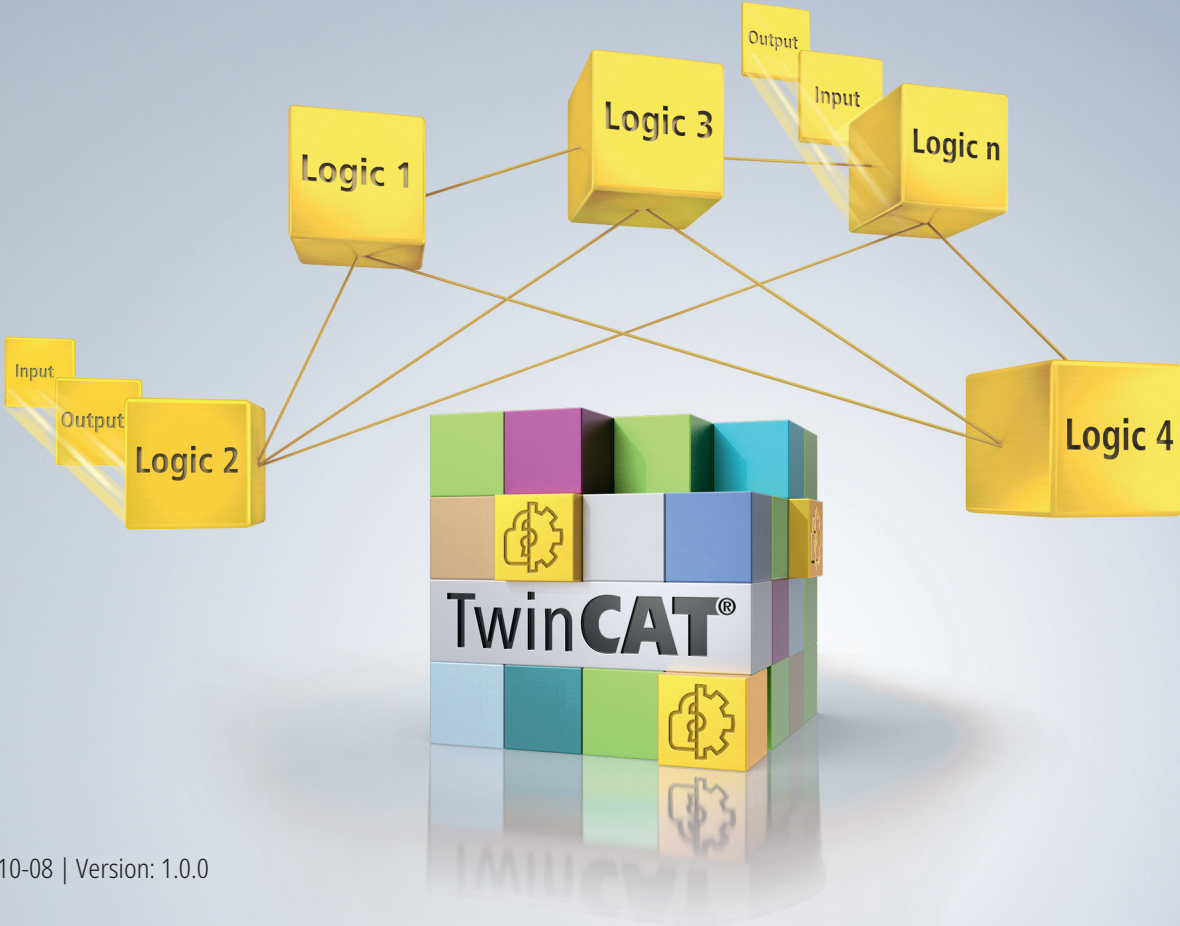Housingless TwinSAFE EJ Modules with digital fail-safe inputs and outputs

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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

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### 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



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## 1.1.3        Limitation of liability

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

**The following is excluded from the liability:**

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

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## 1.2    Version numbers of the documentation

| Version | Comment |
|---------|---------|
| 1.0.0 | • First released version |
| 0.0.1 | • First preliminary version |

**Currentness**

Please check whether you are using the current and valid version of this document. The current version can be downloaded from the Beckhoff homepage at http://www.beckhoff.com/twinsafe. In case of doubt, please contact Technical Support (see Beckhoff Services).

**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. | Version | Title / description |
|---|---|---|
| [1] | 1.3.0 or newer | **Design Guide for EJ backplane for TwinSAFE modules** |
| | | The Design Guide contains specifications for the development of an EJ backplane when TwinSAFE EJ modules are to be used. |
| [2] | 4.7 or newer | **EJxxxx \| EtherCAT plug-in modules - design guide** |
| | | The design guide contains general specifications for the development of an EJ backplane. |
| [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 failure limits 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 June 29, 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. |

# 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**

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

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**Beckhoff Headquarters**

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# 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

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

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

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

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

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

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

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

## 2.2 General safety instructions

### 2.2.1 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.

**Using the SELV/PELV power supply unit**

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

Use a SELV/PELV power supply unit with an output voltage limitation of $U_{max}$ = 60 $V_{DC}$ to supply the TwinSAFE component with 48 $V_{DC}$.

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.

**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.

**Overvoltage protection**

If protection against overvoltage is necessary in your plant, provide a surge filter for the voltage supply to the EJ distribution board and the TwinSAFE EJ modules.

This surge filter can be implemented on the EJ distribution board or as an external filter function block and is intended to limit transients above 36 V.

**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.

**Handling according to IPC standards**

As the EJ modules without housing are PCBs, they must be stored, assembled, and handled in accordance with IPC standards.

