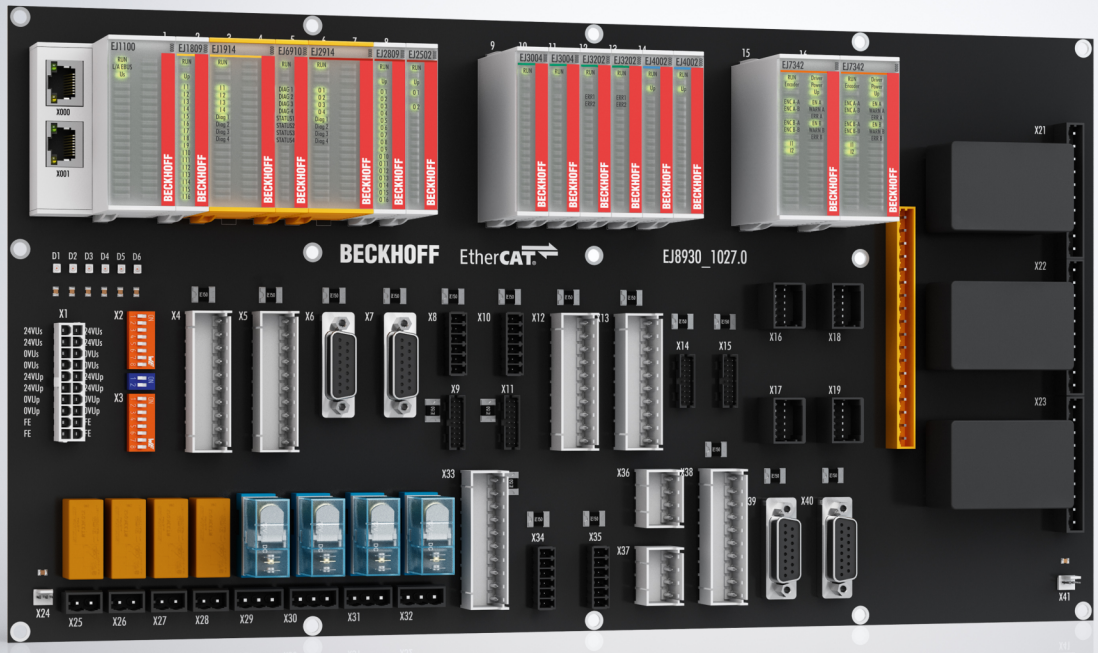
BECKHOFF New Automation Technology

Operating Instructions | EN

EJ6910

TwinSAFE Logic Module



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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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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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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 Documentation issue status

Version	Comment
2.0.0	• Foreword changed to Notes on the documentation [▶ 5] and For your safety [▶ 11] • In chapter Technical data [▶ 19] link to download page of certificates added • In chapter TwinSAFE reaction times [▶ 106] chapter structure revised • Service life [▶ 113] moved • Maintenance and cleaning [▶ 114] and Decommissioning [▶ 115] adjusted • Appendix adjusted and expanded
1.8.1	• Version 1.8.0 added to this table
1.8.0	• Maximum permissible operating temperature changed • In chapter Technical data [▶ 19] Warning notice added • New layout
1.7.0	• Project design limits updated • Description of new features in TwinCAT 3.1 Build 4022 added • Description temperature measurement updated • Intended use added
1.6.0	• Hint and flowchart to Backup/Restore added • Note to the input and output process image added • Description for Sync Manager configuration added • TwinSAFE SC description updated
1.5.1	• Screenshots User Administration updated • State and Diag of TwinSAFE group updated • Technical data *permissible air pressure* expanded
1.5.0	• Screenshots updated • Certificate updated
1.4.0	• Reference to standards updated • Safety parameters updated
1.3.0	• Description of diagnosis object 0xFEA0 extended
1.2.0	• Description Backup/Restore expanded • Description TwinSAFE SC expanded
1.1.0	• Chapters External connections, FB port properties, Parameterization of the alias device, Variable mapping and Customizing updated
1.0.0	• Migration
0.6.0	• 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 Staff qualification

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

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

Trained specialists

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

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

1.4 Safety and instruction

Read the contents that refer to the activities you have to perform with the product. Always read the chapter For your safety [▶ 11] in the operating instructions.

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

1.4.1 Explanation of symbols

Various symbols are used for a clear arrangement:

1. The numbering indicates an action that should be taken.
- The bullet point indicates an enumeration.

[…] The square brackets indicate cross-references to other text passages in the document.

[1] The number in square brackets indicates the numbering of a referenced document.

1.4.1.1 Pictograms

In order to make it easier for you to find text passages, pictograms and signal words are used in warning notices:

⚠ DANGER

Failure to observe will result in serious or fatal injuries.

⚠ WARNING

Failure to observe may result in serious or fatal injuries.

⚠ CAUTION

Failure to observe may result in minor or moderate injuries.

NOTE

Notes

Notes are used for important information on the product. The possible consequences of failure to observe these include:

- Malfunctions of the product
- Damage to the product
- Damage to the environment

Information

This sign indicates information, tips and notes for dealing with the product or the software.

1.5 Beckhoff Support and Service

Support

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

Hotline:	+49 5246/963-157
E-mail:	support@beckhoff.com
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
E-mail:	training@beckhoff.com
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.

2 For your safety

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

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

2.1 Duty of care

Read entire documentation for TwinSAFE component

- TwinSAFE application manual
- EL6910 TwinSAFE logic terminal operating manual
- TwinSAFE Logic FB documentation manual

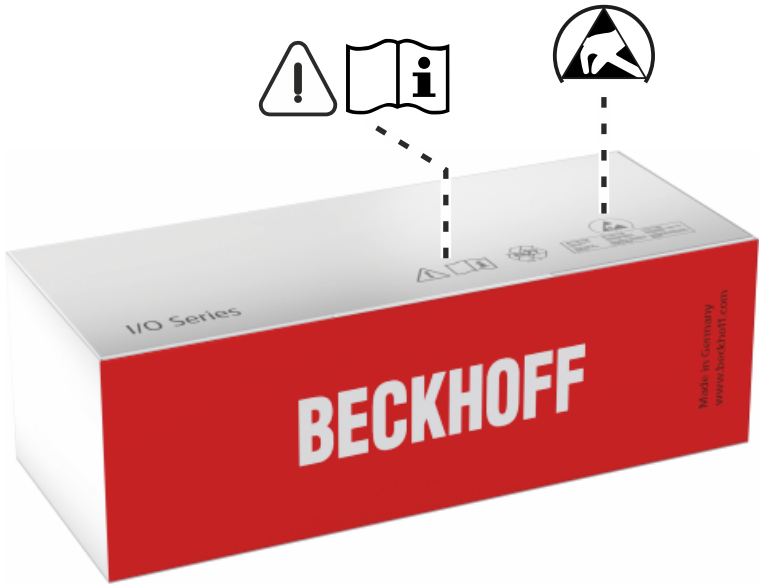
The operator must comply with all the requirements and notes specified in these operating instructions in order to fulfill his duty of care. This includes in particular that you

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

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

2.2 Safety image signs

On Beckhoff products you will find attached or lasered safety pictograms, which vary depending on the product. They serve to serve to ensure safety for people and to prevent damage to the products. Safety pictograms must not be removed and must be legible for the user.



Read and observe the operating instructions
Commissioning is only permitted if the operating instructions have been read and understood beforehand. This applies in particular to the safety instructions and warnings.

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

2.3 General safety instructions

2.3.1 Before operation

Use in machines according to the Machinery Directive

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

Ensure traceability

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

Use SELV/PELV power supply

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

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

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 permissible engineering tools and procedures

The TÜV SÜD certificate applies to the TwinSAFE component, the function blocks available in it, the documentation and the engineering tool. Approved engineering tools are *TwinCAT 3.1*, the *TwinSAFE Loader* and *CODESYS Safety for EtherCAT Safety Module*.

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 or externally generated automatic project creation procedures.

2.3.2 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.

2.3.3 After operation

De-energize and switch off components before working on them

Check all safety-relevant equipment for functionality before working on the TwinSAFE component. Secure the working environment. Secure the machine or plant against being inadvertently started up. Observe the chapter Decommissioning [▶ 115].

3 TwinSAFE System Description

3.1 Extension of the Beckhoff I/O system with safety functions

The TwinSAFE products from Beckhoff enable convenient expansion of the Beckhoff I/O system with safety components, and integration of all the cabling for the safety circuit within the existing fieldbus cable. Safe signals can be mixed with standard signals as required. The transfer of safety-related TwinSAFE telegrams is handled by the standard controller. Maintenance is simplified significantly thanks to faster diagnosis and simple replacement of components.

The following basic functionalities are included in the TwinSAFE components:
digital inputs (e.g. EL19xx, EP1908), digital outputs (e.g. EL29xx), drive components (e.g. AX5805) and logic units (e.g. EL6900, EL6910). For a large number of applications, the complete safety sensor and actuator technology can be wired on these components. The required logical link of the inputs and the outputs is handled by the EL69xx. In addition to Boolean operations, the EL6910 now also enables analog operations.

3.2 Safety concept

TwinSAFE: Safety and I/O technology in one system

- Extension of the familiar Beckhoff I/O system with TwinSAFE components
- Safe and non-safe components can be combined as required
- Logical link of the I/Os in the EL69xx TwinSAFE logic terminal
- Suitable for applications up to SIL 3 according to EN 61508:2010 and Cat 4, PL e according to DIN EN ISO 13849-1:2016-06
- Safety-relevant networking of machines via bus systems
- In the event of an error, all TwinSAFE components always switch to the wattless and therefore safe state
- No safety requirements for the higher-level standard TwinCAT system

Safety over EtherCAT protocol (FSoE)

- Transfer of safety-relevant data via any media (“genuine black channel”)
- TwinSAFE communication via fieldbus systems such as EtherCAT, Lightbus, PROFIBUS, PROFINET or Ethernet
- IEC 61508:2010 SIL 3 compliant
- FSoE is IEC standard (IEC 61784-3-12) and ETG standard (ETG.5100)

Fail-safe principle (fail stop)

The basic rule for a safety system such as TwinSAFE is that failure of a part, a system component or the overall system must never lead to a dangerous condition. The safe state is always the switched off and wattless state.

⚠ CAUTION

Safe state

For all TwinSAFE components the safe state is always the switched-off, wattless state.

3.3 EtherCAT plug-in module system (EJ)

Similar to the EtherCAT terminal system, a module strand consists of a Bus Coupler and any desired I/O modules. In contrast to the EtherCAT Terminals, however, the EtherCAT plug-in modules have no spring-loaded contacts, since the wiring level is outsourced: communication, signal distribution and the supply of power to the modules takes place via plug connectors on the back side of the modules and the conductive tracks of the signal distribution board.

The EtherCAT plug-in modules and the plug level for sensors and actuators can be placed flexibly on the signal distribution board. Signal distribution boards can be user-developed or provided as custom solutions by Beckhoff Automation GmbH & Co. KG.

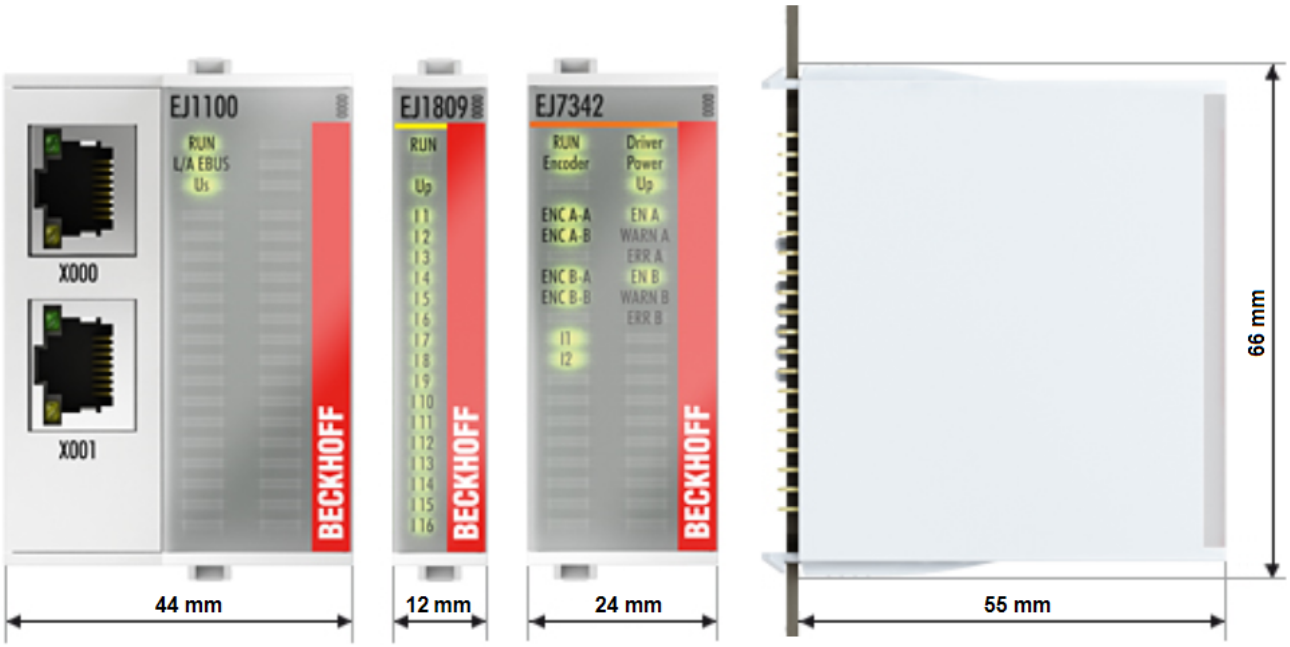


Fig. 1: EtherCAT plug-in module system (EJ)

4 Product description

4.1 EJ6910 - TwinSAFE logic module

The TwinSAFE logic EJ module is the link unit between the TwinSAFE input and output modules.

The EJ6910 module meets the requirements of IEC 61508:2010 SIL 3 and DIN EN ISO 13849-1:2016-06 (Cat 4, PL e).

Fig. 2: EJ6910 - TwinSAFE logic module

4.2 Intended use

⚠ WARNING

Caution - Risk of injury!

TwinSAFE EJ modules may only be used for the purposes described below!

The TwinSAFE EJ modules expand the application range of the Beckhoff EtherCAT system by functions that enable it to be used in the field of machine safety as well. The TwinSAFE EJ modules are designed for machine safety functions and directly associated to industrial automation tasks. It is therefore approved only for applications with a defined fail-safe state. This safe state is the wattless state.

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

⚠ WARNING

System limits

The TÜV-SÜD certificate applies to the TwinSAFE EJ modules, the function blocks available in it, the documentation and the engineering tool. Approved engineering tools are *TwinCAT 3.1*, *TwinSAFE Loader* and *CODESYS Safety for EtherCAT Safety Module*. Any deviations from these procedures or tools, particularly externally generated xml files for TwinSAFE import or externally generated automatic project creation procedures, are not covered by the certificate.

⚠ WARNING

Power supply

An SELV/PELV power supply unit with a voltage limit of U_{max}= 36 V_{DC} on the output side must be used to supply power for the TwinSAFE EJ modules with 24 V_{DC}. Failure to observe this can result in a loss of safety.

⚠ WARNING

Commissioning test

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

⚠ CAUTION

Note the Machinery Directive

The TwinSAFE EJ modules may only be used in machines according to the machinery directive.

⚠ CAUTION

Ensure traceability

The buyer has to ensure the traceability of the device via the serial number.

4.3 Technical data

⚠ WARNING

Keep distance to the maximum values

The EJ modules are assemblies that are integrated into an overall system by the user. Due to the complexity and variability, exact technical limit values for the ambient conditions are not generally valid. In addition, there are many influencing factors 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.

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

Product designation	EJ6910
Number of inputs	0
Number of outputs	0
Status display	4 diagnostic LEDs
Minimum/maximum cycle time	approx. 1 ms / according the project size
Error reaction time	≤ watchdog times
Watchdog time	Min. 2 ms, max. 60000 ms
Input process image	Dynamic, according to the TwinSAFE configuration in TwinCAT 3
Output process image	Dynamic, according to the TwinSAFE configuration in TwinCAT 3
Supply voltage (SELV/PELV)	24 V_{DC} (–15%/+20%)
Current consumption	approx. 222 mA
Power dissipation of the terminal	typically 1 W
Dimensions (W x H x D)	12mm x 66mm x 55mm
Weight	approx. 27 g
Permissible ambient temperature (operation)	-25°C to +45°C
Permissible ambient temperature (transport/storage)	-40°C to +70°C
Permissible air humidity	5% to 95%, non-condensing
Permissible air pressure (operation/storage/transport)	750 hPa to 1100 hPa (this corresponds to a height of approx. -690 m to 2450 m over sea level assuming an international standard atmosphere)
Climate category according to EN 60721-3-3	3K3 (the deviation from 3K3 is possible only with optimal environmental conditions and also applies only to the technical data which are specified differently in this documentation)
Permissible level of contamination according to EN 60664-1	level of contamination 2 (comply with the chapter Maintenance)
Impermissible operating conditions	TwinSAFE EJ modules must not be used under the following conditions: • under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation) • in corrosive environments • in an environment that leads to unacceptable soiling of the Bus Terminal
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Shocks	15 g with pulse duration 11 ms in all three axes
Protection class	IP20
Permitted operating environment	control cabinet or terminal box with minimum protection class IP54 according to IEC 60529
Permissible installation position	see chapter Installation position and minimum distances [▶ 24]
Approvals	CE, TÜV SÜD

4.4 Safety parameters

Key figures	EJ6910
Lifetime [a]	20
Prooftest Interval [a]	not required [1]
PFH_D	1.81E-09
%SIL3 of PFH_D	1.81%
PFD_{avg}	2.56E-05
%SIL3 of PFD_{avg}	2.56%
$MTTF_d$	high
DC	high
Performance level	PL e
Category	4
HFT	1
Element classification [2]	Type B

1. Special proof tests over the whole service life of the EtherCAT EJ6910 module are not required.
2. Classification according to IEC 61508-2:2010 (see chapters 7.4.4.1.2 and 7.4.4.1.3)

The EtherCAT EJ6910 module can be used for safety-related applications as defined in IEC 61508:2010 up to SIL3 and DIN EN ISO 13849-1:2016-06 up to Cat 4, PL e.

For the calculation or estimation of the $MTTF_d$ value from the PFH_D value, further information can be found in the TwinSAFE application manual or in DIN EN ISO 13849-1:2016-06 Table K.1.

4.5 Dimensions

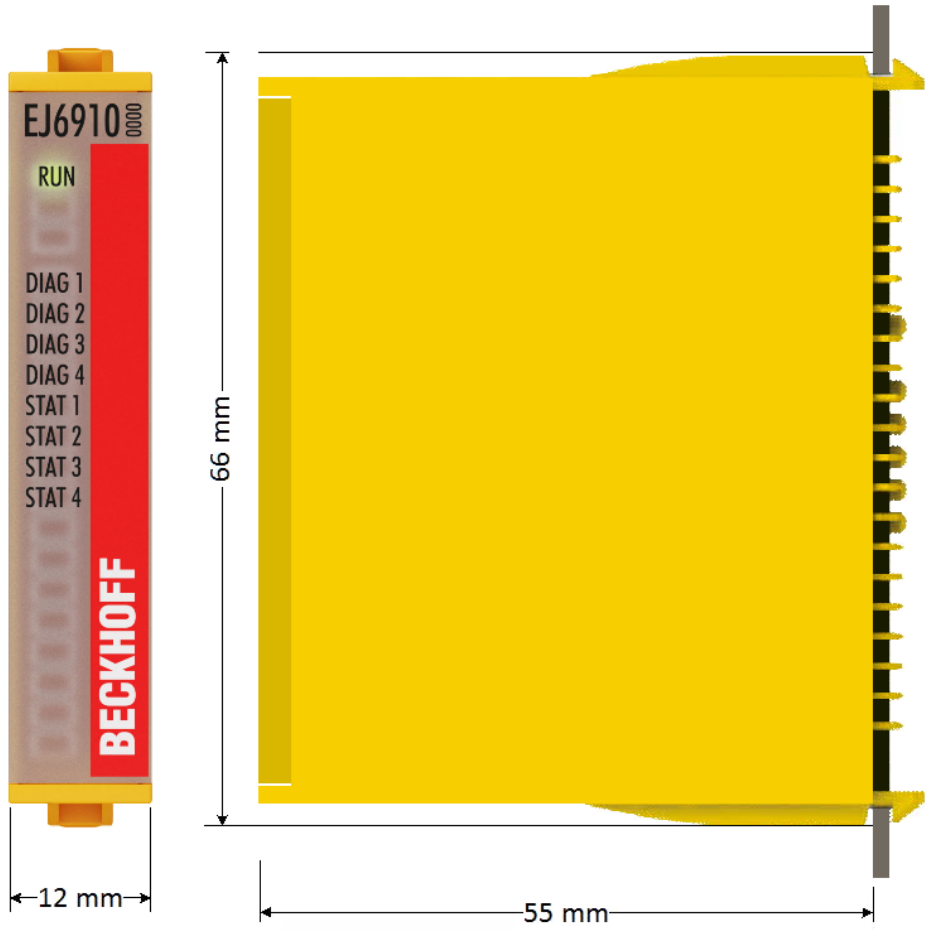


Fig. 3: EJ6910 - dimensions

Width: 12 mm
Height: 66 mm
Depth: 55 mm

5 Operation

5.1 Environmental conditions

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

⚠ WARNING

Risk of injury!

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

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

NOTE

Electromagnetic compatibility

The TwinSAFE components comply with the current standards on electromagnetic compatibility with regard to spurious radiation and immunity to interference in particular.
However, in cases where devices such as mobile phones, radio equipment, transmitters or high-frequency systems that exceed the interference emissions limits specified in the standards are operated near TwinSAFE components, the function of the TwinSAFE components may be impaired.

5.2 Installation

5.2.1 Safety instructions

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

5.2.2 Transport / storage

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

⚠ CAUTION

Note the specified environmental conditions

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

5.2.3 Mechanical installation

⚠ WARNING

Risk of injury!

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

5.2.3.1 Control cabinet / terminal box

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

5.2.3.2 Installation position and minimum distances

For the prescribed installation position the backplane is mounted horizontally (EJ plug connector vertical), and the connection surfaces of the EJ modules face forward (see diagram below). The EJ modules are ventilated from below, which enables optimum cooling of the electronics through convection. The direction indication “down” corresponds to the direction of positive acceleration due to gravity.

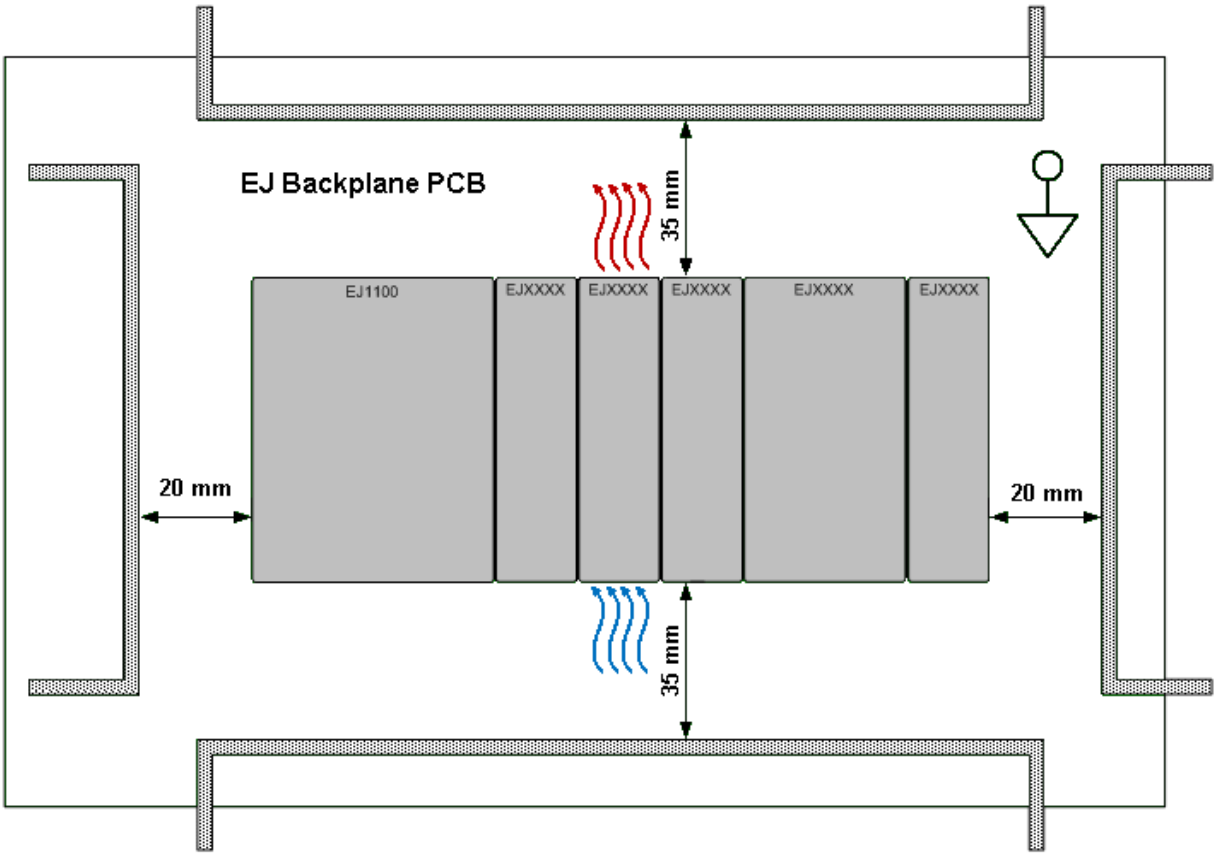


Fig. 4: Installation position and minimum distances

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

5.2.3.3 Temperature measurement

The temperature measurement consists of an EJ1100 EtherCAT coupler, to which EJ modules are attached, based on the typical distribution of digital and analog signal types at a machine. On the EJ6910 a safety project is active, which reads safe inputs and enables safe outputs during the measurement.

External heat sources / radiant heat / impaired convection

The maximum permissible ambient temperature of 45 °C was checked with the example configuration described above. Impaired convection; an unfavorable location near heat sources or an unfavorable configuration of the EtherCAT EJ modules may result in overheating of the modules.

The key parameter is always the maximum permitted internally measured temperature of 110 °C, above which the TwinSAFE components switch to safe state and report an error. The internal temperature can be read from the TwinSAFE components via CoE.

5.2.4 Electrical installation

⚠ WARNING

Risk of injury!

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

5.2.4.1 Connections between EJ modules

The electrical connections between the EJ Bus Coupler and EJ modules are realized automatically by plugging the components into the EJ backplane.

Note the maximum E-bus current!

Observe the maximum current that your EJ Bus Coupler can supply to the E-bus! Use the EJ9400 power supply module if the current consumption of your modules exceeds the maximum current your EJ Bus Coupler can provide.

5.2.4.2 Overvoltage protection

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

5.3 Configuration of the EJ6910 in TwinCAT

⚠ CAUTION

Do not change CoE objects!

Do not change any of the CoE objects in the TwinSAFE EJ modules. Changes in the CoE objects (e.g. via the System Manager or TwinCAT 3) permanently switch the TwinSAFE EJ modules to the *Fail-Stop* state or lead to unexpected behavior of the modules!

5.3.1 Configuration requirements

Configuration of the TwinCAT Safety PLC requires TwinCAT automation software version 3.1 build 4020 or higher. The current version is available for download from the Beckhoff website at www.beckhoff.de.

TwinCAT support

The TwinCAT Safety PLC cannot be used under TwinCAT 2.

5.3.2 Adding an EJ6910

The EJ6910 TwinSAFE logic module is added in the same way as any other EtherCAT device. Open *Safety Terminals* in the list, then select the EJ6910 module.

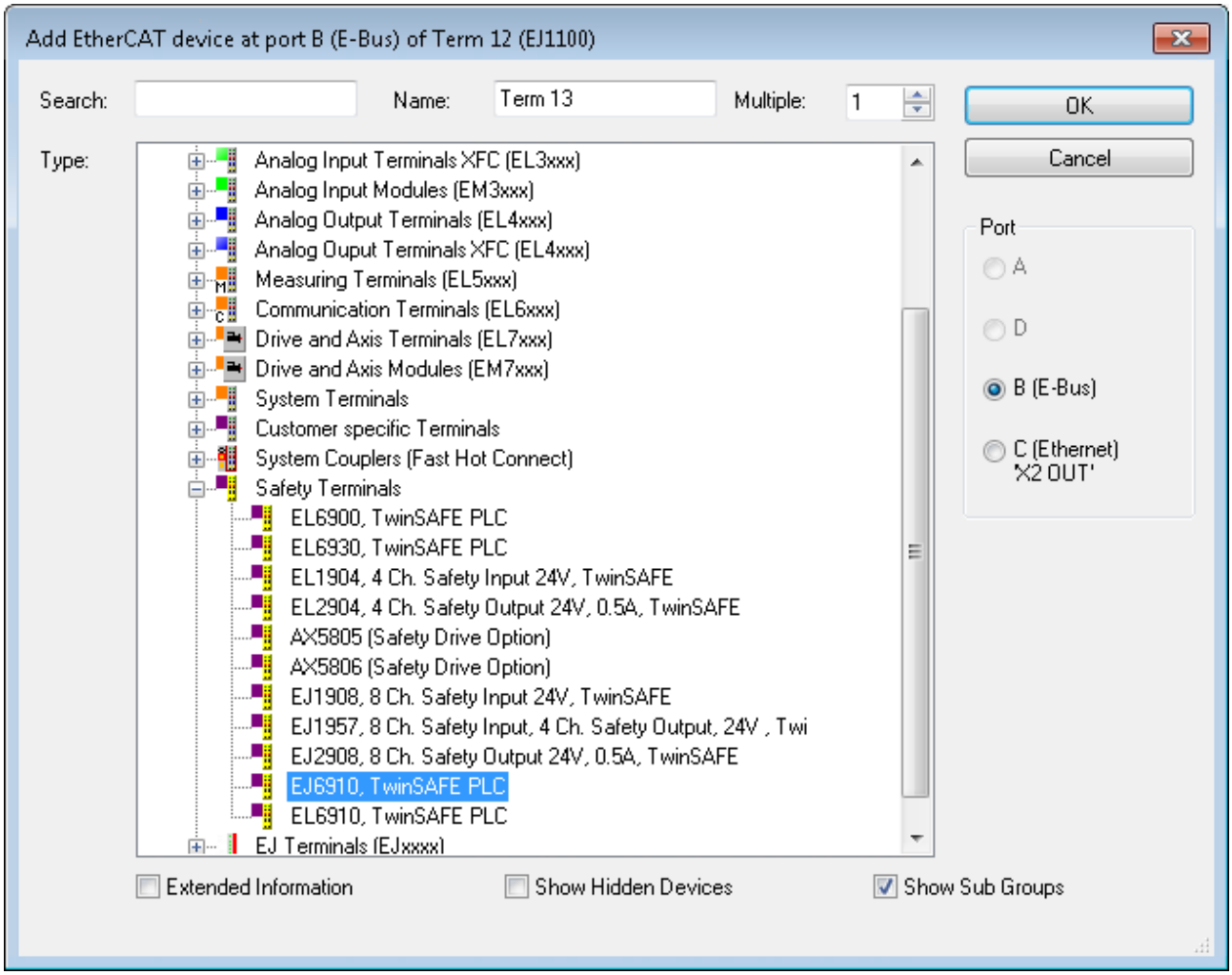


Fig. 5: TwinCAT - adding an EJ6910

Size of the process image

The process image of the EJ6910 TwinSAFE logic module is adjusted dynamically, according to TwinSAFE configuration created in TwinCAT 3.

5.3.3 Address setting on the TwinSAFE EJ modules with 1023 possible addresses

Fig. 6: Address setting on TwinSAFE EJ modules with 1023 possible addresses

Use the 10-way DIP switch on the left of a TwinSAFE EJ module to set the TwinSAFE address of the module. TwinSAFE addresses between 1 and 1023 are available.

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

⚠ WARNING

TwinSAFE address

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

5.3.4 Creating a safety project in TwinCAT 3

5.3.4.1 Add new item

In TwinCAT 3 a new project can be created via *Add New Item…* in the context menu of the *Safety* node.

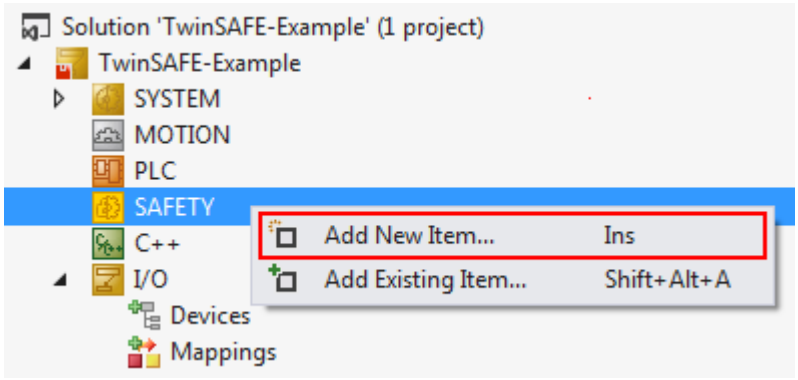


Fig. 7: Creating a safety project - Add New Item

The project name and the directory can be freely selected.

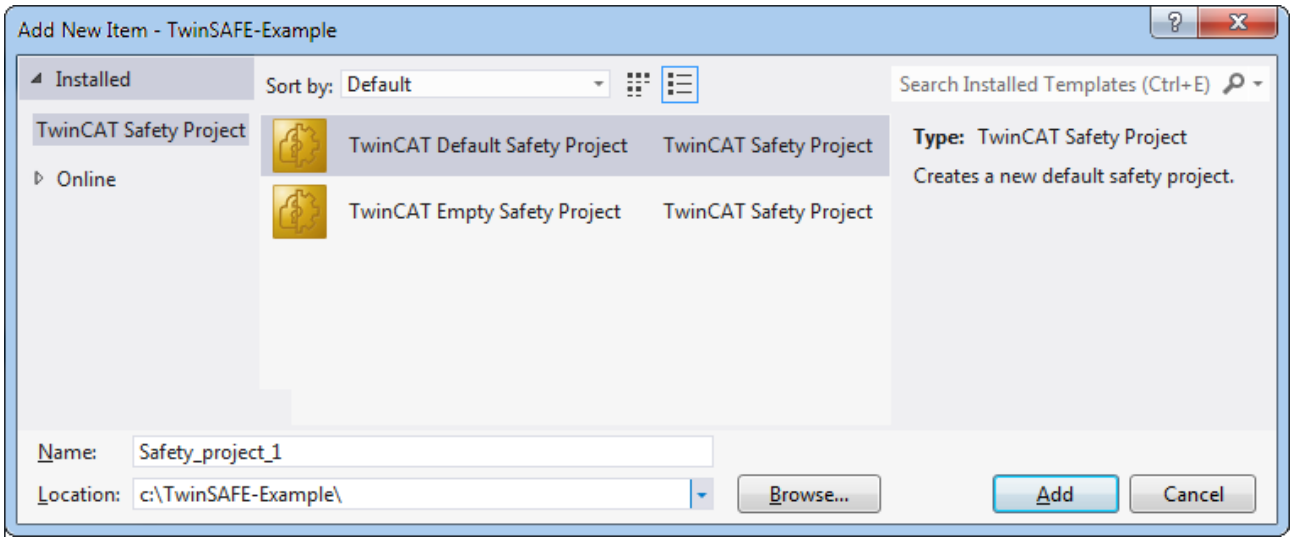


Fig. 8: Creating a safety project - project name and directory

5.3.4.2 TwinCAT Safety Project Wizard

In the TwinCAT Safety Project wizard you can then select the target system, the programming language, the author and the internal project name. Select the setting *Hardware Safety PLC* as the target system and the graphical editor as the programming language. The author and the internal project name can be freely selected by the user.

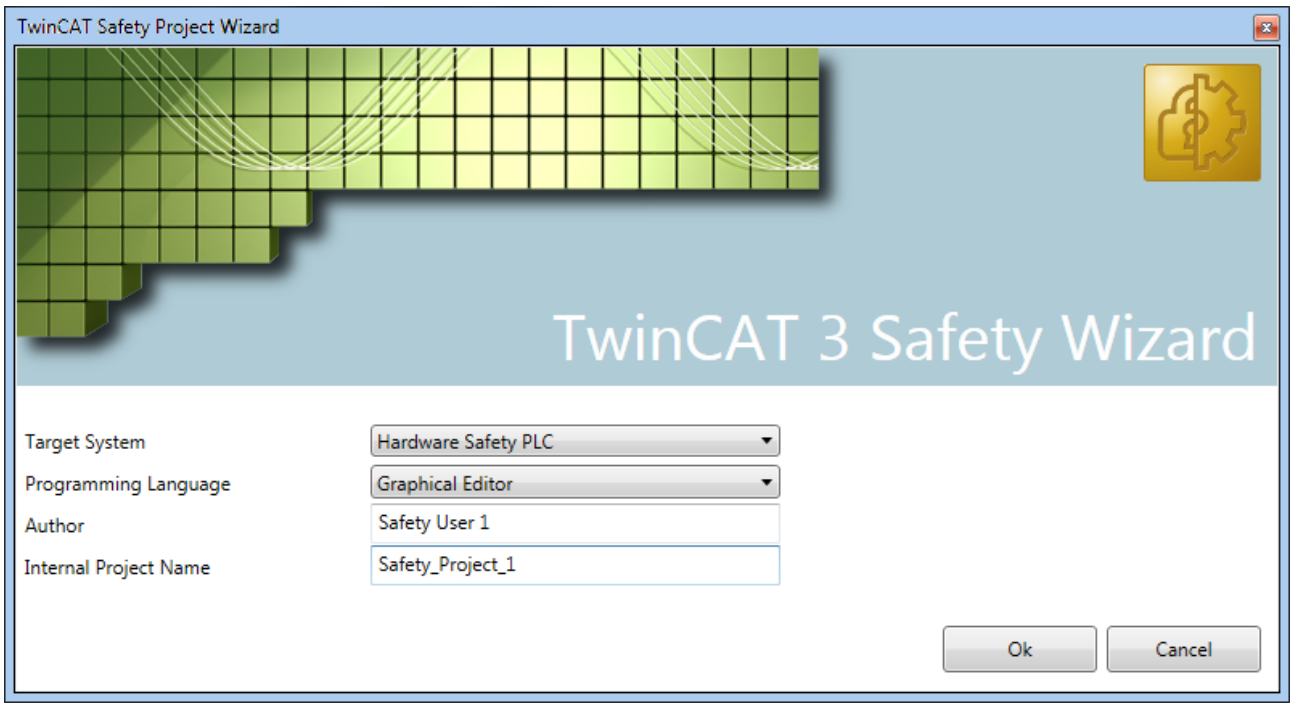


Fig. 9: TwinCAT Safety Project Wizard

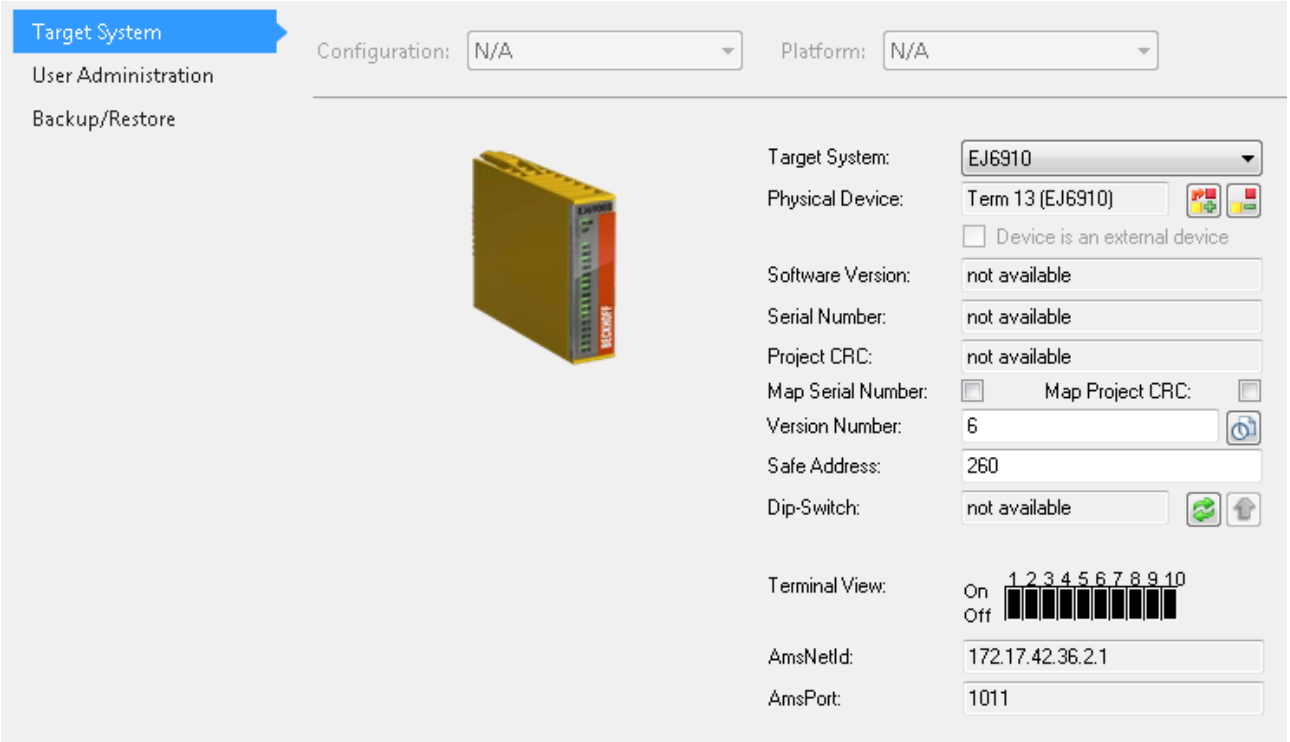
5.3.4.3 Target System

Once the project has been created with the project wizard, the safety project can be assigned to the physical TwinSAFE module EJ6910 by selecting the *Target System* node.

Fig. 10: Selecting the Target System node

Set the target system to EJ6910 via the drop-down list and link it with the EJ6910 module via the Link button

next to *Physical Device*. If online ADS access to the terminal is possible, the software version, serial number, online project CRC and hardware address (DIP switch) are automatically read from the module. The DIP switch address must match the *Safe Address* set by the user.



Linking of target system and TwinSAFE module

5.3.4.4 Alias devices

The communication between the safety logic and the I/O level is realized via an alias level. At this alias level (subnode *Alias Devices*) corresponding alias devices are created for all safe inputs and outputs, and also for standard signal types. For the safe inputs and outputs, this can be done automatically via the I/O configuration.

The connection- and device-specific parameters are set via the alias devices.