## 2.2.2 In 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.

## 2.2.3 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 [▶ 32].

# 3   Intended use

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

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

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

The TwinSAFE EJ modules are intended for operation on an EJ distribution board.

| ⚠ WARNING |
| --- |
| **Improper use** |
| Any use which exceeds the permissible written values from the chapter General technical data [▶ 16] 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 General technical data

## 4.1 Product data

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

| Hardware data | | Explanation |
|---|---|---|
| **Electrotechnical data** | | |
| • Supply voltage | 24 $V_{DC}$ (- 15 % / + 20 %) <br><br> SELV/PELV with maximum 36 $V_{DC}$ | According to IEC 61508-1. |
| • Output current of the clock outputs | typically 8 mA to max. 11 mA | |
| • Output current of the outputs | max. 500 mA | |
| **Signal voltage** | | |
| • "0" inputs | -3 V to 5 V | According to IEC 61131-2, type 3, see chapter Characteristic curve of the inputs [▶ 21]. |
| • "1" inputs | 11 V to 30 V | |
| **Reading back the outputs (diagnostic thresholds)** | | |
| • Signal voltage "1" | > 5.61 V | |
| • Signal voltage "0" | < 1.68 V | |
| **Actuators** | | |
| • Actuators | • inductive <br> • ohmic <br> • capacitive | When selecting actuators, please ensure that the test pulses do not lead to actuator switching. |
| • Actuator switching frequency (inductive load) | max. 2.5 mH at 100 Hz <br> max. 1 H at 1 Hz | These are example working points. The user must evaluate the actuators used in relation to energy. |
| **Cable length** | | |
| • unshielded | max. 100 m | With a cross-section of 0.75 mm$^2$ or 1 mm². |
| • shielded | max. 100 m | |

| Software data | | Explanation |
|---|---|---|
| **Reaction times** | | |
| • Response time in operation *read input/write to E-bus* | 4 ms <br> maximum see fault reaction time | |
| • Fault reaction time | Adjustable <br><br> ≤ watchdog time | |
| • Watchdog time | min. 2 ms, max. 60000 ms | |
| • Cycle time | approx. 500 µs or according to project size (if a user-specific project is used) | |
| **Process image** | | |
| • Input | Dynamic in accordance with the configuration. | |
| • Output | Dynamic in accordance with the configuration. | |

> **i** **Specific technical data**
>
> The specific technical data for the respective product together with the safety parameters can be found in the respective product-specific sub-chapter.

## 4.2 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.

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### ⚠ WARNING

**Keep a distance from the maximum values**

The EJ modules are integrated into an overall system by the user. Due to complexity and variability, exact technical limits for environmental conditions are not universally applicable. In addition, many influencing factors exist that cannot be fully derived in this documentation.

Therefore, keep as large a distance as possible from the maximum values.

*Non-observance can endanger safety.*

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### ⚠ WARNING

**Do not use TwinSAFE components under the following operating conditions:**

- under the influence of ionizing radiation (exceeding the natural background radiation)
- in corrosive environments[1]
- in an environment that leads to unacceptable contamination of the TwinSAFE component

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

| Permissible requirements for the environment | | Explanation |
|---|---|---|
| **Environmental conditions** | | |
| • Class for climatic environmental conditions | 3K3 | Conforms to IEC 60721-3-3:2019.<br>The deviation from 3K3 is only possible under optimum environmental conditions and also applies only to the technical data which are specified differently in this documentation. |
| • Pollution degree | 2 | According to IEC 60664-1:2020. |
| **Operating conditions** | | |
| • EMC requirements | Must be considered by the customer. | Conforms to EN 61000-6-2 / EN 61000-6-4. |
| • Vibration resistance | Must be considered by the customer. | Conforms to EN 60068-2-6 / EN 60068-2-27. |
| • Shock resistance | Must be considered by the customer. | Conforms to EN 60068-2-6 / EN 60068-2-27. |
| • Protection rating | No protection rating | |
| • Permitted operating environment | In a control cabinet or terminal box, with minimum protection rating IP54. | Conforms to IEC 60529:1989 + A1:1999 + A2:2013. |
| • Correct installation position | Variable | |
| **Temperatures** | | |
| • during operation | -25 °C to +45 °C | The temperature increase to +55 °C is only possible with optimum ambient conditions and minimum distances. |
| • during transport and storage | -40 °C to +70 °C | |

| Permissible requirements for the environment | | Explanation |
|---|---|---|
| **Ambient air** | | |
| • Air humidity | 5% to 95% | Non-condensing. |
| • Air pressure | 750 hPa to 1100 hPa | Corresponds to an altitude of approx. -690 m to 2450 m above sea level, assuming an international standard atmosphere. |

### 4.2.1    EJ backplane

> ⚠ **CAUTION**
>
> **EJ backplane**
>
> Make sure that the TwinSAFE EJ modules are used only on an EJ backplane that has been developed and manufactured in accordance with the *Design Guide for EJ backplanes for TwinSAFE modules* (see References [▶ 8]).

> **i**  **Pin-out and coding of the TwinSAFE EJ modules**
>
> The pin-out of the TwinSAFE EJ modules is listed in the document *Design Guide for EJ backplane for TwinSAFE modules* (see References [▶ 8]).
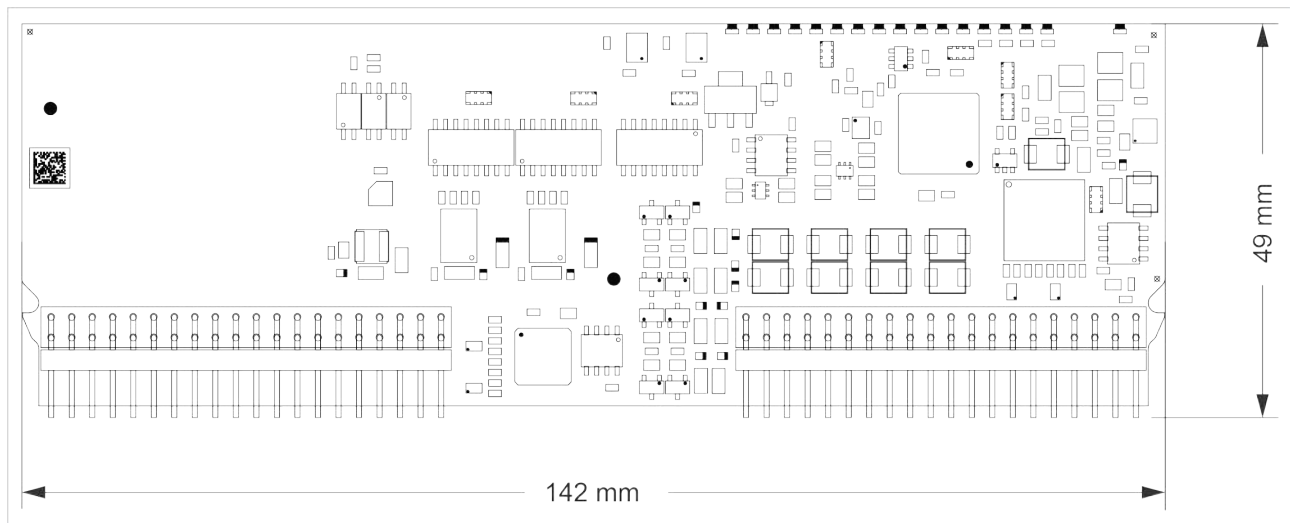
## 4.3    Dimensions



Fig. 1: EJxxxx - dimensions (long modules)

The thickness of the circuit boards is 1.6 mm.

## 4.4    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".

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

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

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

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

Date Code: CW  YY  SW  HW

| Legend: | Example: Date Code 17 11 05 00 |
|---|---|
| CW: calendar week of manufacture | Calendar week: 17 |
| YY: year of manufacture | Year: 2011 |
| SW: software version | Software version: 05 |
| HW: hardware version | Hardware version: 00 |

You will find the serial number and Date Code as a sticker in the packaging.

# 5 General operation / function

## 5.1 Installation position and minimum distances

The EJ modules without housing can be installed in any position. The minimum distances are defined in the Design Guide of the EJ modules. See document [2] at References [▶ 8].

## 5.2 Digital input

### 5.2.1 Parameterization

Two indices are provided under the safety parameters for the parameterization of the inputs. These are the general settings for the test pulse outputs and the channel-specific settings for the input filter. In the TwinSAFE EJ modules an input module consists of two channels.

| Linking | Connection | Safety Parameters | Process Image |

| Index | Name | Value | Unit |
|---|---|---|---|
| ▲ 8000:0 | FSIN Module 1 Settings Common | >4< | |
| 8000:01 | ModuloDiagTestPulse | 0x00 (0) | |
| 8000:02 | MultiplierDiagTestPulse | 0x01 (1) | |
| 8000:04 | Diag TestPulse active | TRUE (1) | |
| ▲ 8001:0 | FSIN Module 1 Settings Channel | >5< | |
| 8001:01 | Channel 1.InputFilterTime | 0x0019 (25) | x 10^-4 second |
| 8001:02 | Channel 1.DiagTestPulseFilterTime | 0x0002 (2) | x 10^-4 second |
| 8001:04 | Channel 2.InputFilterTime | 0x0019 (25) | x 10^-4 second |
| 8001:05 | Channel 2.DiagTestPulseFilterTime | 0x0002 (2) | x 10^-4 second |
| ▷ 8010:0 | FSIN Module 2 Settings Common | >4< | |
| ▷ 8011:0 | FSIN Module 2 Settings Channel | >5< | |

| Edit |

Fig. 2: Digital input - safety parameters

| Index | Name | Default value / unit | Description |
|---|---|---|---|
| 80x0:01 | ModuloDiagTestPulse | 0x00 / integer | Modulo value for the frequency of the generation of a test pulse.<br>0 -> every time<br>1 -> every second time<br>... |
| 80x0:02 | MultiplierDiagTestPulse | 0x01 / integer | Length of the test pulse in multiples of 2 ms |
| 80x0:04 | Diag TestPulse active | TRUE / Boolean | Activation of test pulses for the corresponding input module |
| 80x1:01 | Channel 1.InputFilterTime | 0x0019 / 0.1 ms | Input filter of safe input 1. Following this time the internal input signal changes to the applied signal state. |
| 80x1:02 | Channel 1.DiagTestPulseFilterTime | 0x0002 / 0.1 ms | Input filter for the test pulse signal |
| 80x1:04 | Channel 2.InputFilterTime | 0x0019 / 0.1 ms | Input filter of safe input 2. Following this time the internal input signal changes to the applied signal state. |
| 80x1:05 | Channel 2.DiagTestPulseFilterTime | 0x0002 / 0.1 ms | Input filter for the test pulse signal |

The index is incremented by 0x10 for each input module in accordance with the number of inputs.