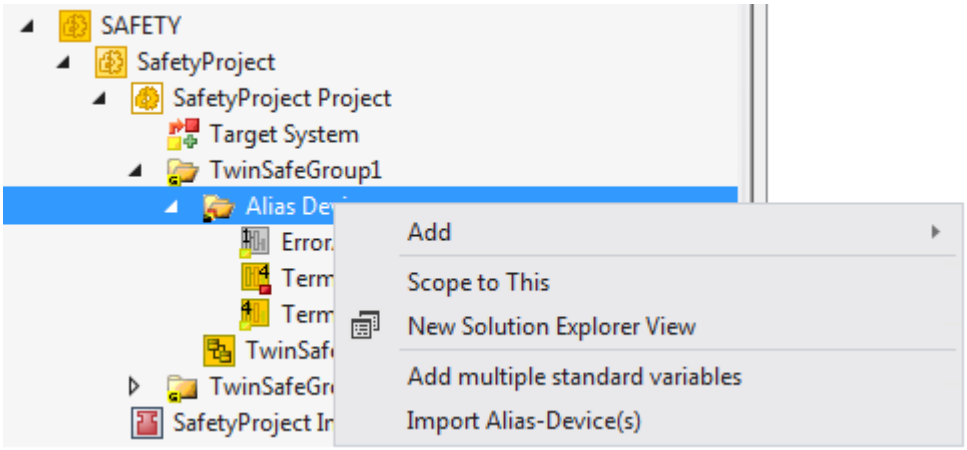


Fig. 11: Starting the automatic import from the I/O configuration

If the automatic import is started from the I/O configuration, a selection dialog opens, in which the individual terminals to be imported can be selected.

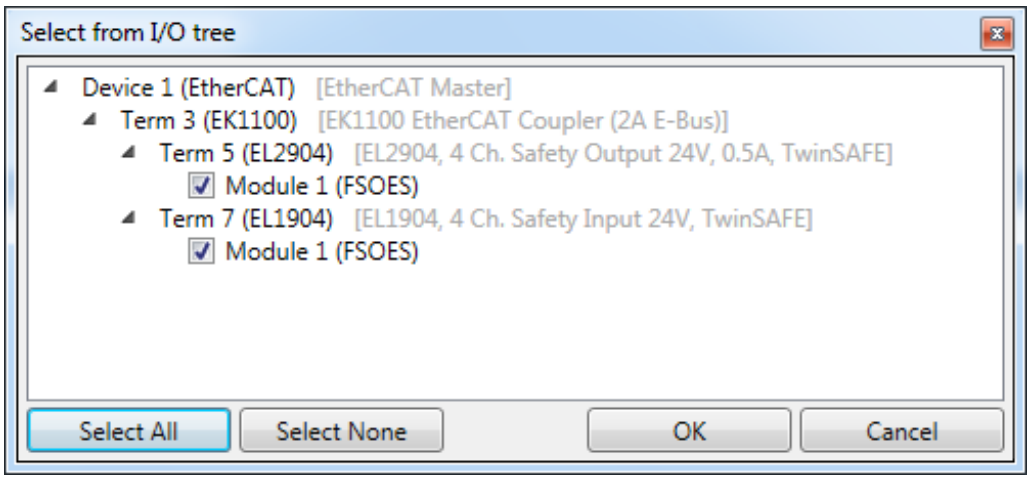


Fig. 12: Selection from the I/O tree

The alias devices are created in the safety project when the dialog is closed via OK.

Alternatively, the user can create the alias devices individually. To this end select *Add* and *New item* from the context menu, followed by the required device.

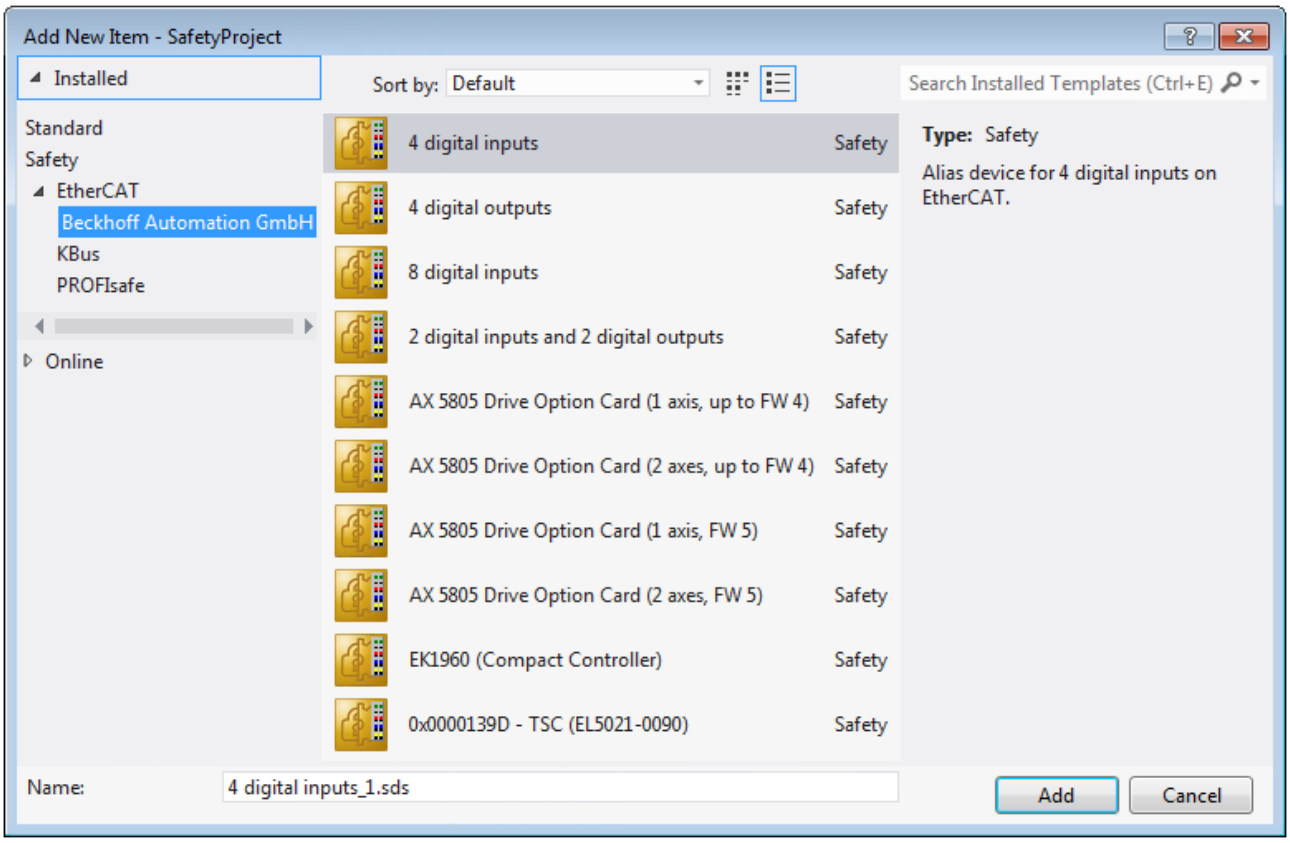


Fig. 13: Creating alias devices by the user

5.3.4.5 Parameterization of the alias device

The settings can be opened by double-clicking on the Alias Device in the safety project structure.

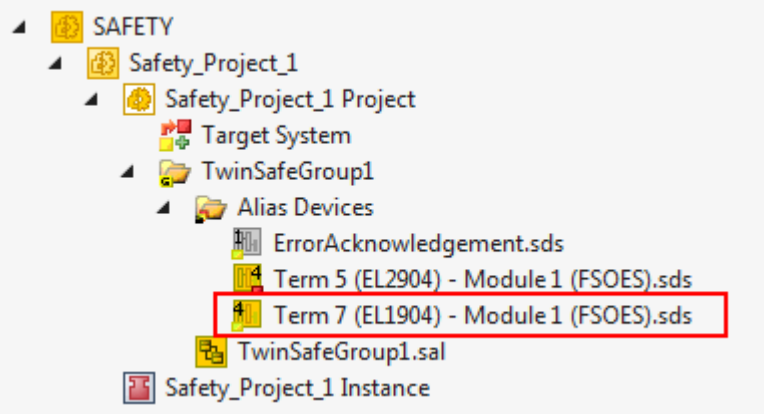


Fig. 14: Alias Device in the safety project structure

The *Linking* tab contains the FSoE address, the checkbox for setting as *External Device* and the link to the physical I/O device. If an ADS online connection to the physical I/O device exists, the DIP switch setting is displayed. Re-reading of the setting can be started via the button . The links to the EL6910/EJ6910 process image are displayed under *Full Name (input)* and *Full Name (output)*.

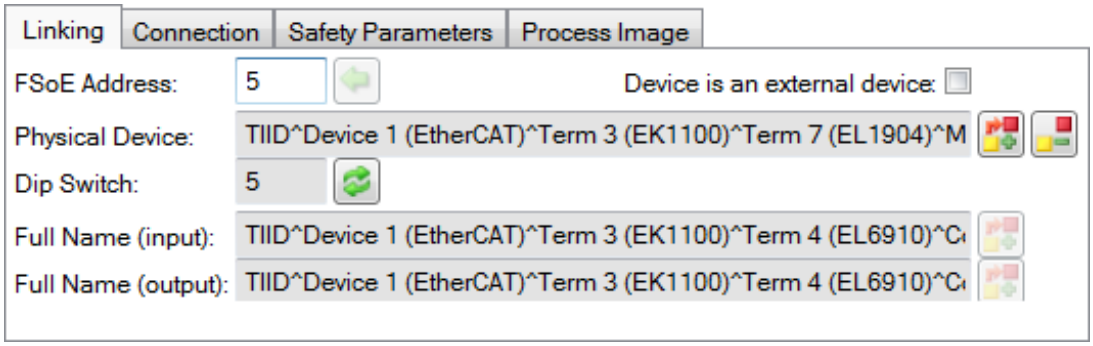


Fig. 15: Links to EL6910/EJ6910 process image

The *Connection* tab shows the connection-specific parameters.

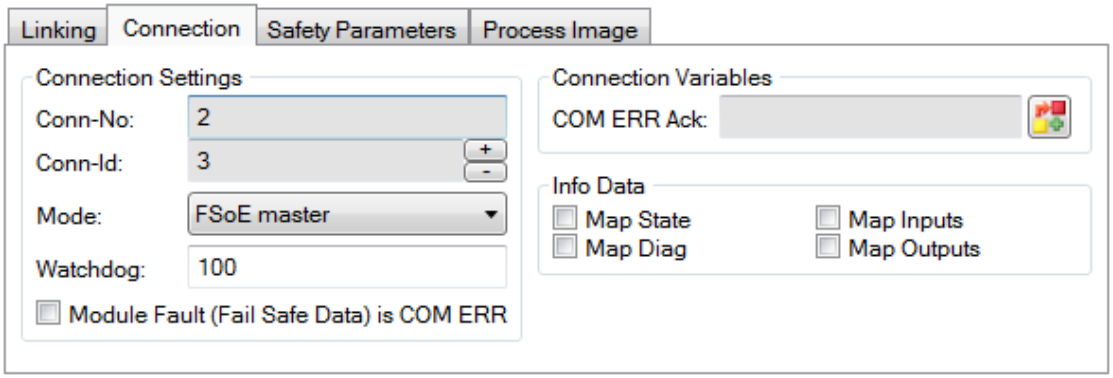


Fig. 16: Connection-specific parameters

Parameter	Description	User interaction required
Conn. no.	Connection number - automatically assigned by the TwinCAT system	No
Conn ID	Connection ID: preallocated by the system, but can be changed by the user. A Conn ID must be unique within a configuration. Duplicate connection IDs result in an error message.	Check
Mode	FSoE master: EL6910/EJ6910 is FSoE master for this device. FSoE slave: EL6910/EJ6910 is FSoE slave for this device.	Check

Parameter	Description	User interaction required
Watchdog	Watchdog time for this connection. A ComError is generated if the device fails to return a valid telegram to the EL6910/EJ6910 within the watchdog time.	Yes
Module Fault is ComError	This checkbox is used to specify the behavior in the event of an error. If the checkbox is ticked and a module error occurs on the Alias Device, this also leads to a connection error and therefore to disabling of the TwinSAFE group, in which this connection is defined.	Yes
ComErrAck	If ComErrAck is linked to a variable, the connection must be reset via this signal in the event of a communication error.	Yes
Info data	The info data to be shown in the process image of the EL6910/EJ6910 can be defined via these checkboxes. Further information can be found in the documentation for *TwinCAT function blocks for TwinSAFE Logic terminals*.	Yes

The EL6910/EJ6910 support activation of a ComErrAck at each connection. If this signal is connected, the respective connection must be reset after a communication error via the signal ComErrAck, in addition to the ErrAck of the TwinSAFE group. This signal is linked via the link button next to COM ERR Ack. The following dialog can be used for selecting an alias device. The signal can be cancelled via the *Clear* button in the *Map to* dialog.

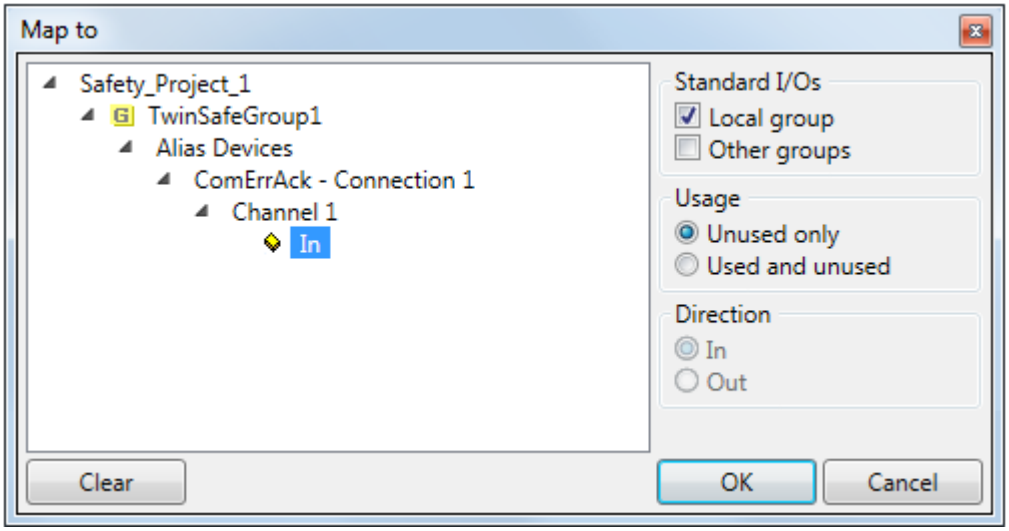


Fig. 17: Selecting an alias device

The safety parameters matching the device are displayed under the *Safety Parameters* tab. They have to be set correctly to match the required performance level. Further information can be found in the TwinSAFE application manual.

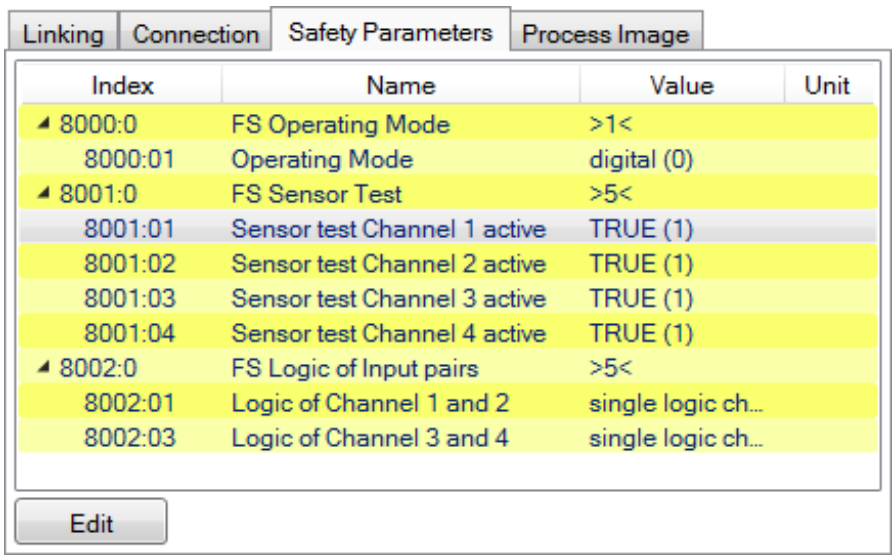


Fig. 18: Safety parameter for the device

5.3.4.6 Connection to AX5805/AX5806

There are separate dialogs for linking an AX5805 or AX5806 TwinSAFE Drive option card, which can be used to set the safety functions of the AX5000 safety drive options.

Creating and opening of an alias device for an AX5805 results in five tabs; the *Linking*, *Connection* and *Safety Parameters* tabs are identical to other alias devices.

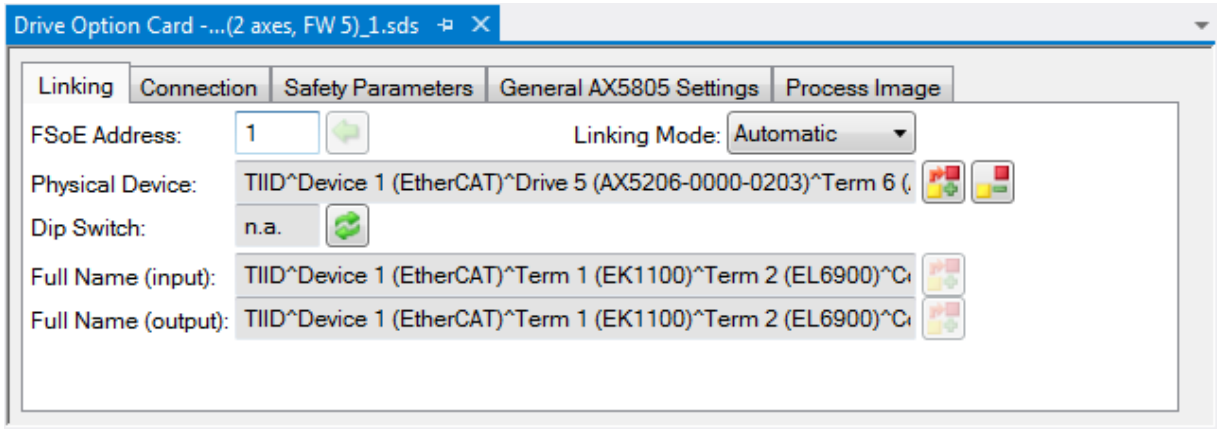


Fig. 19: AX5000 safety drive functions

The *General AX5805 Settings* tab can be used to set the motor string and the SMS and SMA functions for one or two axes, depending on the added alias device.

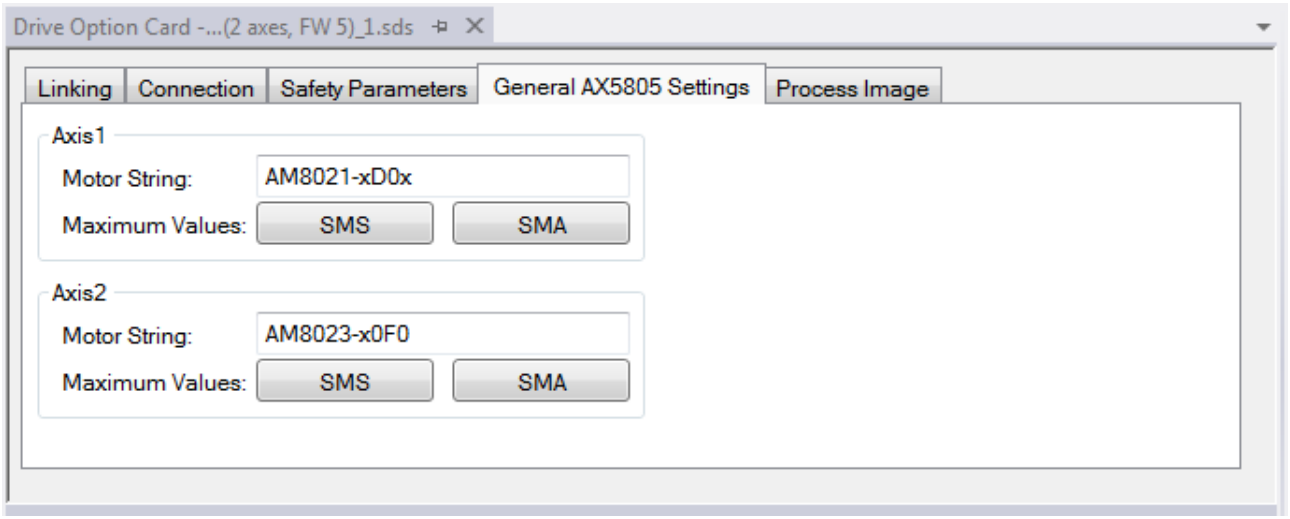


Fig. 20: AX5000 safety drive options - general AX5805 settings

The Process Image tab can be used to set the different safety functions for the AX5805.

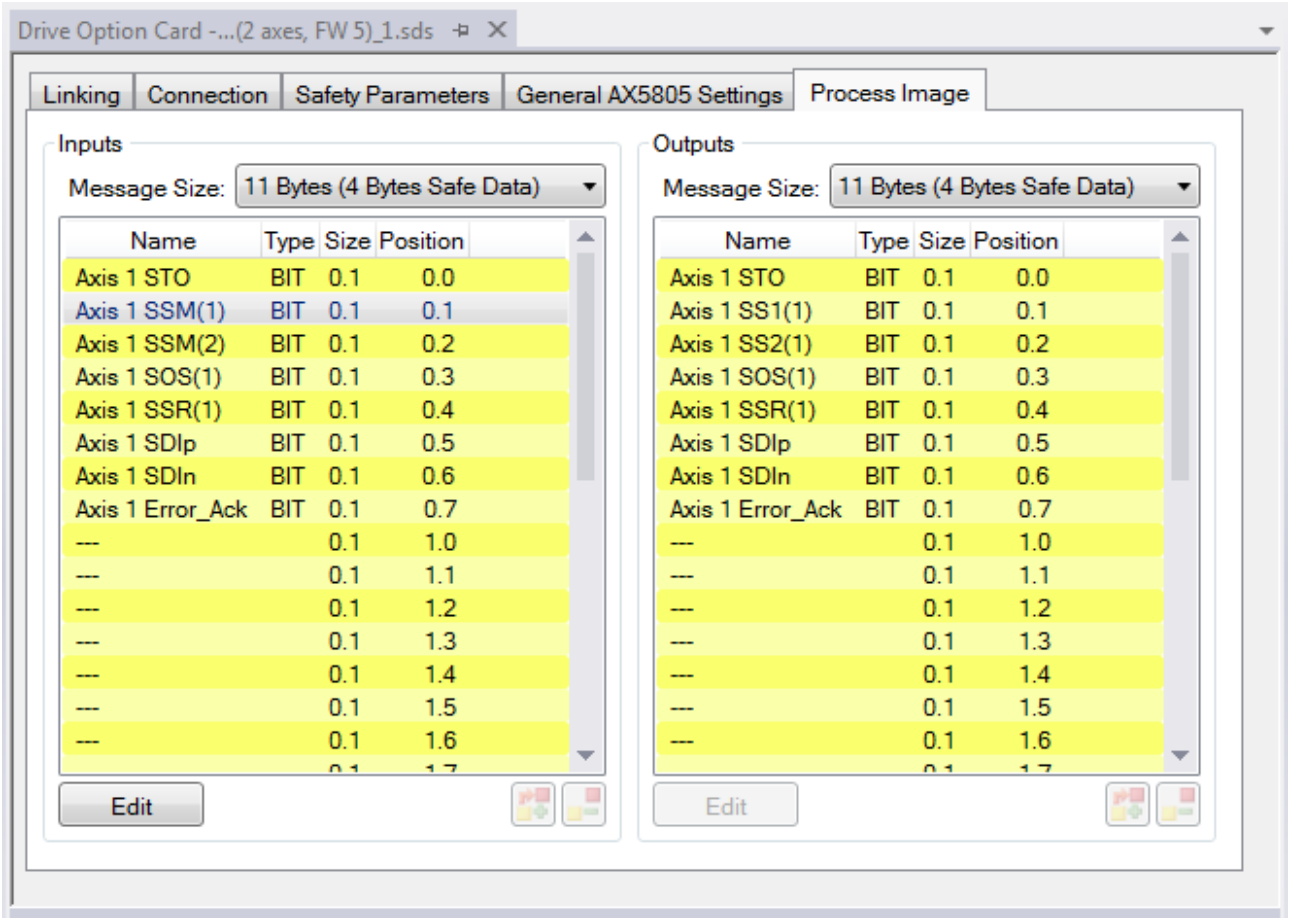


Fig. 21: AX5000 safety drive options - Process Image

The parameters under the *General AX5805 Settings* and *Process Image* tabs are identical to the parameters under the *Safety Parameters* tab. Offers user-friendly display and editing of the parameters. The parameters under the *Safety Parameters* tab can also be edited.

The parameters for this function can be set by selecting a function in the inputs or outputs and pressing the *Edit* button. New safety functions can be added in the process image by selecting an empty field (---) and pressing *Edit*.

The parameter list corresponding to the safety function can be shown; in addition, an optional diagram of the function can be shown. At present the diagram is still static and does not show the currently selected values.

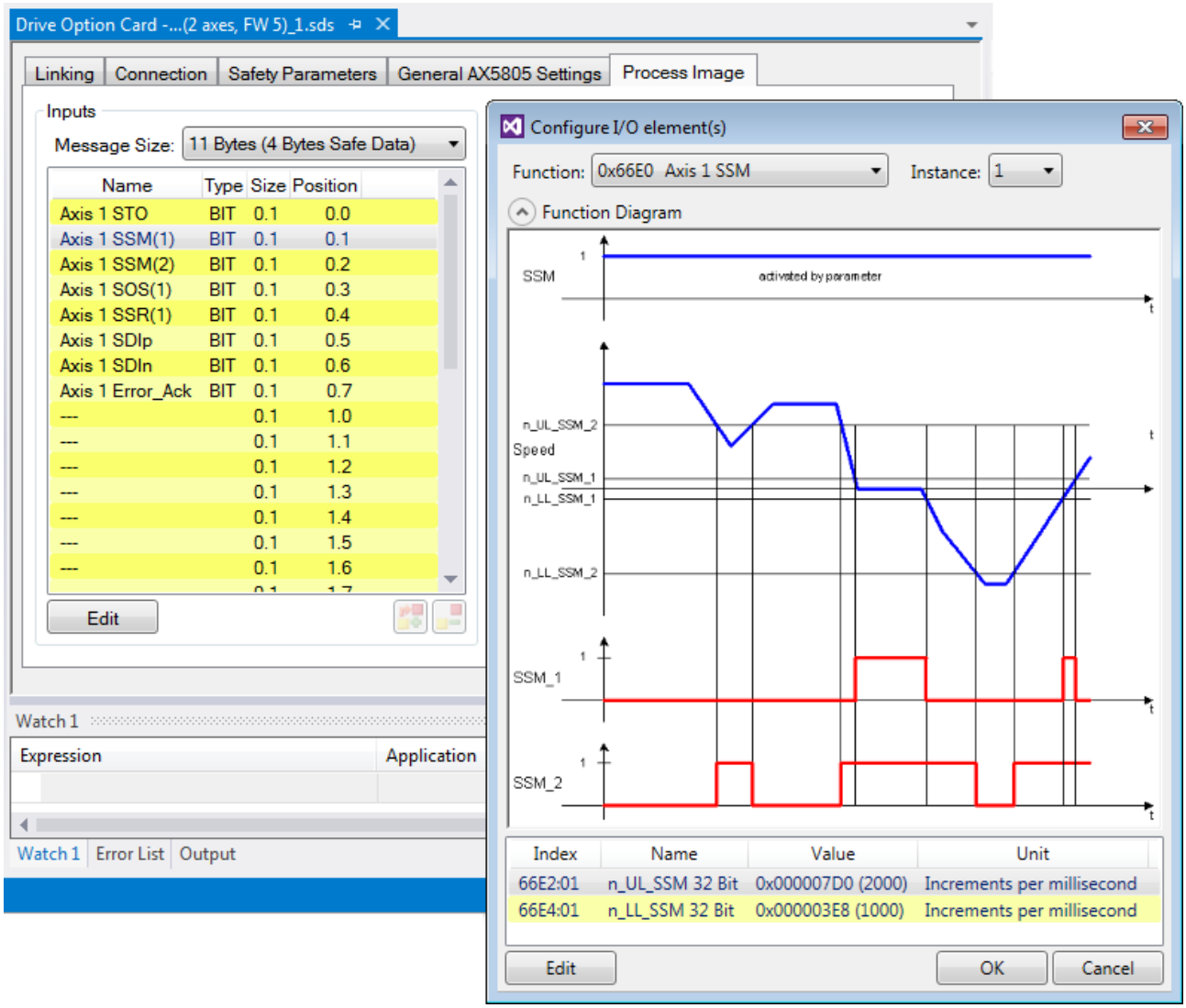


Fig. 22: AX5000 safety drive options - Function Diagram

5.3.4.7 External connection

An external *Custom FSoE Connection* can be created for a connection to a further EL69x0, EJ6910, KL6904 or third-party device. If a dedicated ESI file exists for a third-party device, the device is listed as a selectable safety device, and the *Custom FSoE Connection* option is not required.

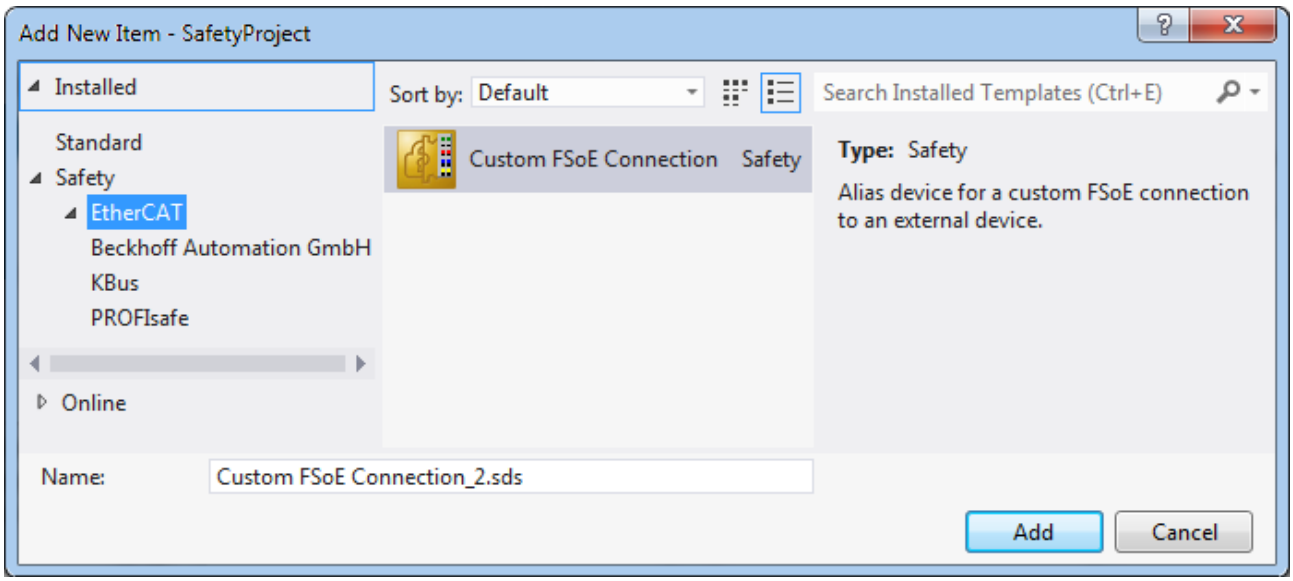


Fig. 23: Creating an external connection (Custom FSoE Connection)

Before the connection can be used and linked further, the process image size must be parameterized. This can be set under the *Process Image* tab. Suitable data types for different numbers of safety data are provided in the dropdown lists for the input and output parameters.

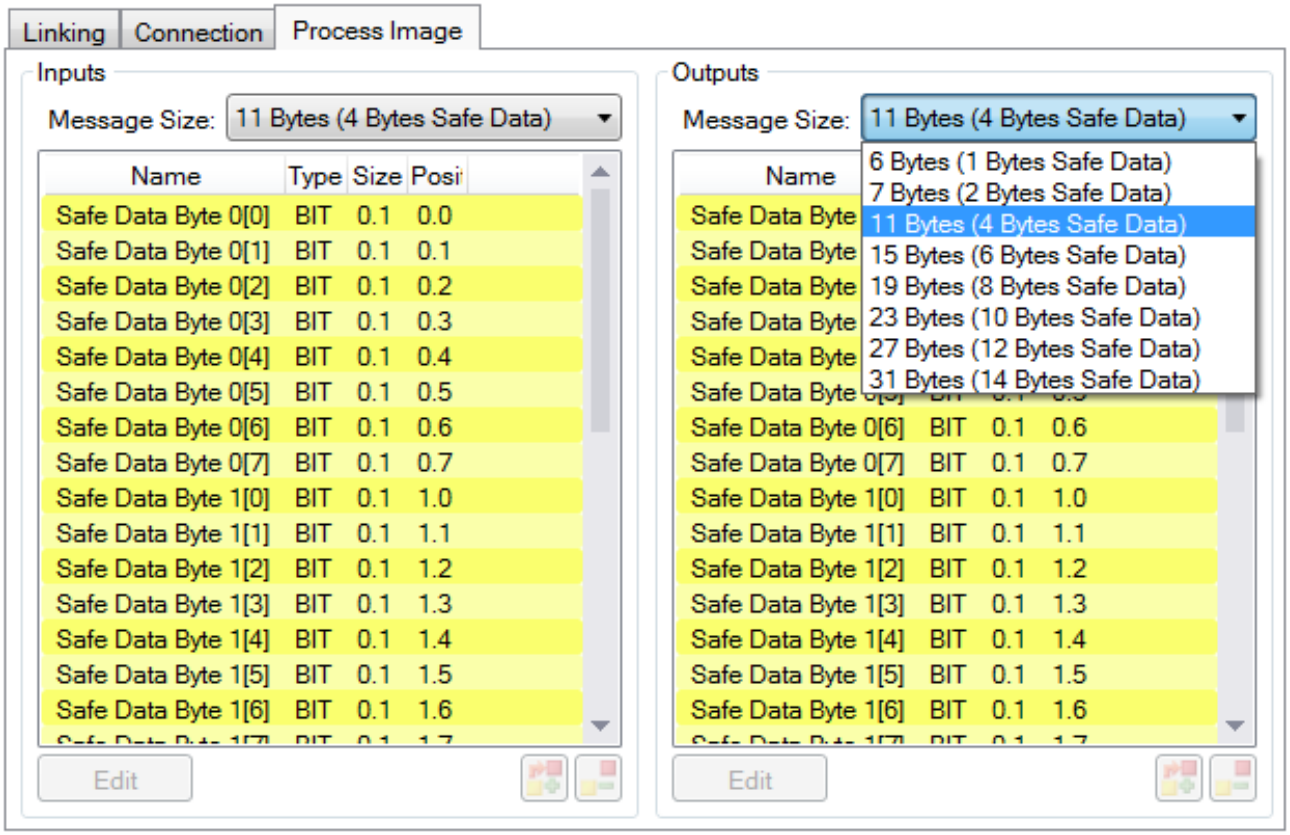


Fig. 24: Parameterization of the process image size

Once the size is selected, the individual signals within the telegram can be renamed, so that a corresponding plain text is displayed when these signals are used in the logic. If the signals are not renamed, the default name is displayed in the editor (Safe Data Byte 0[0], …).

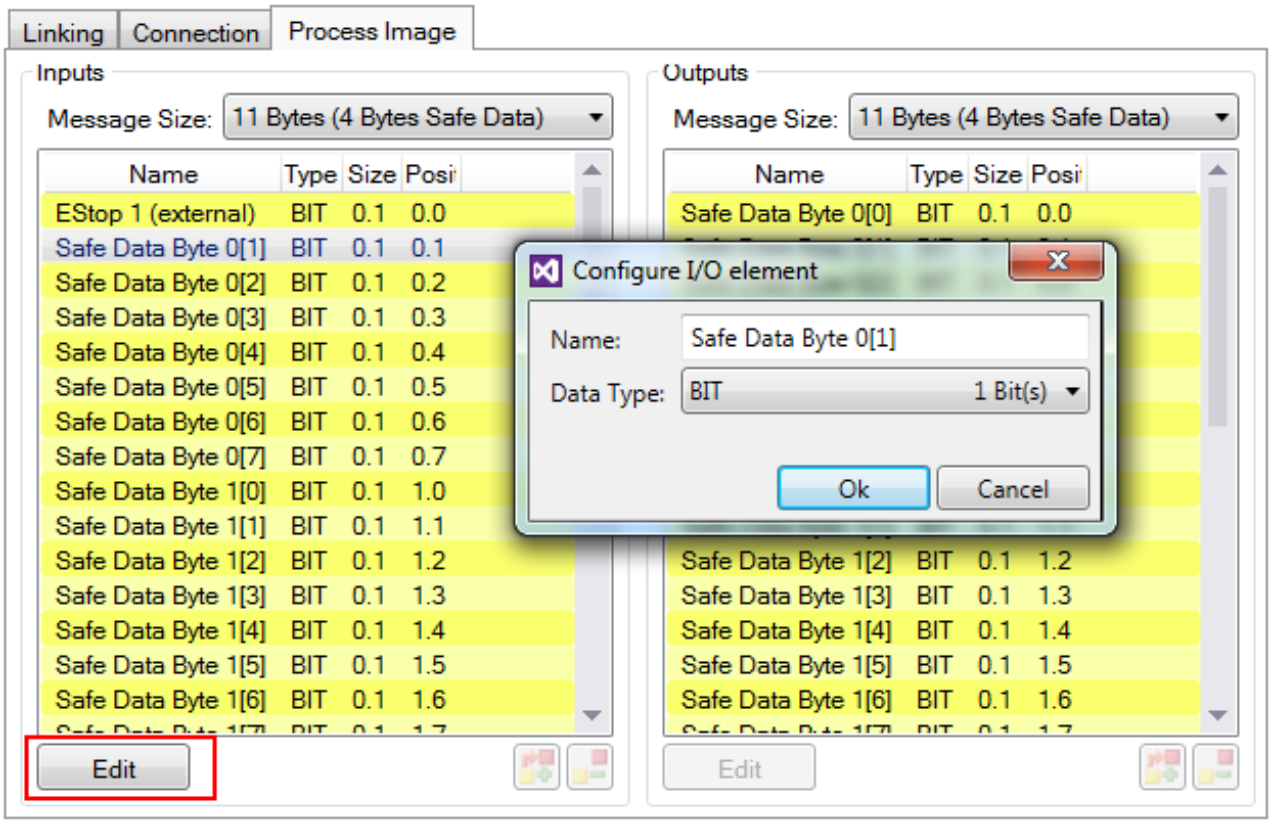


Fig. 25: Renaming the individual signals within the telegram

The connection is linked under the *Linking* tab. The Link button next to *Full Name (input)* and *Full Name (output)* can be used to select the corresponding variable.

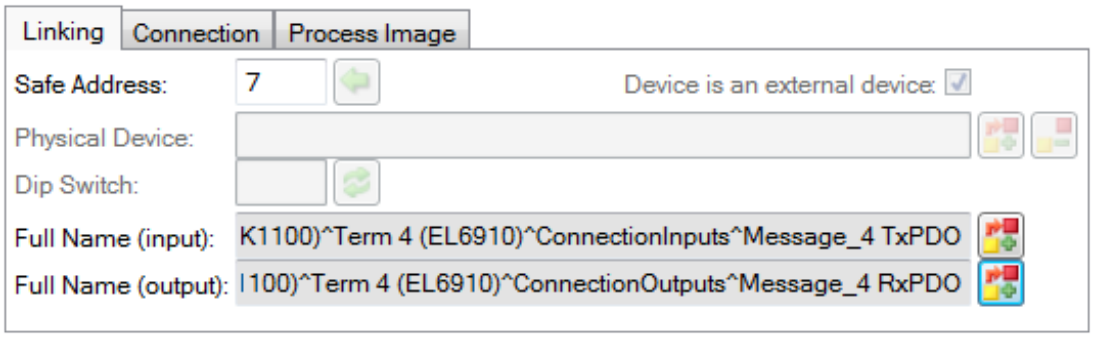


Fig. 26: Selecting the variables

This can be a PLC variable, for example, which is then forwarded to the remote device or can be linked directly with the process image of an EtherCAT Terminal (e.g. EL69x0 or EL6695).

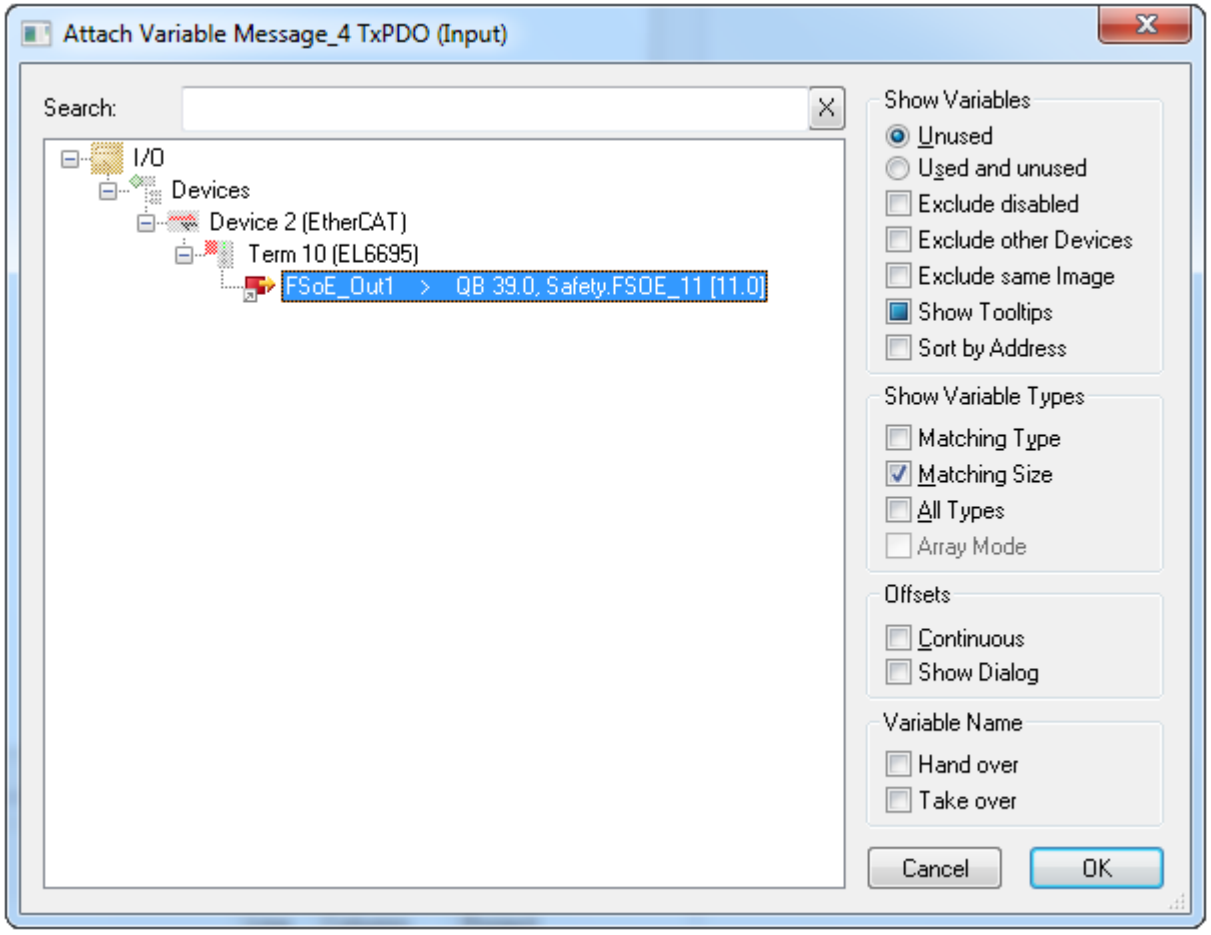


Fig. 27: Direct linking with the process image of an EtherCAT Terminal

Further information can be found in the TwinCAT documentation for the variable selection dialog.