## 5.2.2 Characteristic curve of the inputs

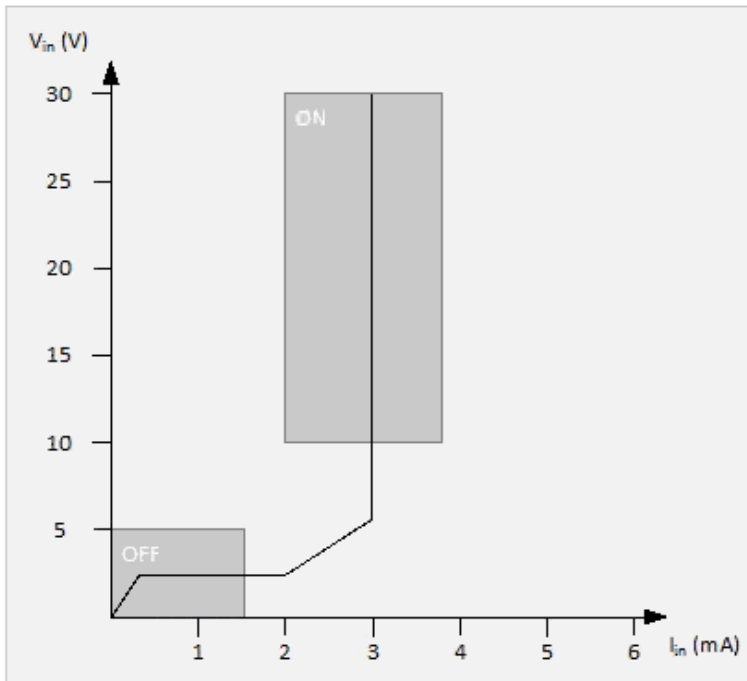The characteristic curve of the inputs is similar to type 3 according to EN 61131-2.

Fig. 3: Characteristic curve of the inputs

# 5.3 Digital output

| NOTICE |
|---|
| **protected wiring** |
| If the wiring of the outputs or the connected actuators leaves the control cabinet, the user must ensure that the wiring is protected. |

| ⚠ WARNING |
|---|
| **Active loads** |
| The use of active loads (with their own power supply) is not permissible unless the manufacturer of the load ensures the non-reactivity of the power supply to the control signal. |

| ⚠ DANGER |
|---|
| **Clocked signals inside a sheathed cable** |
| If clocked signals from different output modules are used inside a single sheathed cable, then a module error such as a cross-circuit or external power supply must lead to the switch-off of all of these modules. This switch-off must be executed by the user program. |

## 5.3.1 Parameterization

The outputs are parameterized via the *Safety Parameters* tab of the alias devices. A TwinSAFE EJ output module consists of four channels.

| Linking | Connection | Safety Parameters | Process Image | Internal Safety Parameters | Internal Process Image | Internal Direct Mappings |

| Index | Name | Value | Unit | |
|---|---|---|---|---|
| ⊿ 8000:0 | FSOUT Module 1 Settings Common | >4< | | |
| 8000:01 | ModuloDiagTestPulse | 0x00 (0) | | |
| 8000:02 | MultiplierDiagTestPulse | 0x02 (2) | | |
| 8000:03 | Standard Outputs active | FALSE (0) | | |
| 8000:04 | Diag TestPulse active | TRUE (1) | | |
| ▷ 8010:0 | FSOUT Module 2 Settings Common | >4< | | |

Edit

Fig. 4: Digital output –safety parameters

| Index | Name | Default value / unit | Description |
|---|---|---|---|
| 80x0:01 | ModuloDiagTestPulse | 0x00 / integer | Modulo value for the frequency of the generation of a test pulse.<br>0 -> every time<br>1 -> every second time<br>... |
| 80x0:02 | MultiplierDiagTestPulse | 0x02 / integer | Length of the test pulse in multiples of 400 µs |
| 80x0:03 | Standard outputs active | FALSE / Boolean | Activation of the logical AND operator of the safe and standard outputs of the module |
| 80x0:04 | Diag TestPulse active | TRUE / Boolean | Activation of test pulses for the corresponding output module |

The index is incremented by 0x10 for each output module in accordance with the number of outputs.

**Testpulse length of the output signals**

The setting via the parameter MultiplierDiagTestPulse controls the test pulses of the individual channels. In addition, the second internal switch off path is also tested. This leads to a prolongation of the length of the test pulses by approx. 700µs.

Together with the setting MultiplierDiagTestPulse = 2 results in a minimum test pulse length of 1.5 ms.

The parameter MultiplierDiagTestPulse can not be reduced to 1 since a reliable readback of the test pulse at the output is not possible.

**ℹ Testpulse length of the output**

The minimum useful setting of MultiplierDiagTestPulse = 2 results in a total test pulse length of approx. 1.5 ms.

## 5.3.2        Actuators

The outputs have a maximum permissible output current of 0.5 A. This must not be exceeded. The simultaneity factor of the outputs of an EJ module is 100%.

Inductive, resistive and capacitive loads are supported.

# 5.4        Status LEDs

The status LEDs of the TwinSAFE EJ modules are labeled STAT1 to STAT4.

| STAT1 | STAT2 | STAT3 | STAT4 | Meaning |
|---|---|---|---|---|
| Off | Off | Off | lit | No TwinSAFE project available on the component |
| Off | Off | lit | lit | TwinSAFE project loaded, but not yet in RUN state |
| lit | Off | lit | lit | TwinSAFE project loaded and in RUN state. Customization is active for at least one TwinSAFE group |
| lit | lit | lit | lit | TwinSAFE project loaded and in RUN state. Customization is NOT active |

# 5.5        Diagnostic LEDs

The diagnostic LEDs of the TwinSAFE EJ modules are labeled DIAG1 to DIAG4.