The *Connection* tab is used to set the connection-specific parameters.

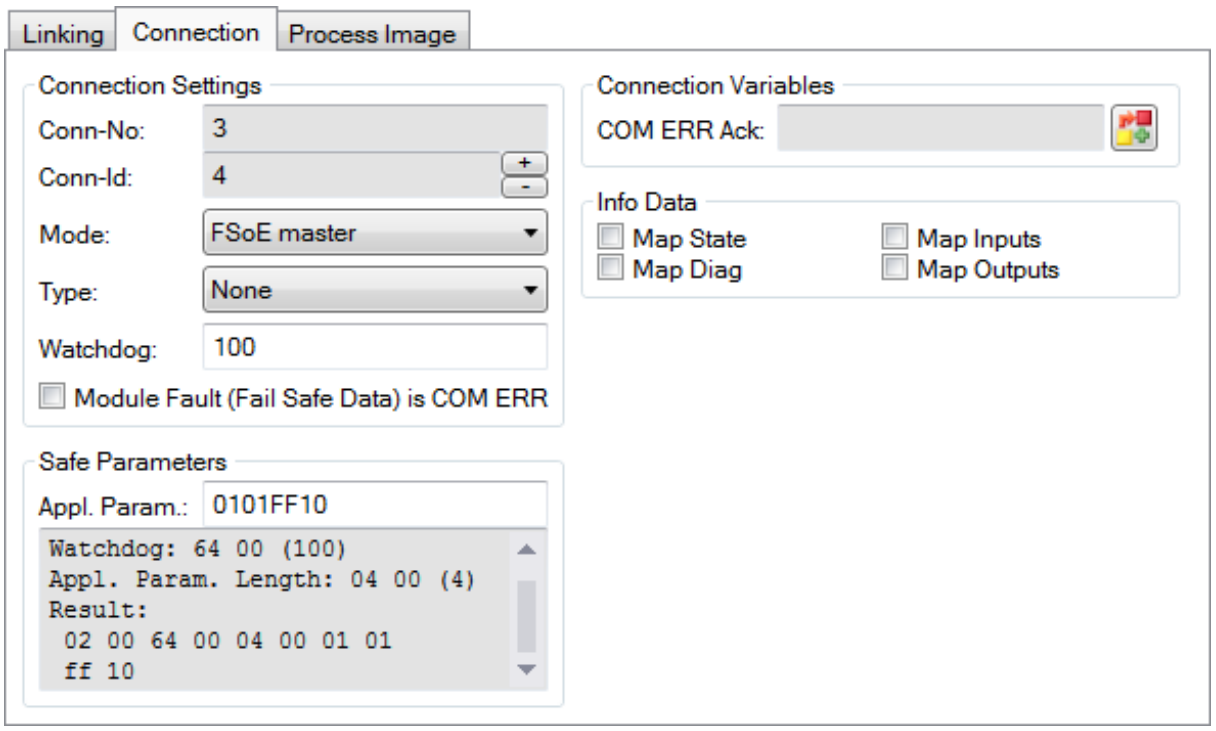


Fig. 28: Connection-specific parameters

Detailed information about the individual settings can be found in the following table.

Parameter	Description	User interaction required
Conn. no.	Connection number: is automatically assigned by the TwinCAT system	No
Conn ID	Connection ID: preallocated by the system, but can be changed by the user. A Conn ID must be unique within a configuration. Duplicate connection IDs result in an error message	Check
Mode	FSoE master: EL6910/EJ6910 is FSoE master for this device. FSoE slave: EL6910/EJ6910 is FSoE slave for this device.	Check
Type	None: Setting for third-party equipment, for which no ESI file is available. KL6904: Setting for KL6904 (safety parameter inactive) EL69XX: Setting for EL6900/EL6930/EL6910/EJ6910 (safety parameter inactive)	Yes
Watchdog	Watchdog time for this connection: A ComError is generated, if the device fails to return a valid telegram to the EL6910 within the watchdog time.	Yes
Module Fault is ComError	This checkbox is used to specify the behavior in the event of an error. If the checkbox is ticked and a module error occurs on the Alias Device, this also leads to a connection error and therefore to disabling of the TwinSAFE group, in which this connection is defined.	Yes
Safe Parameters (Appl. Param)	Device-specific parameters: The parameter length is automatically calculated from the number of characters that is entered. This information will typically be provided by the device manufacturer.	Yes
ComErrAck	If ComErrAck is linked to a variable, the connection must be reset via this signal in the event of a communication error.	Yes
Info data	The info data to be shown in the process image of the EL6910/EJ6910 can be defined via these checkboxes. Further information can be found in the documentation for *TwinCAT function blocks for TwinSAFE Logic terminals*.	Yes

5.3.4.8 Creating the safety application

The safety application is realized in the SAL worksheet pertaining to the TwinSAFE group (SAL - **S**afety **A**pplication **L**anguage).

The toolbox provides all the function blocks available on the EL6910/EJ6910.

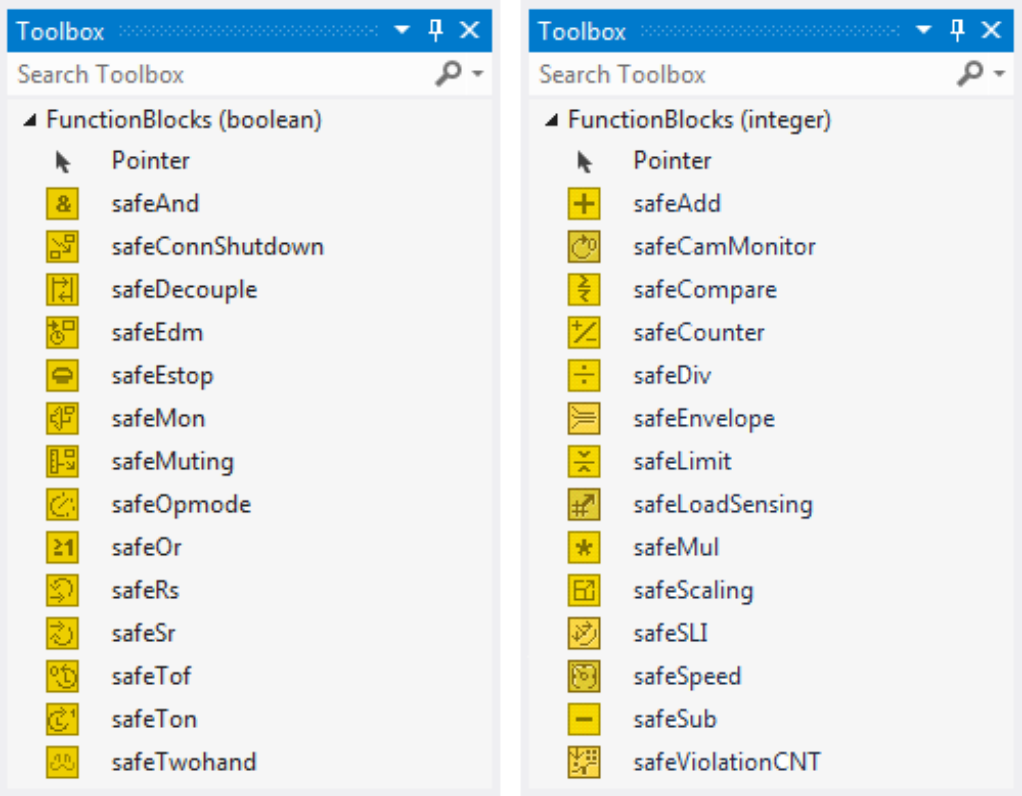


Fig. 29: Function blocks available for EL6910/EJ6910

The function blocks can be moved from the toolbox into the SAL worksheet via drag and drop. Variables can be created by clicking next to a function block input or output, which can then be linked with alias devices in the *Variable Mapping* dialog.

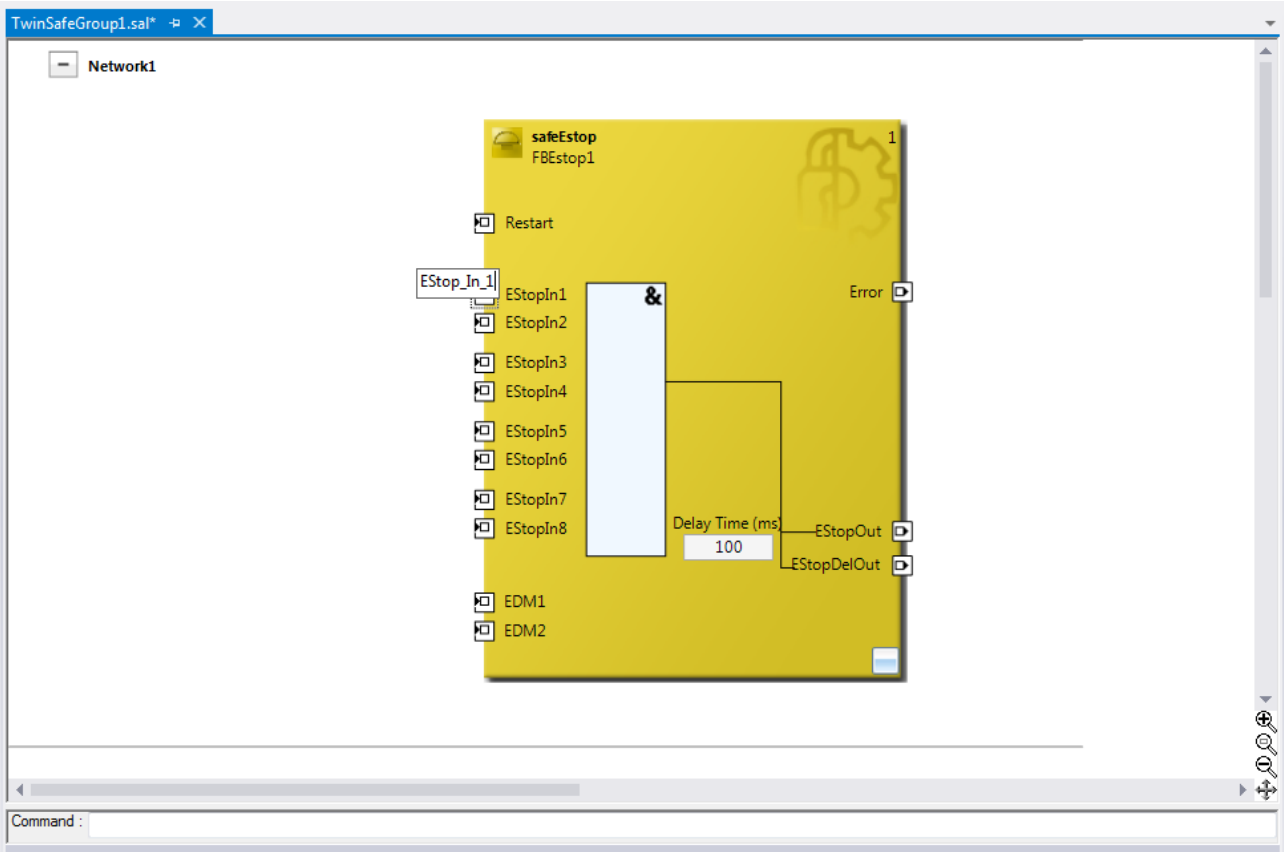


Fig. 30: Function block on the SAL worksheet

Once the pointer connector Pointer has been selected from the toolbox, connections between the input and output ports of the function blocks can be dragged with the mouse.

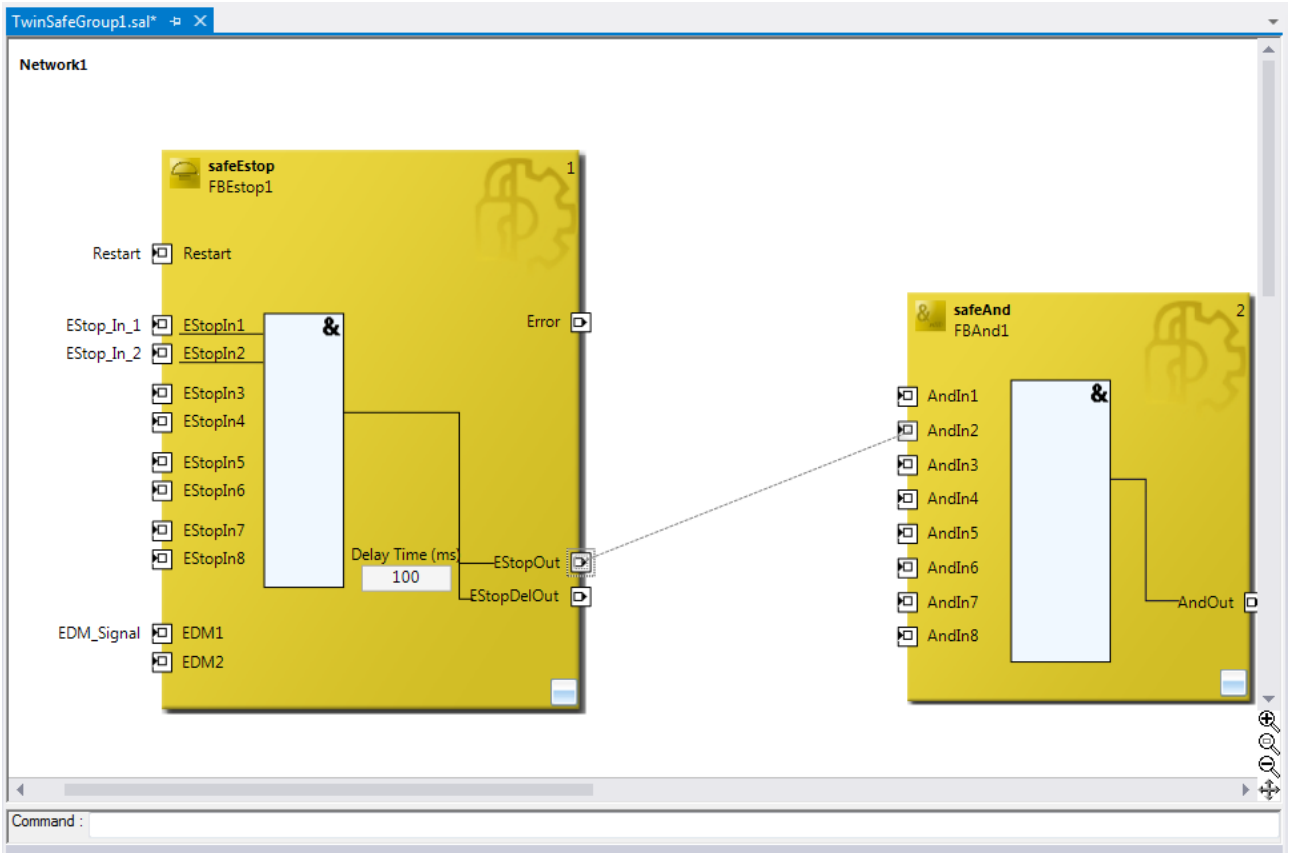


Fig. 31: Dragging a connection between two function blocks

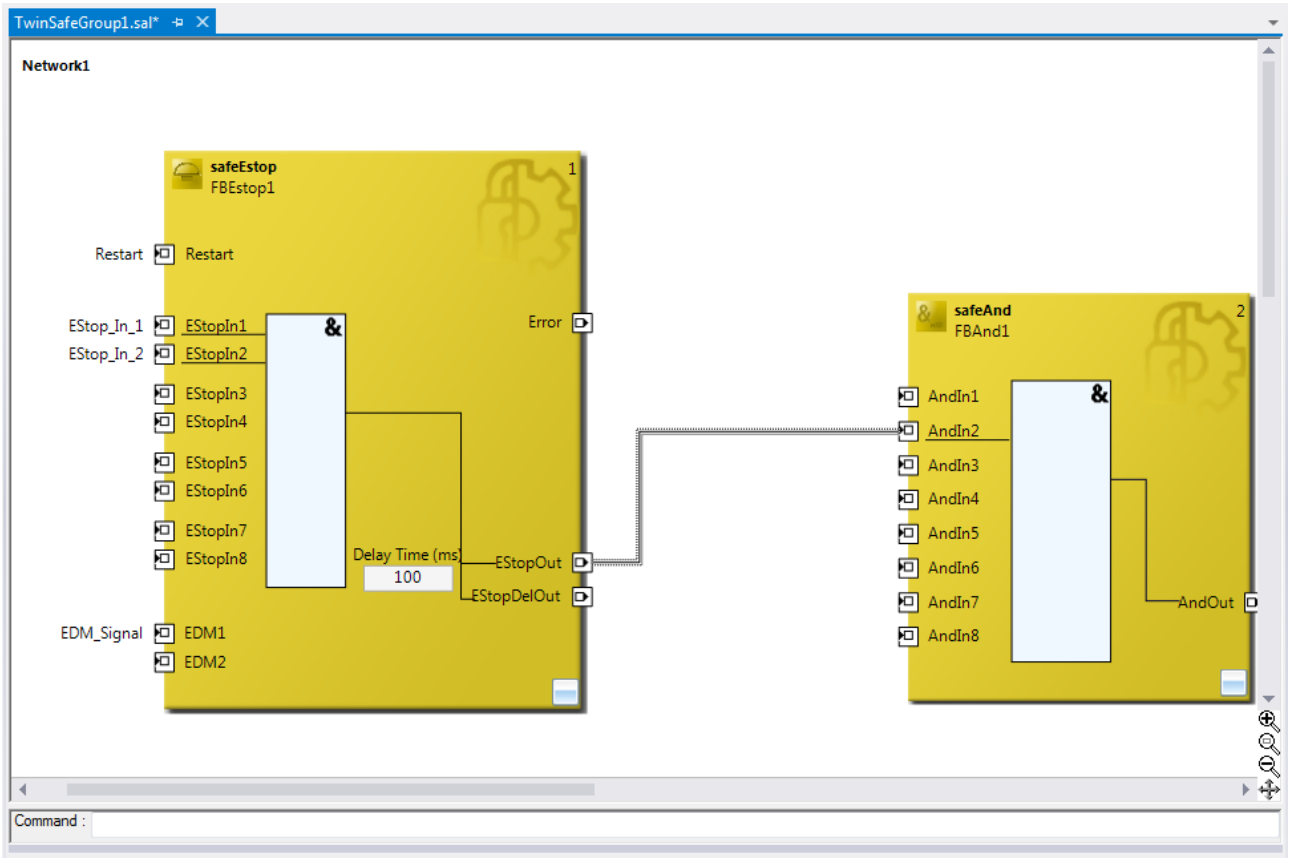


Fig. 32: Connection between two function blocks

5.3.4.9 Networks

For structuring the safety application, several networks can be created within a sal worksheet. Right-click in the worksheet and select *Add After* and *Network* or *Add Before* and *Network* to create a network after or before the current network.

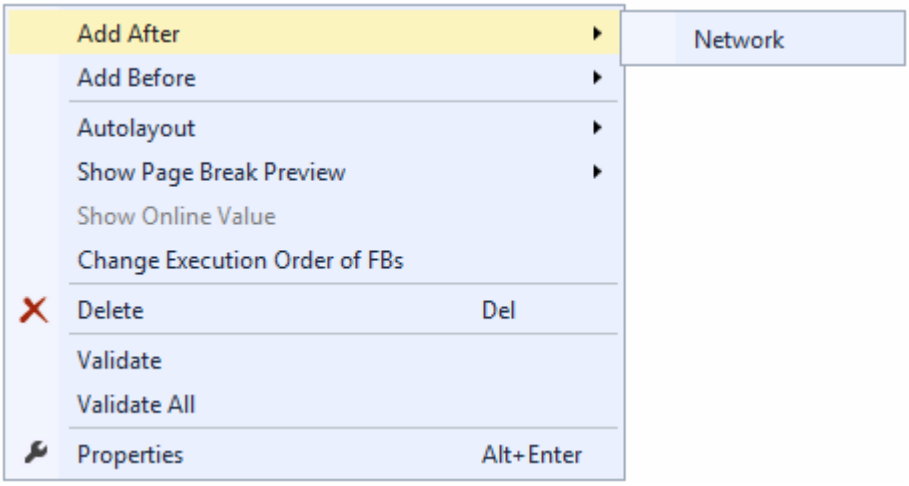


Fig. 33: Creating a network

The instance path to the FB port to be linked can be specified, in order to exchange signals between the networks. The instance path consists of the network name, the FB name and the FB port, each separated by a dot. The input of the instance path is case-sensitive.

<Network name>.<FB name>.<FB port name>

Sample: Network1.FBEstop1.EStopIn3

Alternatively, *Change Link* can be selected by opening the context menus next to the FB port.

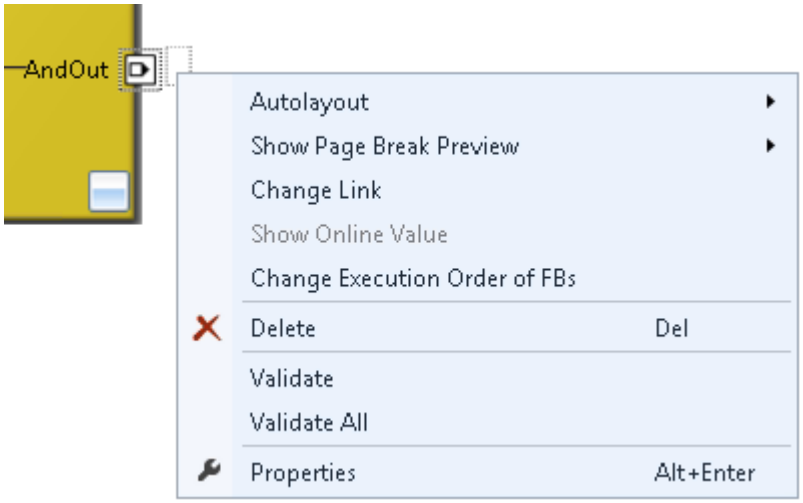


Fig. 34: Change Link

This function opens a dialog for selecting a suitable FB port.