## 5.5.1        Flashing codes

| LED | lit | flashes | flickers | off |
|---|---|---|---|---|
| DIAG1 (green) | Environment variables, operating voltage and internal tests are in the valid range • If DIAG2 flashes, a logic error code applies | - | | Environment variables, operating voltage and internal tests are outside the valid range • If DIAG2 flashes, an environment error code applies |
| DIAG2 (red) | Together with DIAG3 and 4: Global shutdown[1] has occurred (see diag history of the TwinSAFE components). | Logic or environment error code according to Diag1 and tables below is output | Error of the safe input or output module | Together with DIAG3 and 4: Global fault[1] has occurred (see diag history of the TwinSAFE components). |
| DIAG3 (red) | Global fault or global shutdown on µC1[1] | - | | No global fault or global shutdown on µC1[1] |
| DIAG4 (red) | Global fault or global shutdown on µC2[1] | - | | No global fault or global shutdown on µC2[1] |

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

**Logic error codes of LED DIAG2 (if LED DIAG1 is lit)**

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

**Environment error codes of LED DIAG2 (if LED DIAG1 is off)**

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

## 5.5.2 Flash code display

| LED | Display | Description |
|---|---|---|
| flashing |  | 400 ms ON / 400 ms OFF<br>1 second pause between the flash codes |
| flickering |  | 50 ms ON / 50 ms OFF |

# 6  EJ1918-0001

## 6.1  Overview



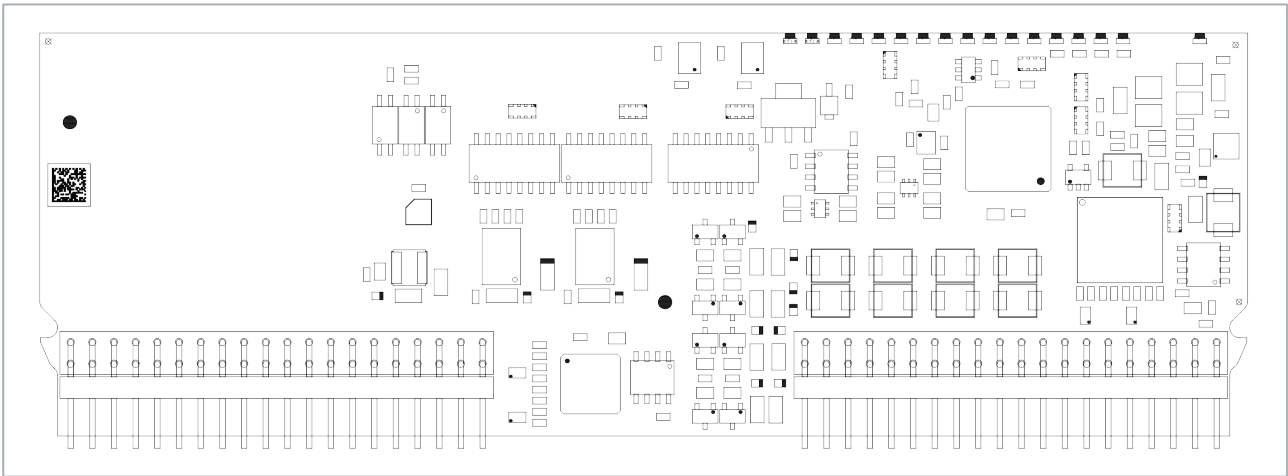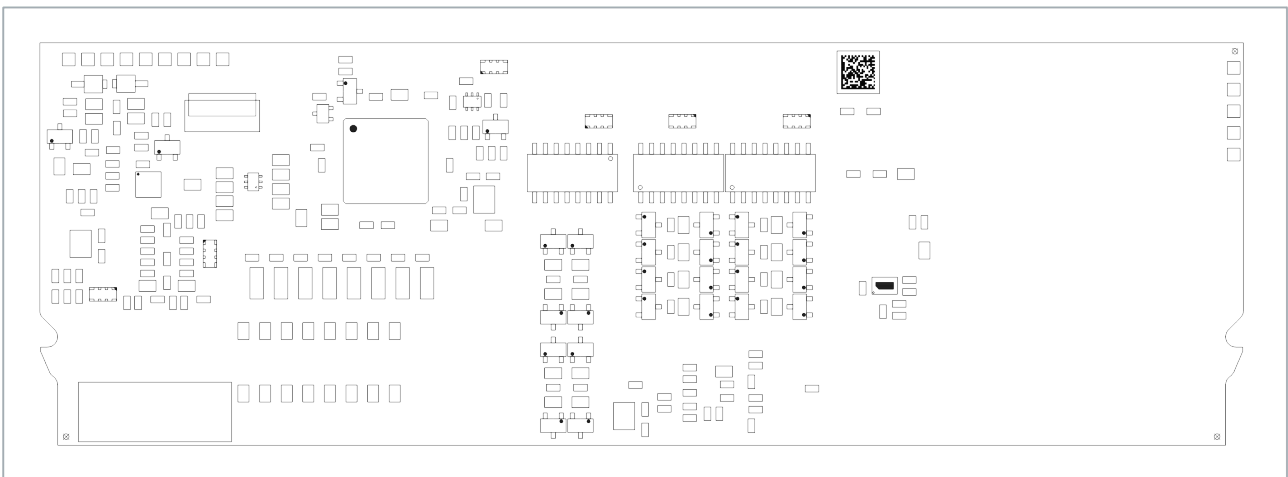Fig. 5: EJ1918-0001 - Product overview top



Fig. 6: EJ1918-0001 - Product overview bottom

The EJ module EJ1918-0001 without housing is a digital input module for sensors with potential-free contacts for 24 $V_{DC}$. The module has 8 fail-safe inputs and 8 clock outputs and complies with the requirements of IEC 61508:2010 SIL 3 and EN ISO 13849-1:2023 PL e.

The EJ module is parameterized via four input modules.

## 6.2 Address switch

The EJ1918-0001 has three address switches that are connected to the PCB via a flat-ribbon cable. They can be used to set the safety address.

> **ⓘ** **Installation**
>
> The address switches on the EJ1918-0001 are not placed directly on the PCB. The address switches must be installed and secured by the customer.
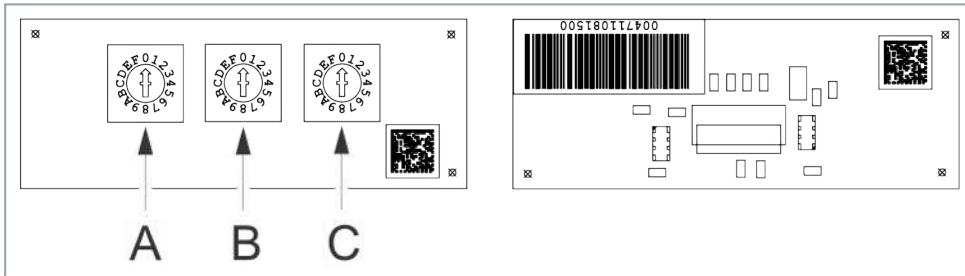


Fig. 7: Address switch

The address is set in hexadecimal form:

- A: x1 (x1h)
- B: x16 (x10h)
- C: x256 (x100h)
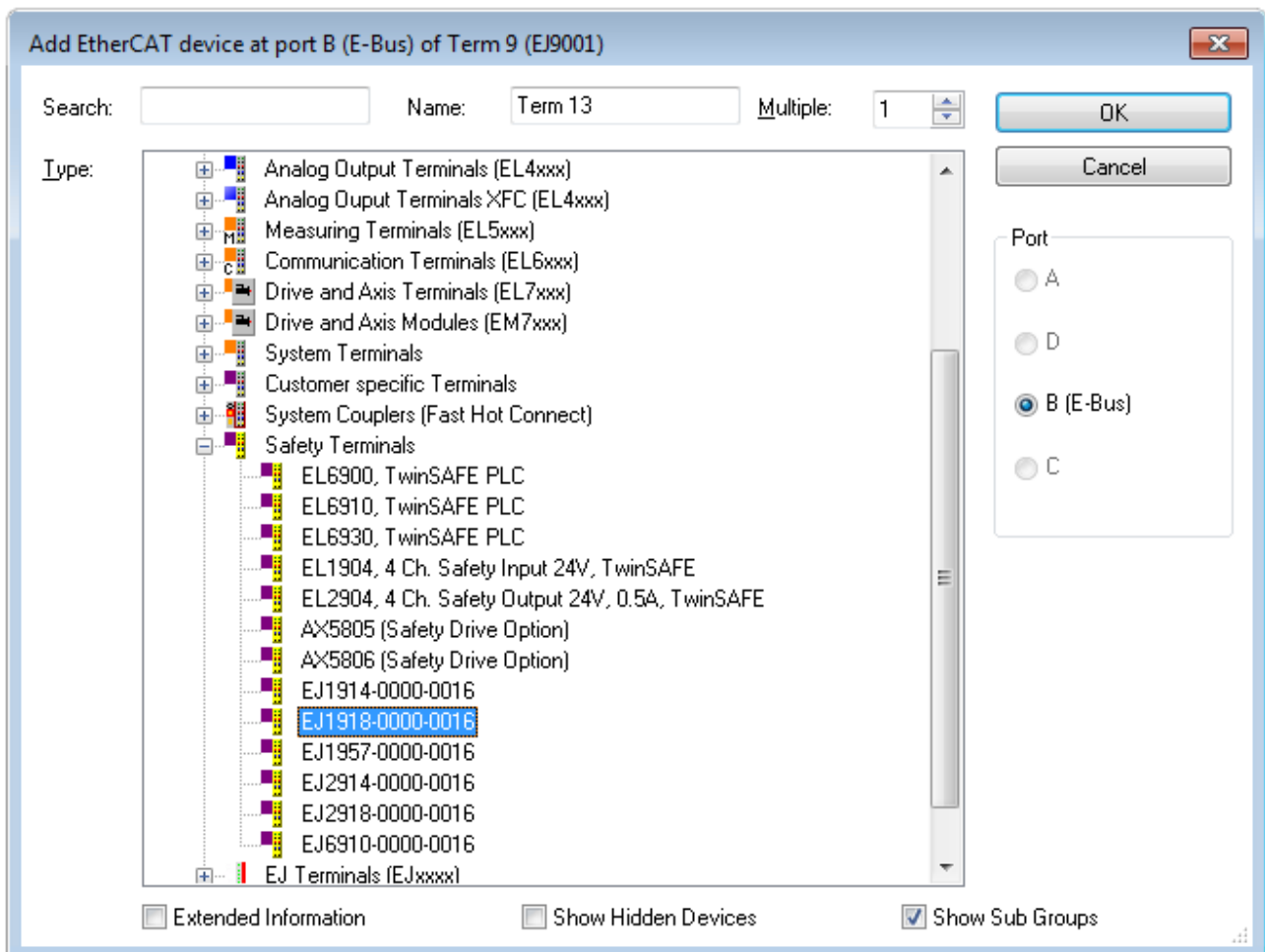
## 6.3 Inserting the EJ module



Fig. 8: Adding the EJ module

## 6.4      Specific product data

| Product property | EJ1918-0001 |
|---|---|
| Number of inputs | 8 |
| Number of clock outputs | 8 |
| Number of outputs | - |
| Status display | 8 (one green LED per input) |
| Diagnostic display | 4 (1 green, 3 red LEDs) |
| Current consumption of the module electronics at 24 V (without current consumption of sensors) | 8 channels occupied: typically 26 mA<br>0 channels occupied: typically 3 mA |
| Current consumption via E-bus | 8 channels occupied: approx. 290 mA |

## 6.5      Target failure measures

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

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

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

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

| Target failure measures | | Explanation |
|---|---|---|
| Lifetime | 20 | |
| Proof test interval | not required | Special proof tests during the entire lifetime of the TwinSAFE component are not required. |
| PFH$_D$ | 3.21E-09 | |
| %SIL 3 of PFH$_D$ | 3.2% | |
| PFD$_{avg}$ | 4.95E-05 | |
| %SIL 3 of PFD$_{avg}$ | 5.0% | |
| MTTF$_D$ | 2406 a | |
| DC | 98.3% | |
| SIL | 3 | Conforms to IEC 61508:2010. |
| Performance Level | e | Conforms to EN ISO 13849-1:2023. |
| Category | 4 | Conforms to EN ISO 13849-1:2023. |
| 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. |