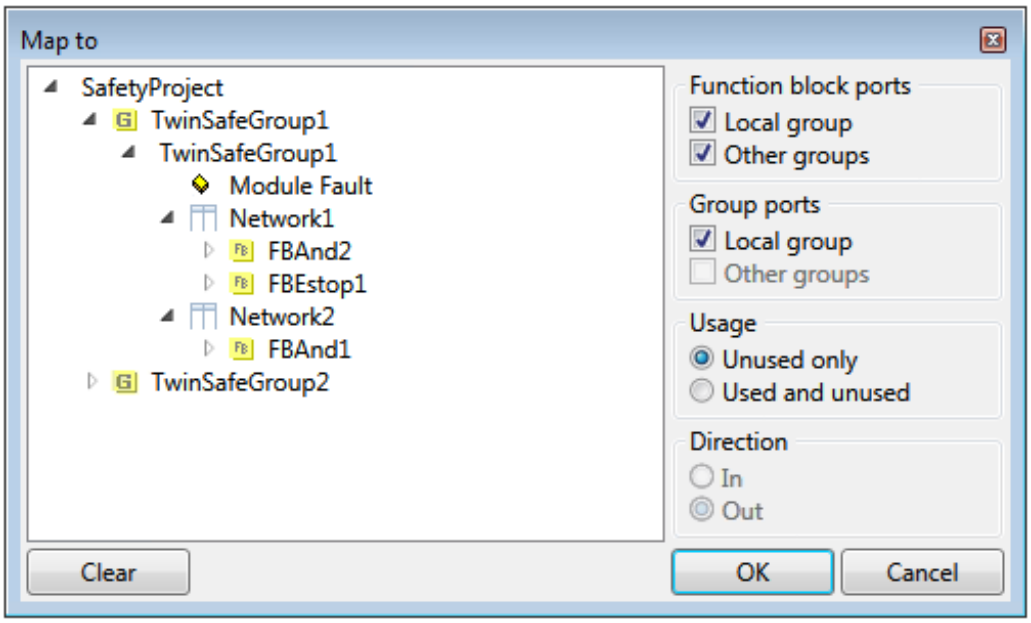


Fig. 35: Dialog for selecting a suitable FB port

Once the link has been created on one side of the connection, the link is automatically set/displayed on the opposite side.

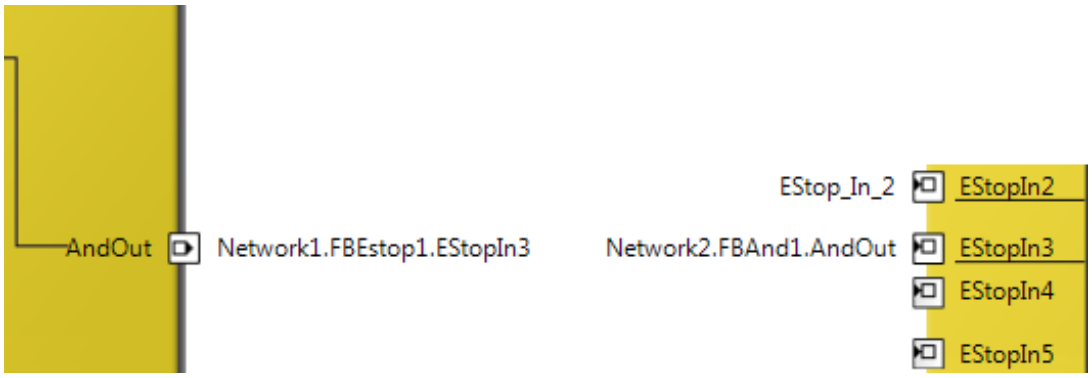


Fig. 36: Link display

5.3.4.10 TwinSAFE groups

It makes sense to create TwinSAFE groups in cases where different machine safety zones are to realize, or simply in order to separate the fault behavior. Within a group, a FB or connection error (here: alias device) leads to a group error and therefore to switching off all outputs for this group. If an error output of an FB is set, it will be forwarded as a logical 1 signal.

A group can be created by opening the context menu of the safety project and selecting *Add* and *New Item...*.

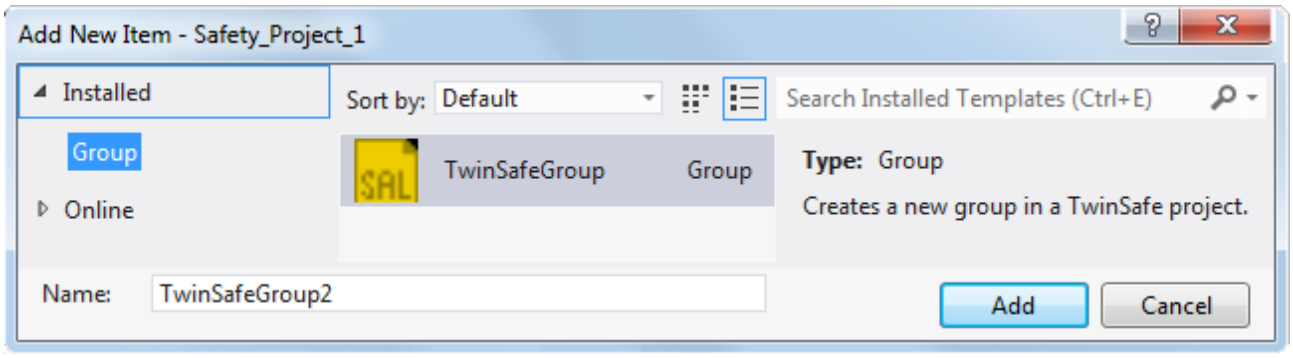


Fig. 37: Creating a TwinSAFE group

Like the first group, the group of a subitem for the alias devices and a sal worksheet.

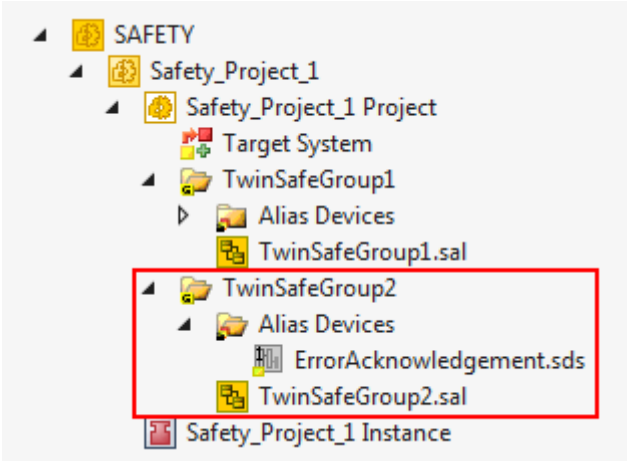


Fig. 38: Components of the TwinSAFE group

The instance path to the FB port to be linked can be specified, in order to exchange signals between the groups. The instance path consists of the group name, the FB name and the FB port, each separated by a dot. The input of the instance path is case-sensitive.

<group name>.<network name>.<FB name>.<FB port name>

Sample: TwinSafeGroup1.Network1.FBEstop1.EStopIn3

Alternatively, *Change Link* can be selected by opening the context menus next to the FB port.

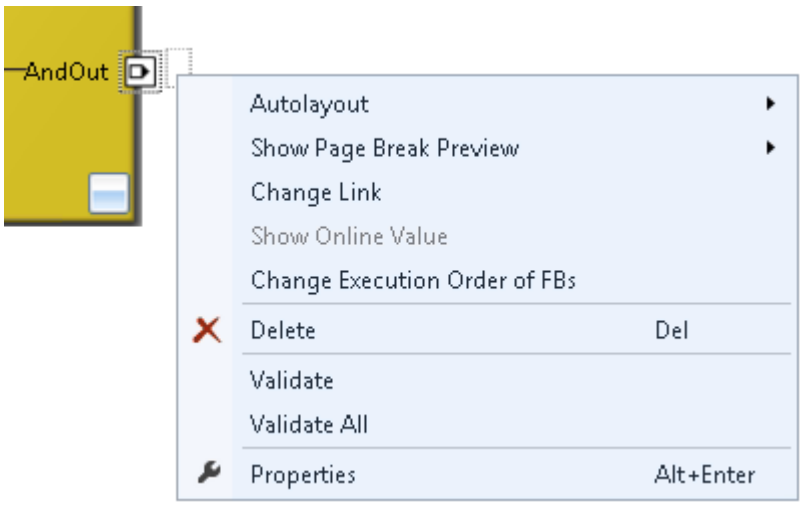


Fig. 39: Change Link

This function opens a dialog for selecting a suitable FB port.

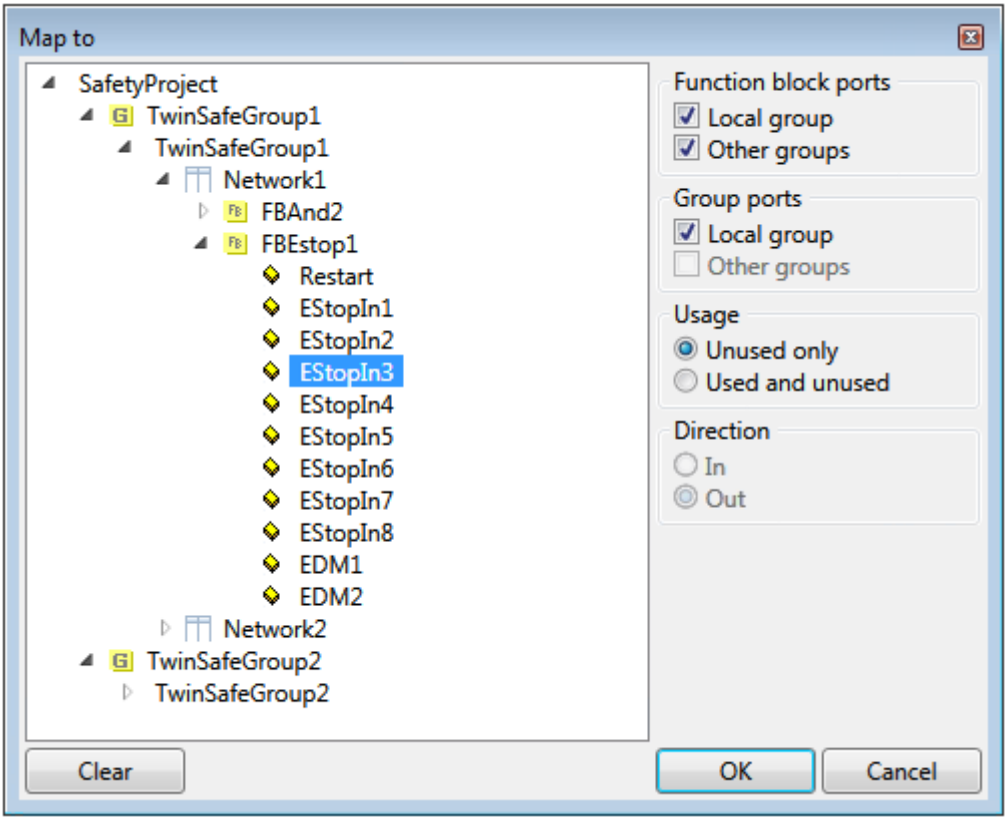


Fig. 40: Dialog for selecting a suitable FB port

Once the link has been created on one side of the connection, the link is automatically set/displayed on the opposite side.

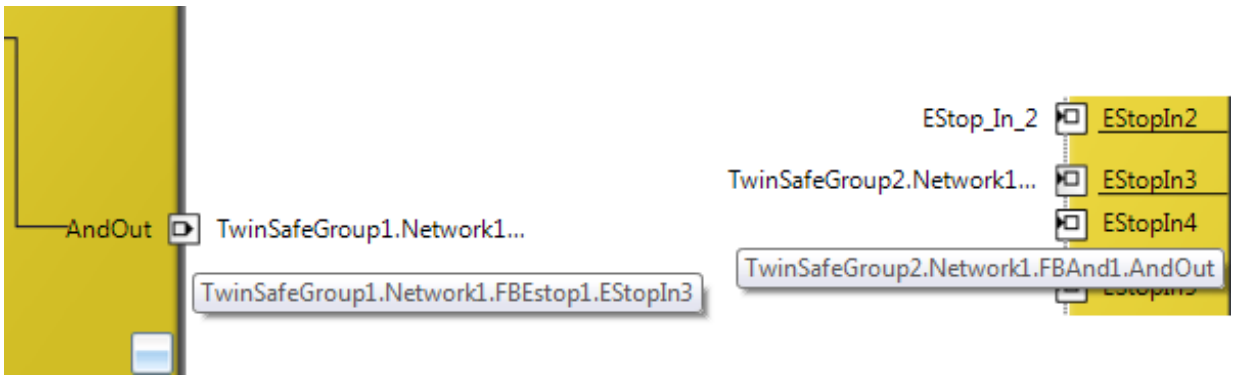


Fig. 41: Link display

5.3.4.11 Variables of the TwinSAFE group

The inputs and outputs of the TwinSAFE groups are consolidated under the *Group Ports* tab of the *Variable Mapping* dialog.

Group inputs EL6910/EJ6910

For a project to be valid, as a minimum the signals *Run/Stop* and *ErrAck* must be linked.

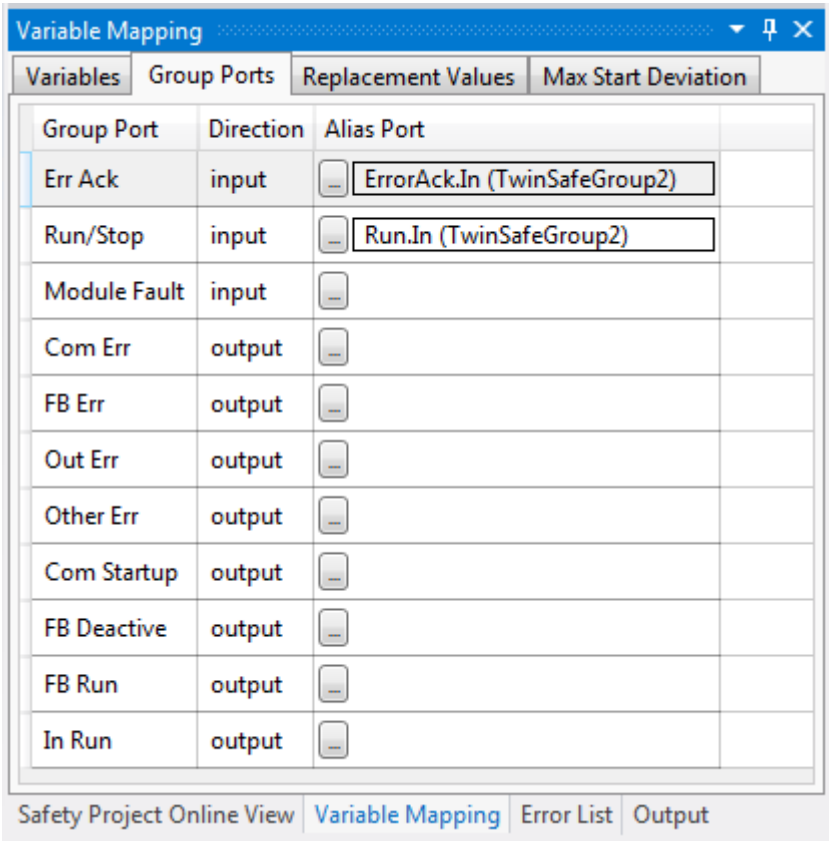


Fig. 42: The Variable Mapping dialog

Group Port	Direction	Description
Err Ack	IN	Error Acknowledge for resetting errors within the group - Signal must be linked with a standard variable
Run/Stop	IN	1 - Run; 0 – Stop - Signal must be linked with a standard variable
Module Fault	IN	Input for an error output of another module that is connected, e.g. EK1960

Group Port	Direction	Description
Com Err	OUT	Communication error in one of the connections
FB Err	OUT	Error at one of the FBs used
Out Err	OUT	not used
Other Err	OUT	ModuleFault OR AnalogValueFault OR WaitComTimeoutFault
Com Startup	OUT	At least one of the connections of this group is in startup
FB Deactive	OUT	The group was deactivated. (See also chapter Customizing / disabling TwinSAFE groups [▶ 99])
FB Run	OUT	FBs of the TwinSAFE group are processed
In Run	OUT	TwinSAFE group is in RUN state

Group State

Value	Status	Description
1	RUN	Input RUN=1, no error in the group, and all connections have started up without error
2	STOP	Input RUN = 0
4	ERROR	Group is in error, see Diagnostic information
5	RESET	After an error has occurred, all errors have been rectified and the Err Ack signal is 1
6	START	The group remains in this state as long as not all connections have started up after the start of the group (RUN=1)
7	STOPERROR	When the group is started or initialized, it assumes the STOPERROR status if the TwinSAFE connections are assigned to the group. The group switches from STOPERROR state into ERROR state if the Run input is TRUE.
16	DEACTIVE	Group was deactivated via customizing
17	WAITCOMERROR	This state is set when the customizing function “Passivate” is selected and the system waits for ComError of the group

Group Diag

Value	Status	Description
0	-	No error
1	FBERROR	at least one FB is in ERROR state
2	COMERROR	at least one connection is faulty
3	MODULEERROR	the input ModuleFault is 1
4	CMPERROR	On startup, at least one analog FB input deviates from the last saved value (Power-On Analog Value Check Error)
5	DEACTIVATE ERROR	In "passivate manual control unit" mode the timeout has elapsed while waiting for the COM error
6	RESTARTERROR	The TwinSAFE Logic program was restarted because the EtherCAT connection was restarted or a user logged in without reloading the TwinSAFE Logic program (or parts of it).

5.3.4.12 Order of the TwinSAFE groups

The order of the groups can be changed, in order to realize a defined processing sequence of the safety application.

To this end, select the entry *Edit TwinSAFE Group Order* via the node menu of the safety project node. A dialog opens, in which the order of the groups can be changed. The individual groups do not necessarily have to be numbered in consecutive ascending order. The numbering can contain gaps.

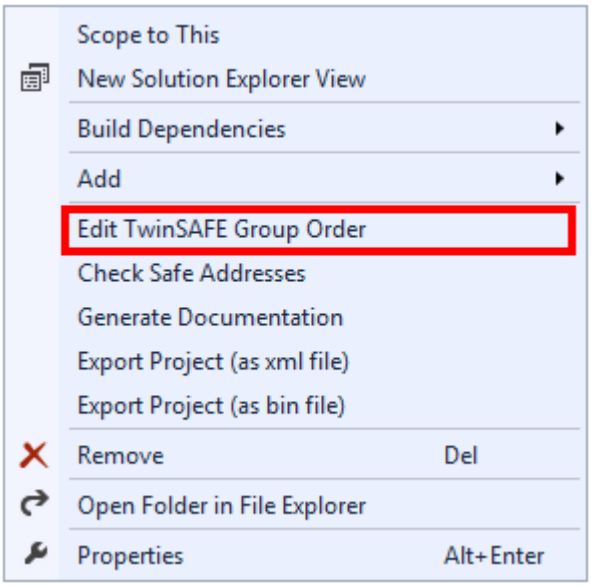


Fig. 43: Context menu Edit TwinSAFE Group Order

The current group order is shown in the column *Current Value*. The new order is specified by entering a value in the column *New Value,* followed by *OK*.

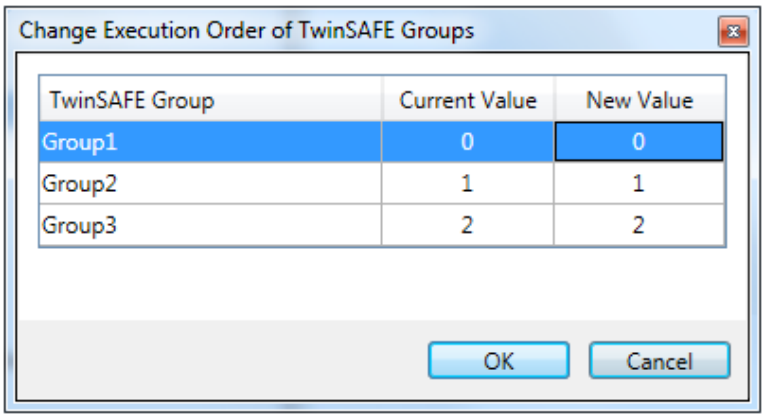


Fig. 44: Dialog Change Execution Order of TwinSAFE Groups

5.3.4.13 Command line

The *command line* below the SAL worksheet can be used to enter commands for executing functions.

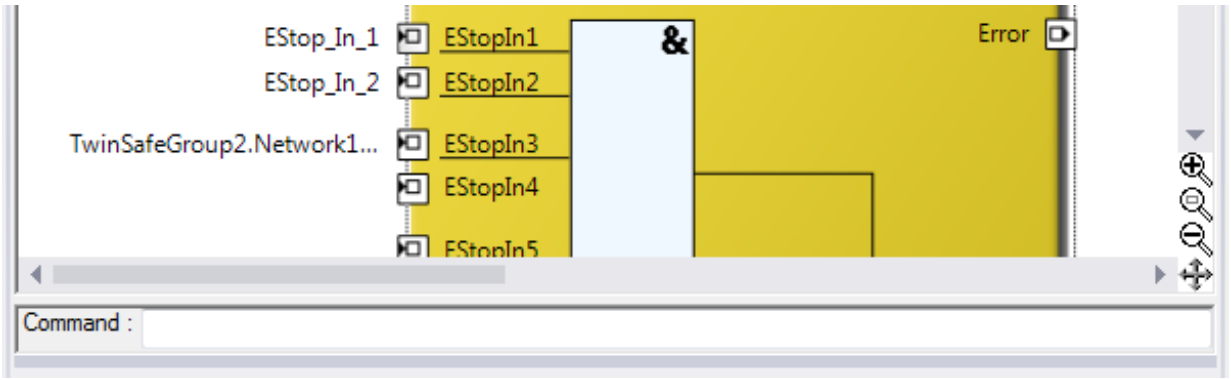


Fig. 45: The command line below the SAL worksheet

Currently the commands listed in the following table are supported.