# 7    EJ1957-0001

## 7.1    Overview
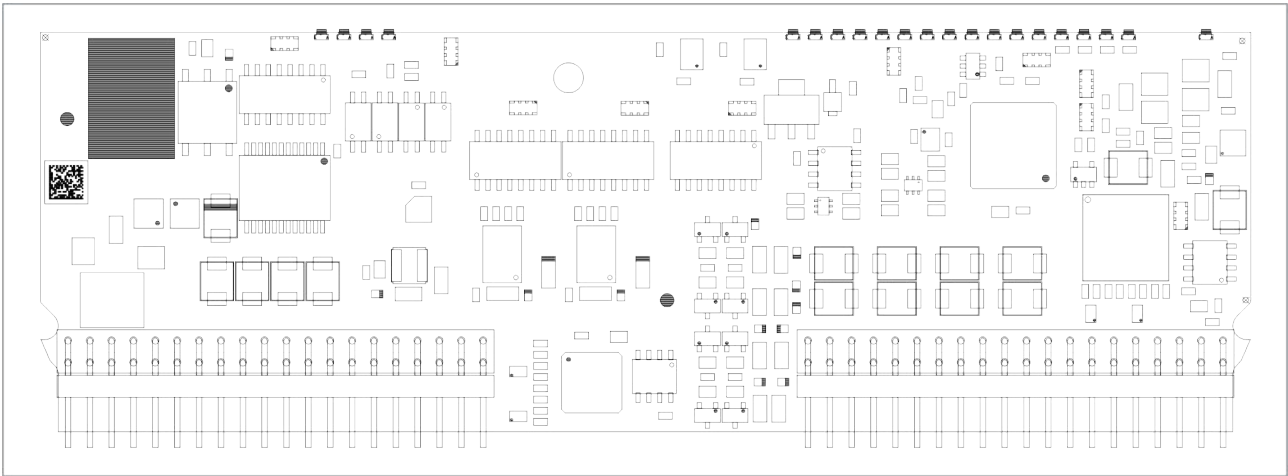


Fig. 9: FB6901-1957 - Product overview top
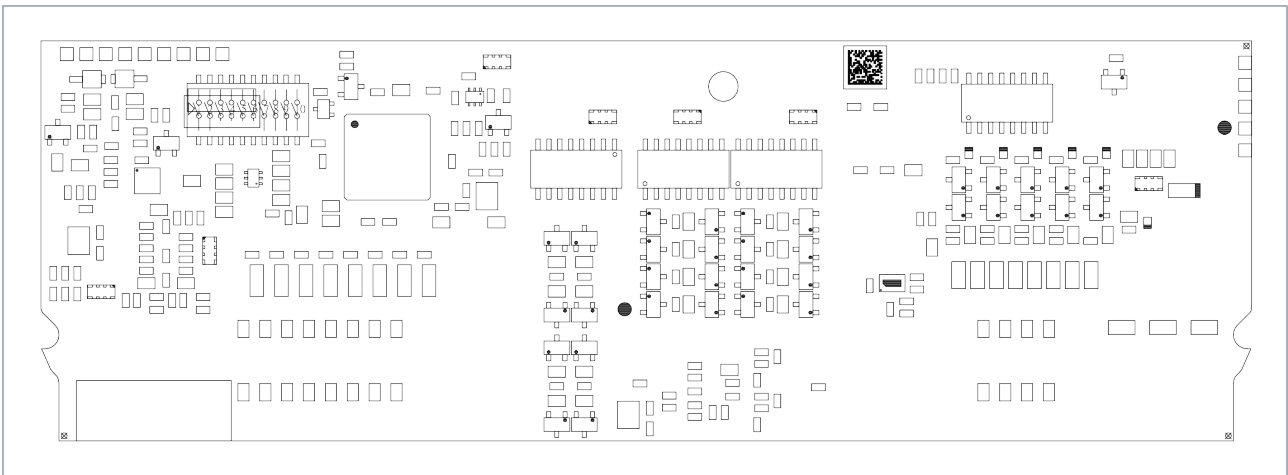


Fig. 10: FB6901-1957 - Product overview bottom

The EJ module EJ1957-0001 without housing is a digital input and output module for sensors with potential-free contacts for 24 $V_{DC}$. The EJ module has 8 fail-safe inputs with 8 clock outputs and 4 fail-safe outputs and meets the requirements of IEC 61508:2010 SIL 3 and EN ISO 13849-1:2023 PL e.

The EJ module is parameterized via four input modules and one output module.