Command	Description
FBNAME FB_INSTANCENAME NETWORKNAME;	Adding a function block Sample: safeAnd FBAnd1 Network1
FB_INSTANCENAME->PORTNAME = VARIABLE_NAME;	Creating a variable mapping Sample: FBAnd1->AndIn1 = testVariable
FB_INSTANCENAME->PORTNAME = FB_INSTANCENAME->PORTNAME;	Creating a connection between two FBs Sample: FBAnd1->AndIn1 = FBOr1->OrOut;

5.3.4.14 FB port properties

The behavior of the inputs can be parameterized by opening the properties for the upper input of an input pair or an individual input of the function block. For an input group, such as the function block ESTOP, the individual inputs to be activated or deactivated, and single- or two-channel evaluation can be set.

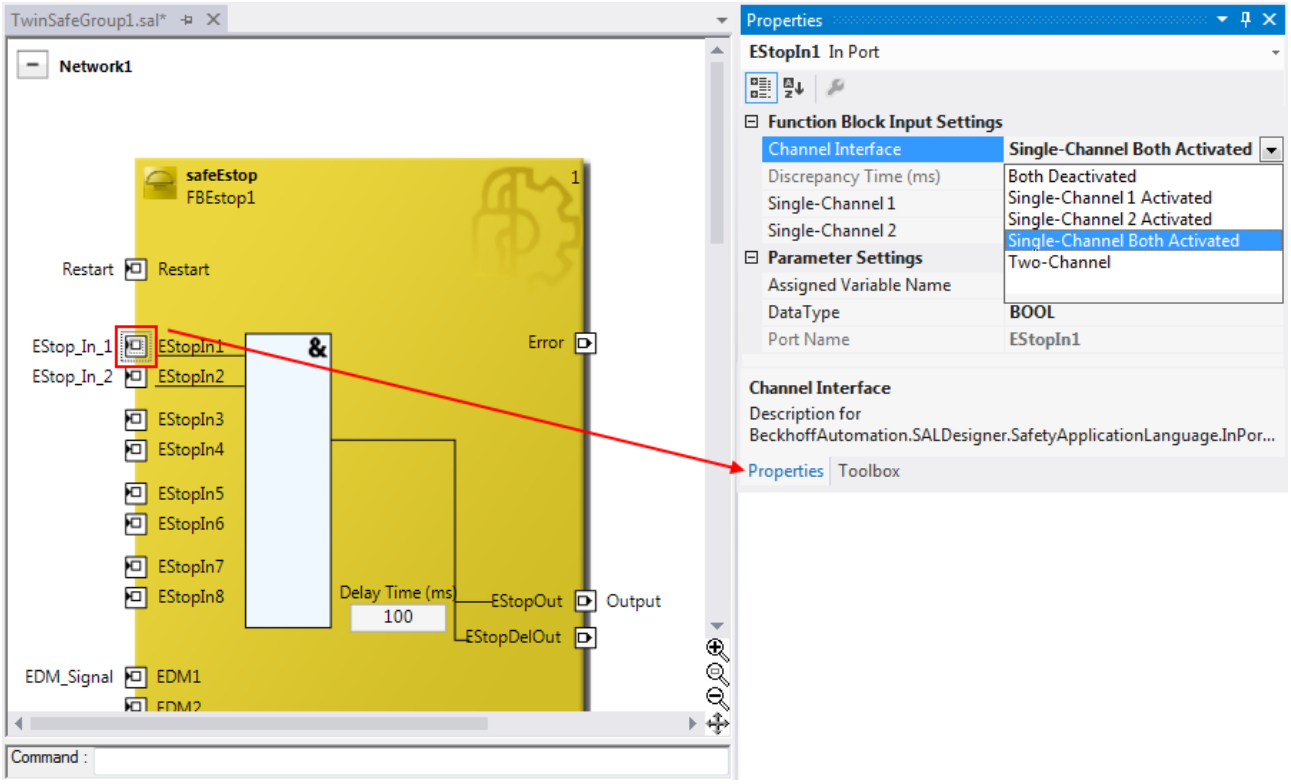


Fig. 46: FB port properties

Channel Interface	Description
Both Deactivated	Both inputs are deactivated
Single-Channel 1 Activated	Channel 1: Single-channel evaluation Channel 2: deactivated
Single-Channel 2 Activated	Channel 1: deactivated Channel 2: Single-channel evaluation
Single-Channel Both Activated	Channel 1: Single-channel evaluation Channel 2: Single-channel evaluation
Two-Channel	Both inputs are activated, and two-channel evaluation with *Discrepancy Time (ms)*

If the *Two-Channel* evaluation is enabled, the corresponding *Discrepancy time (ms)* can be set in milliseconds. For each input there is a setting to indicate whether the input should be evaluated as *Break Contact (NC)* or *Make Contact (NO)*. When a variable or a connecting line is connected to the function block, the corresponding channel is enabled automatically.

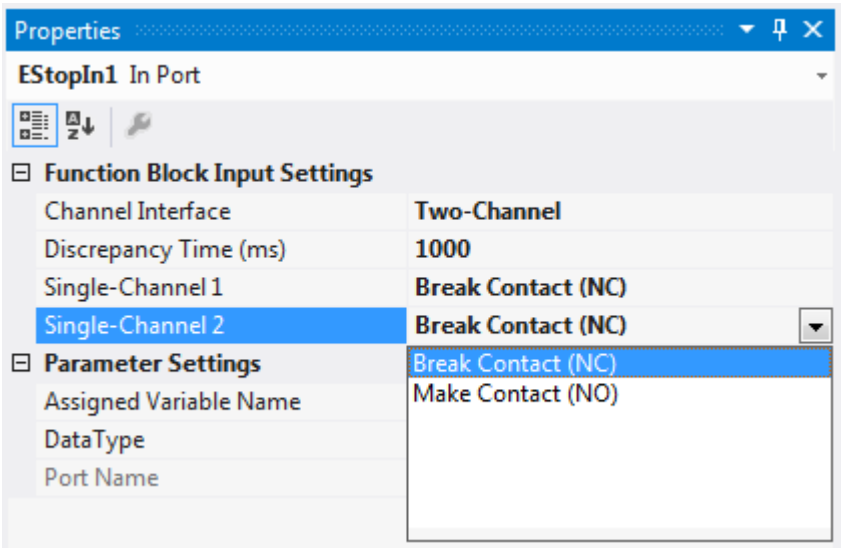


Fig. 47: Make Contact (NO) / Break Contact (NC) setting

These settings are also accessible for each individual port of an FB via the context menu item *Change InPort Settings*.

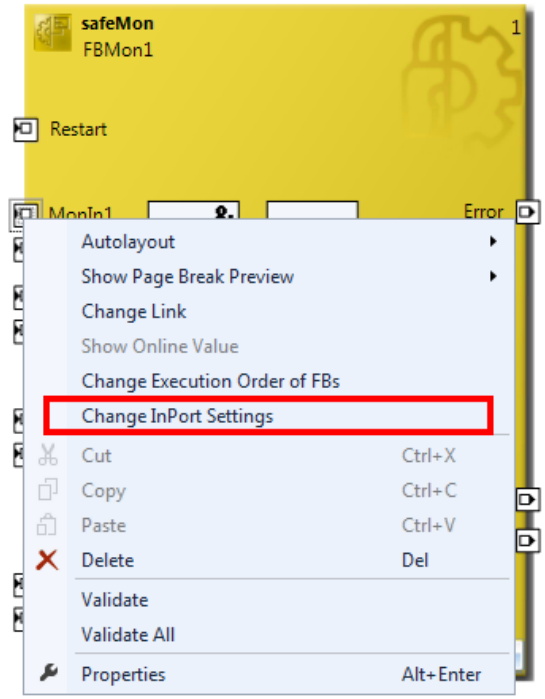


Fig. 48: Menu Change Inport Settings

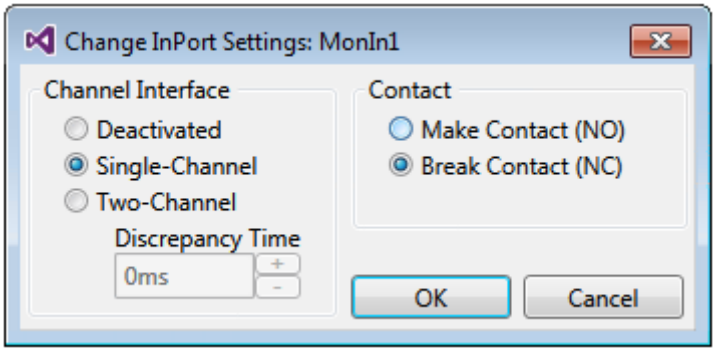


Fig. 49: Dialog Change InPort Settings

5.3.4.15 Variable Mapping

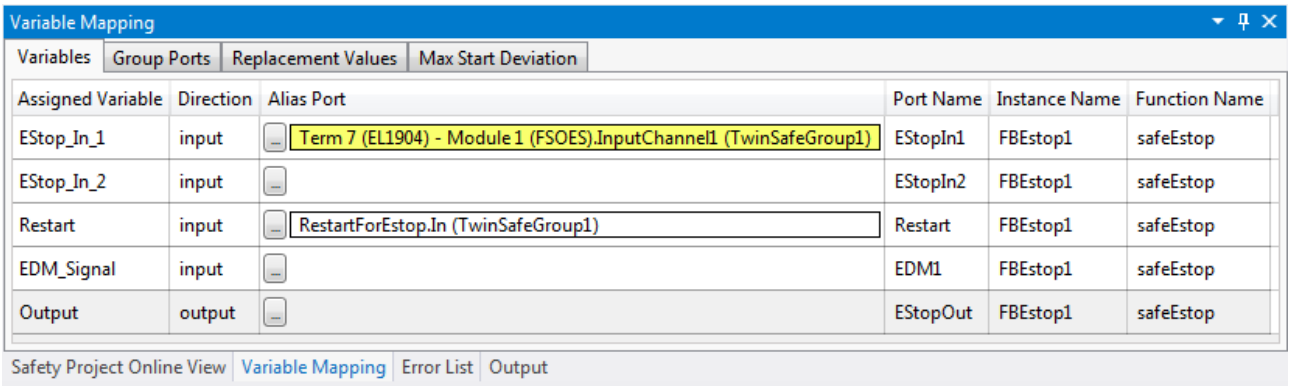


Fig. 50: Variable Mapping

Variables are linked to the alias devices in the *Variable Mapping* window. Use the Link button to open the selection dialog for the alias port. Safe only signal types or safe and standard signal types are offered in the selection dialog, depending on the port setting of the FB. Safe Boolean signals are shown with a yellow background, standard signal types with a white background.

If several outputs are to be written by one variable, these signals can be assigned by holding down the CTRL key and selecting the channels.

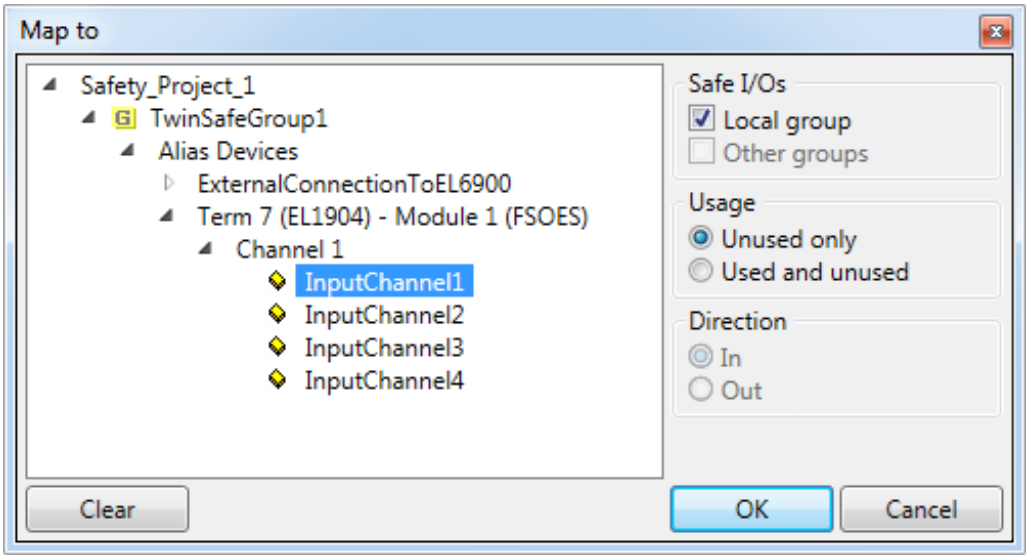


Fig. 51: Selection dialog for the alias port

5.3.4.16 Safety toolbars

Once the development of the safety project is complete, the project has to be loaded onto the target system, in this case EL6910/EJ6910. To this end the toolbars *TwinCAT Safety* and *TwinCAT Safety CRC* have to be added.

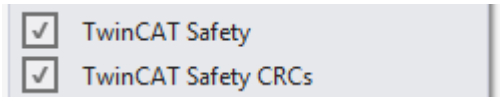


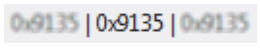
Fig. 52: Activation of the TwinCAT Safety and TwinCAT Safety CRC toolbars

Fig. 53: Display of the TwinCAT Safety and TwinCAT Safety CRC toolbars

Toolbar TwinCAT Safety

Icon	Name	Description
	Verify Safety Project	The safety project is checked for validity.
	Verify Complete Safety Project	The safety project including the hardware level is checked for validity.
	Download Safety Project	Loading the safety project onto the target system, here EL6910/ EJ6910
	Delete Safety Project	Deleting the safety project from the target system, here EL6910/ EJ6910
	Show Online Data of Safety Project	Switching on the Online View for the safety project.
	Customize Safety Project	Customizing the safety project (switching off TwinSAFE groups and setting of safe substitute values for the group outputs). This is possible if the online and offline CRC are the same and at least one group has been configured for customizing.

Toolbar TwinCAT Safety CRC

Icon	Name	Description
	CRC Toolbar	Left-click on the toolbar to initiate an update of the CRCs by the user. Red icon: CRCs are different
	CRC Toolbar	Green icon: All CRCs are identical
	Online CRC	CRC of the safety project on EL6910/EJ6910. This value is read online by the EL6910/EJ6910. In the absence of an ADS connection to the EL6910/EJ6910, this value is displayed with .
	Downloaded CRC	CRC of the safety project that was loaded last. If no safety project is loaded when the TwinCAT project is opened, the value is displayed with .
	Offline CRC	CRC of the current safety project, as stored in the safety editor. A CRC is displayed, if the stored project is valid. If the project is invalid, is displayed as CRC.

5.3.4.17 Checking the TwinSAFE addresses

The hardware addresses of the alias devices used can be checked and set via the dialog *Check Safe Addresses*.

To this end, select the entry *Check Safe Addresses* via the node menu of the safety project node. A dialog opens, which lists all alias devices that use hardware addresses. The addresses set in the software (*Safe/ FSoE Address*) and the hardware addresses (*Hardware Address*) are shown in separate columns for each alias device and for the target system. In the column *Take Hardware Address* the user can specify whether the hardware addresses for the alias devices settings are applied when the dialog is closed via the *OK* button.

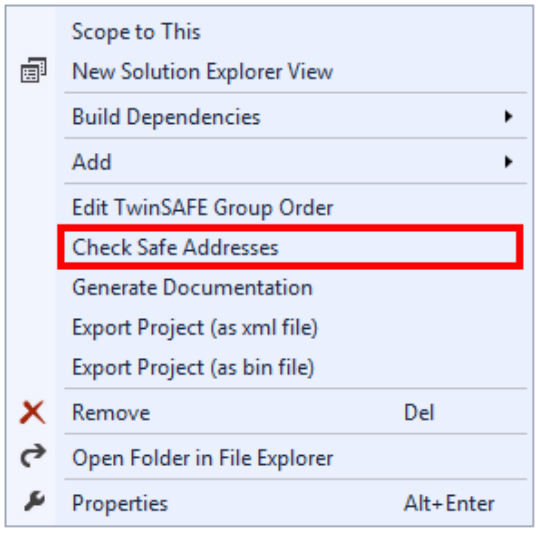


Fig. 54: Check Safe Addresses context menu

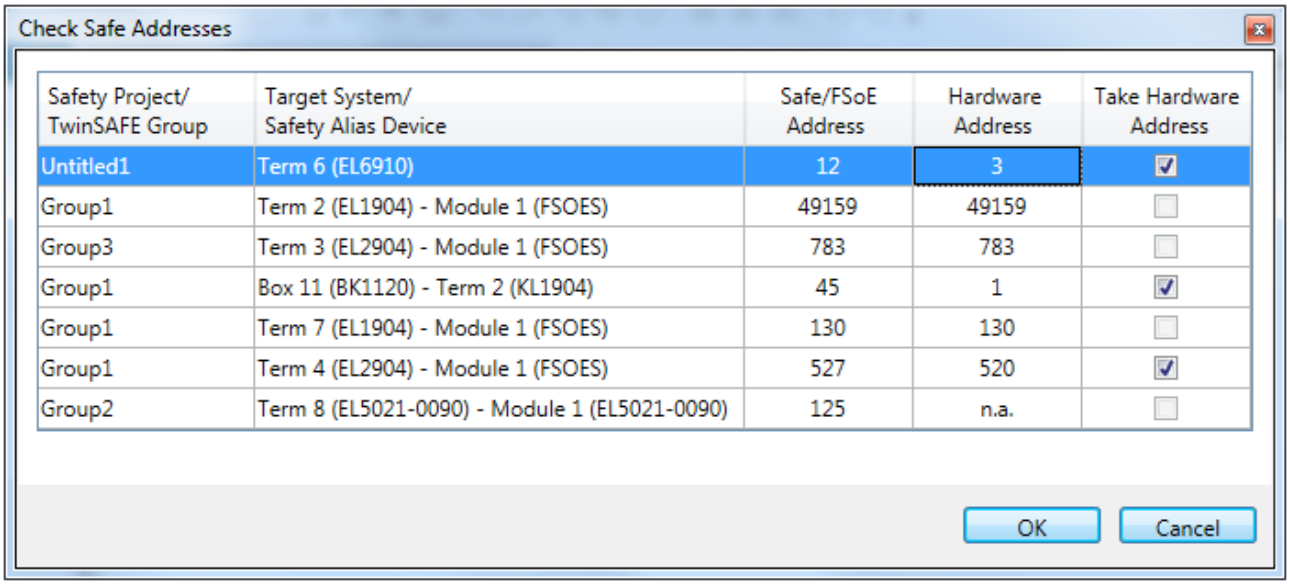


Fig. 55: Check Safe Addresses dialog

5.3.5 Downloading the safety application

Before downloading the safety project to the EL6910/EJ6910 or a logic component, the project should first be checked for validity. If the hardware is complete, the hardware level can be used for checking, or checking can take place at the project level , if online access is only available for the EL6910/EJ6910 or the logic component. If the check returns no errors, the project download can continue.

⚠ CAUTION

Use only qualified tools

Only use a qualified tool (see note on system limits) for loading, verifying and enabling the project on the EL6910/EJ6910 or the logic component!

User name and password are case-sensitive

Pay attention to upper/lower case characters for the user name and password.
The standard user is *Administrator,* the standard password is *TwinSAFE*.

NOTE

Power supply during download

Make sure that the TwinSAFE Logic is not switched off during the download. This can lead to unexpected behavior or permanently disable the TwinSAFE Logic.

⚠ WARNING

Execution of the safety application

During a login or download of a safety application, the execution of the current project is stopped on the TwinSAFE Logic.

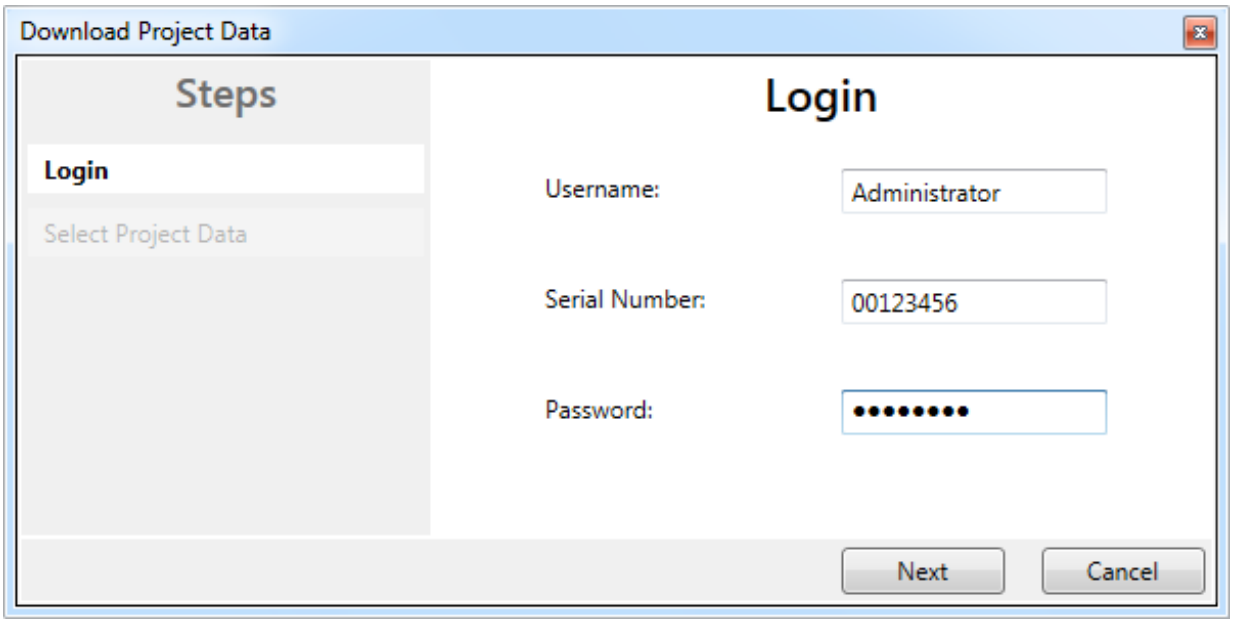


Fig. 56: Download Project Data – The Login dialog

In the *Download Project Data* dialog specify the user name, the serial number of the EL6910/EJ6910 or the logic component onto which the project is to be loaded, and the user password. The default user name is *Administrator,* the default-password is *TwinSAFE*. Use the *Next* button to move to the next dialog.