## 7.2 Inserting the EJ module
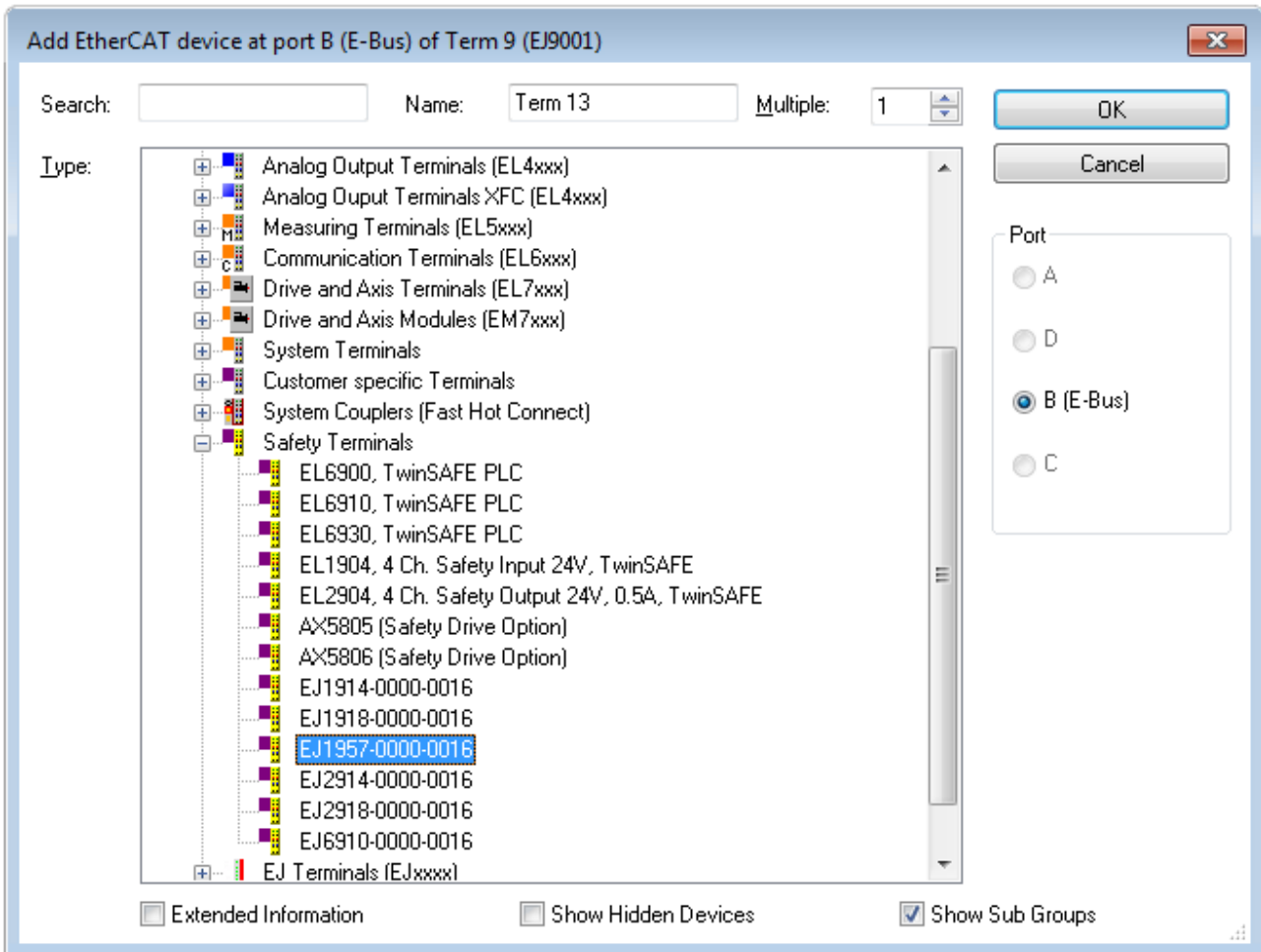


Fig. 11: Adding the EJ module

## 7.3 Specific product data

| Product property | EJ1957-0001 |
|---|---|
| Number of inputs | 8 |
| Number of clock outputs | 8 |
| Number of outputs | 4 |
| Status display | 12 (one green LED per input/output) |
| Diagnostic display | 4 (1 green, 3 red LEDs) |
| Current consumption of the module electronics from 24 V (without current consumption of sensors and actuators) | 12 channels occupied: typically 46 mA<br>0 channels occupied: typically 3 mA |
| Current consumption via E-bus | 12 channels occupied: approx. 330 mA |

# 7.4    Target failure measures

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

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

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

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

| Target failure measures | | Explanation |
|---|---|---|
| Lifetime | 20 | |
| Proof test interval | not required | Special proof tests during the entire lifetime of the TwinSAFE component are not required. |
| PFH$_D$ | 4.43E-09 | |
| %SIL 3 of PFH$_D$ | 4.4% | |
| PFD$_{avg}$ | 5.0E-05 | |
| %SIL 3 of PFD$_{avg}$ | 5.0% | |
| MTTF$_D$ | 1731 a | |
| DC | 98.4% | |
| SIL | 3 | Conforms to IEC 61508:2010. |
| Performance Level | e | Conforms to EN ISO 13849-1:2023. |
| Category | 4 | Conforms to EN ISO 13849-1:2023. |
| 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. |

# 8 Maintenance and cleaning

Do not operate the TwinSAFE component if it is unacceptably dirty. Further information can be found in Environmental conditions [▶ 17].

TwinSAFE components are basically maintenance-free.

# 9 Decommissioning

## 9.1 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.

## 9.1.1 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.

# 10 Appendix

## 10.1 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.

## 10.2 Focus of certificates

The decisive document for the certified components from the TwinSAFE range is the EC Type Examination Certificate. In addition to the test frame, this also contains the respective component or component family under consideration.

The current certificates of all TwinSAFE components with the underlying standards and directives can be found at https://www.beckhoff.com/de-de/support/downloadfinder/zertifikate-zulassungen/.

If the document contains only the first four digits of the product name (ELxxxx), the certificate is valid for all available variants of this component (ELxxxx-abcd). This applies to all components such as EtherCAT Terminals, EtherCAT Boxes, EtherCAT plug-in modules and bus terminals.



**EC-Type Examination Certificate**
No. M6A 062386 0055 Rev. 01

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

Using an EL1918 as an example, as shown in the figure, this means that the EC Type Examination Certificate applies to both the EL1918 and the available EL1918-2200 variant.

For EJ modules without housing, the EJx9xx certificate also applies to the EJ1918-0001 and EJ1957-0001.

# List of figures

## Trademark statements

More Information:
**www.beckhoff.com/EJx9xx**