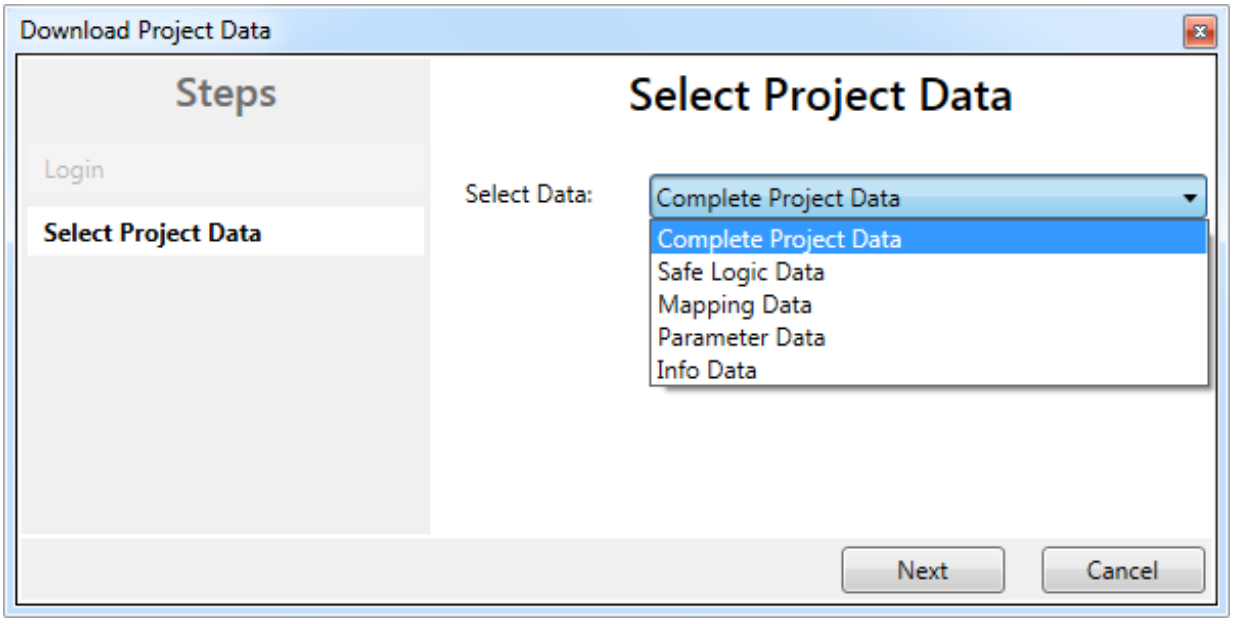


Fig. 57: Download Project Data – The Select Project Data dialog

In the *Select Project Data* dialog select *Complete Project Data* to load the whole project onto the EL6910/ EJ6910 or the logic component. Use the *Next* button to move to the next dialog.

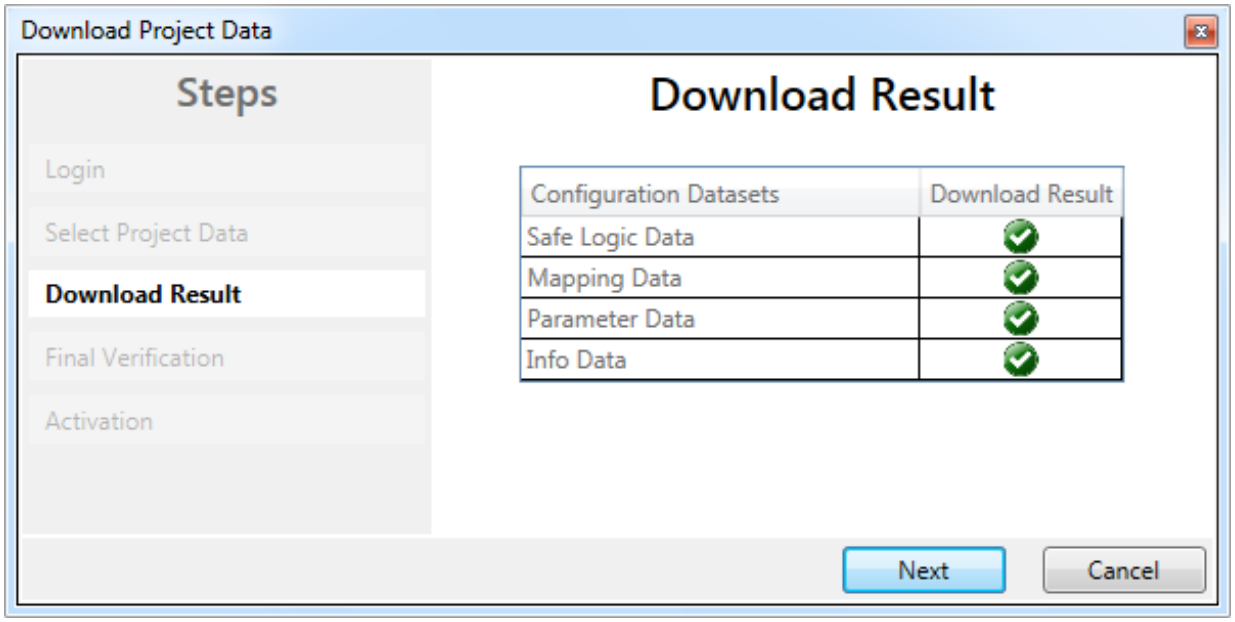


Fig. 58: Download Project Data – The Download Result dialog

Once the download is complete, the download results are displayed. Use the *Next* button to move to the next dialog.

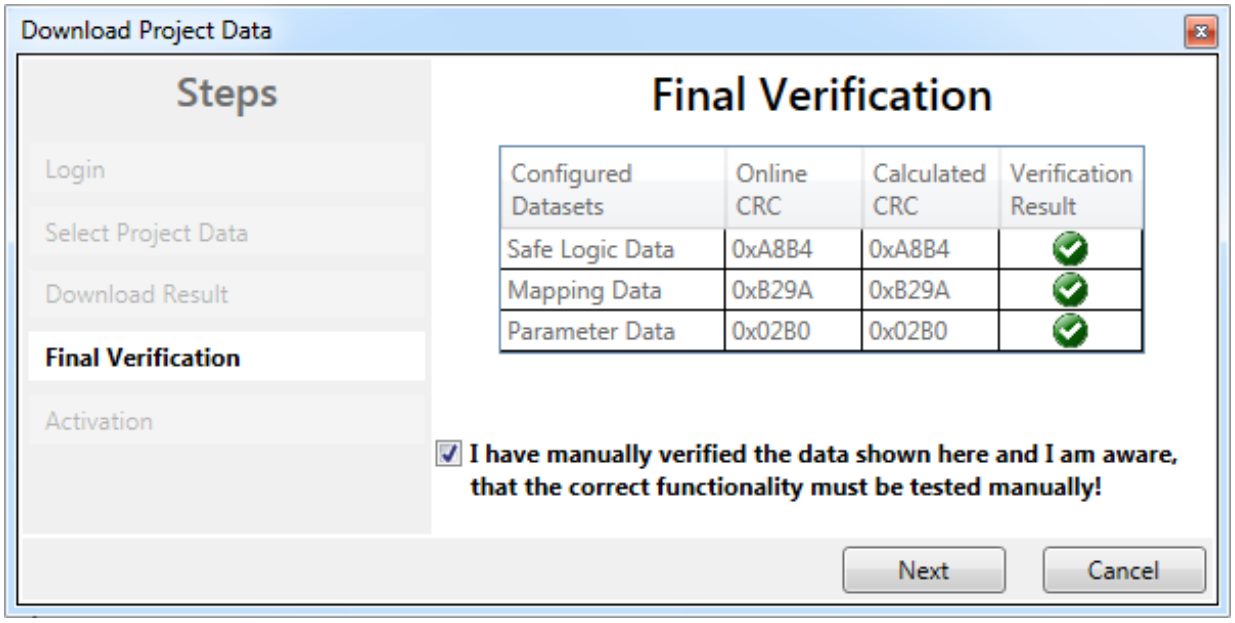


Fig. 59: Download Project Data – The Final Verification dialog

The locally calculated CRCs and the online CRCs of the safety project are displayed in the *Final Verification* dialog. They are automatically checked for equality and displayed via the column *Verification Result*. The user must also check these data for equality and then confirm this by ticking the checkbox. Use the *Next* button to move to the next dialog.

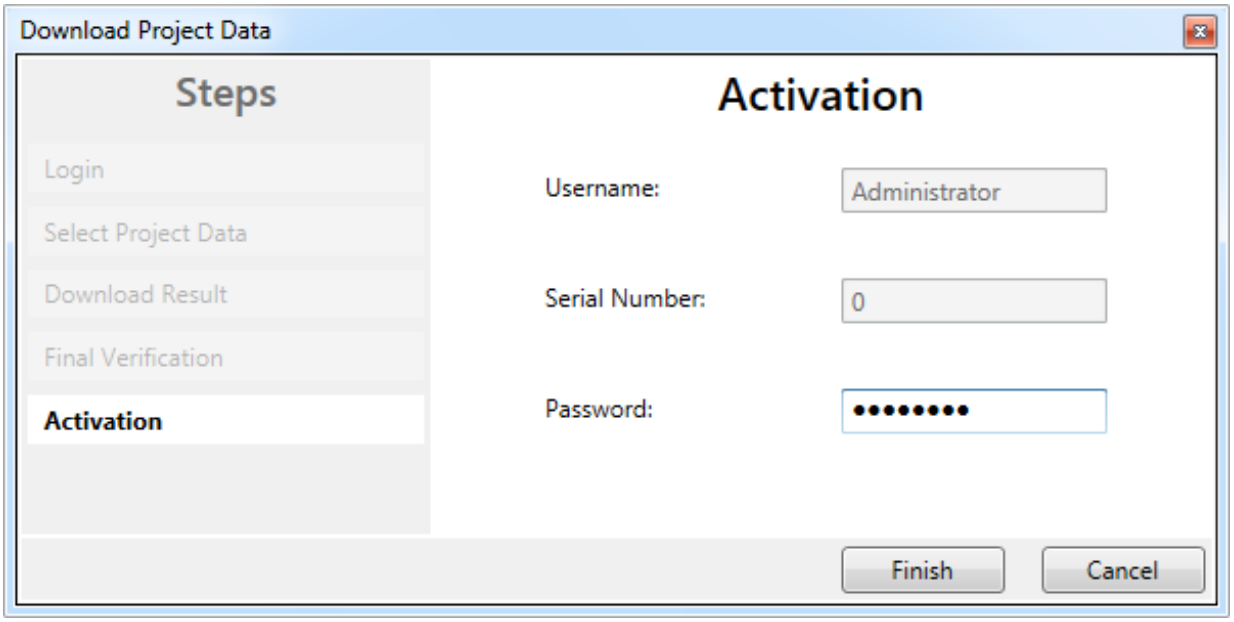


Fig. 60: Download Project Data – The Activation dialog

In the *Activation* dialog the user re-enters the password to activate the safety project on the EL6910/EJ6910 or the logic component. Use the *Finish* button to complete the download of the safety project.

⚠ WARNING

Verification of the input and output process data

After downloading the safety-related program to the TwinSAFE logic, the user must check that the input and output process data of the TwinSAFE logic are plausible, within the valid value range and in the expected magnitude. This is especially true for analog signals, which are transmitted via e.g. PROFIsafe, FSoE sensors, TwinSAFE SC terminals or external control systems to the TwinSAFE logic. It is particularly important to check whether the device uses the Motorola or the Intel format or Big or Little Endian.

Project data	Description
Safe Logic Data	Safe Logic Data contains the safety related program.
Mapping Data	Mapping Data contains the link data for inputs, outputs, function blocks, connections etc.
Parameter Data	Parameter Data contains the safe user parameters that are stored on the TwinSAFE Logic. These can be safe substitute values and the user parameters of the connections.
Info Data	Info Data contains the settings which Info Data for connections, function blocks, groups etc. are activated and have to be filled by the TwinSAFE Logic.

Info Data of the safety project

The Info Data will NOT take effect to the calculation of the project CRC. This allows the Info Data to be changed at a later stage without changing the project CRC.
If the Info Data for an existing project are changed, a project download including at least the Info Data must be carried out, despite the fact that the CRC is unchanged, otherwise the Info Data will not be filled. In addition, the TwinCAT configuration must be activated so that the process image size in TwinCAT matches the expected size within the TwinSAFE Logic.

5.3.6 Online Mode

In Online mode the current values of the safety project are displayed. A green color change indicates logical 1 within the SAL worksheet and the variable mapping. No color change means logical 0.

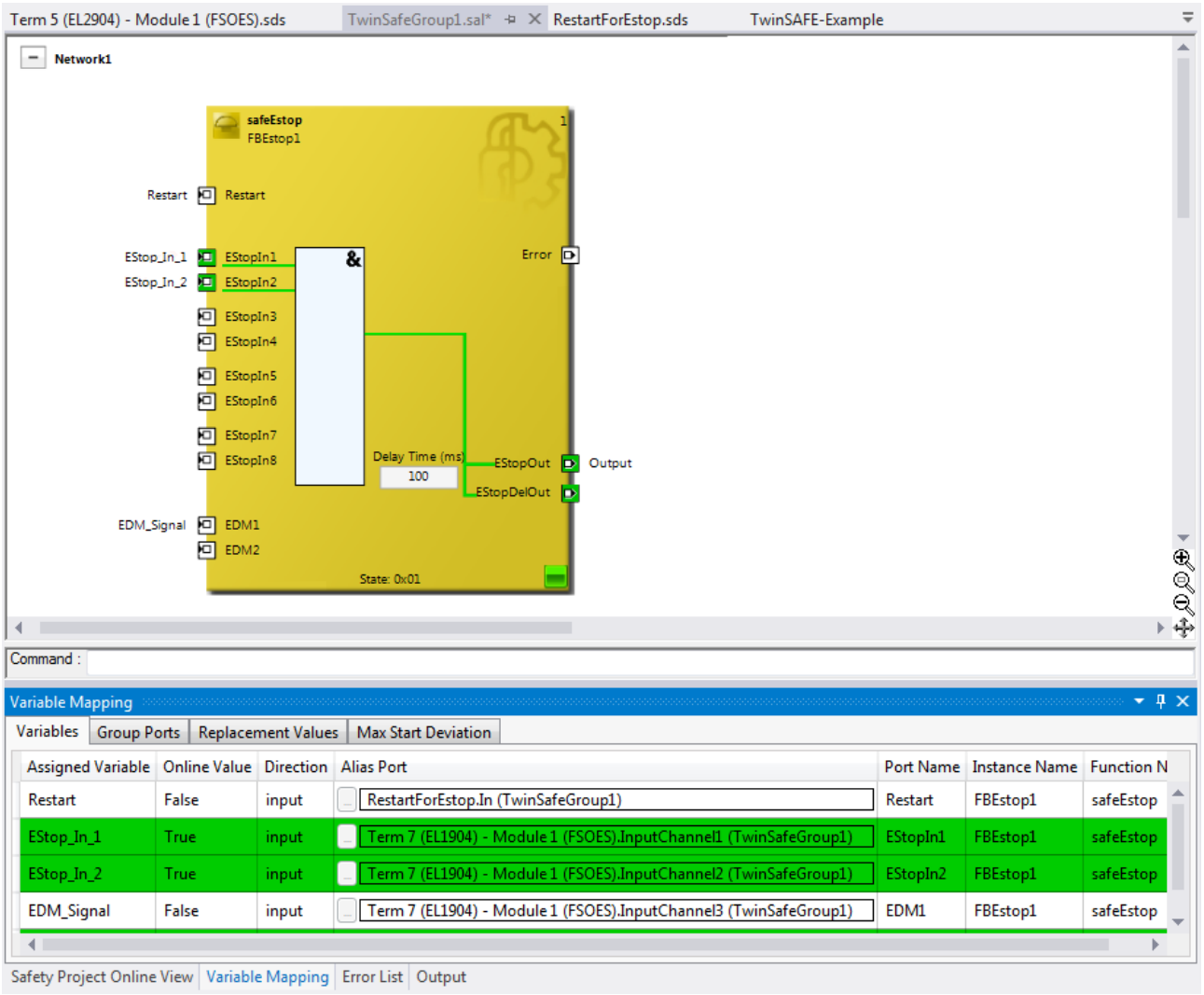
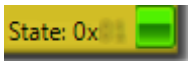
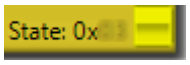
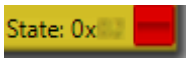


Fig. 61: SAL worksheet and variable mapping in online mode

On each function block the current FB state is shown as text and in the form of an icon. The different states are listed in the FB documentation. The following table describes the icons.

FB Icon	Description
	FB State: RUN In RUN state no error is present, and the output of the FB is set.
	FB State: SAFE In SAFE state no error is present, and the output of the FB is NOT set.
	FB State: ERROR/STOP In ERROR/STOP state an FB error is present or the FB is still in STOP state. This is the case if the group has not yet been started.

In addition, the online display can be extended by displaying analog and digital values. To this end the function can be enabled or disabled by selecting *Show Online Values* from the context menu in the SAL worksheet.

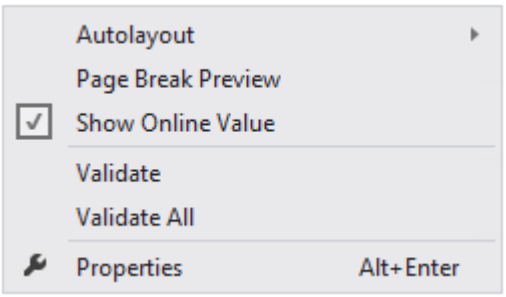


Fig. 62: Activation of Show Online Values

In online mode the analog and digital values are then displayed as text next to the respective variables.

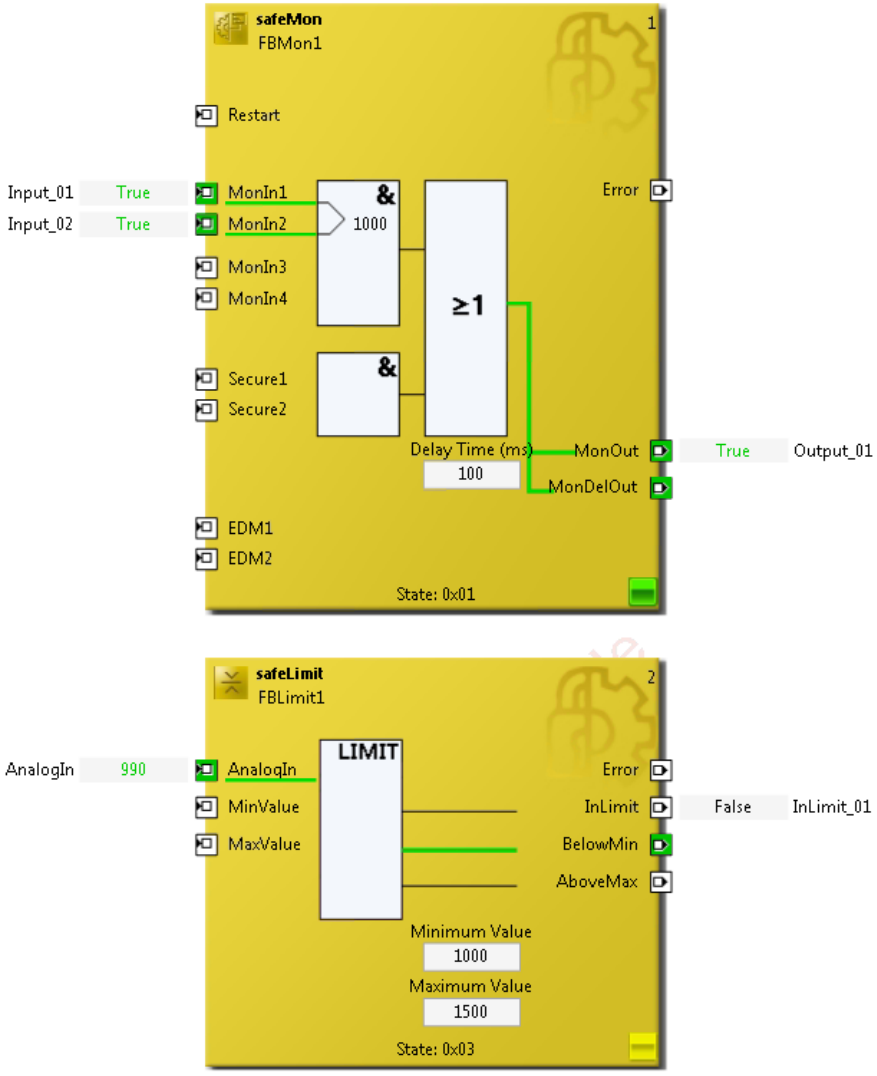


Fig. 63: Display of the analog and digital values in online mode

Detailed information about the whole safety project is shown on the *Safety Project Online View* tab. Any errors in the connections or function blocks are displayed in plain text.

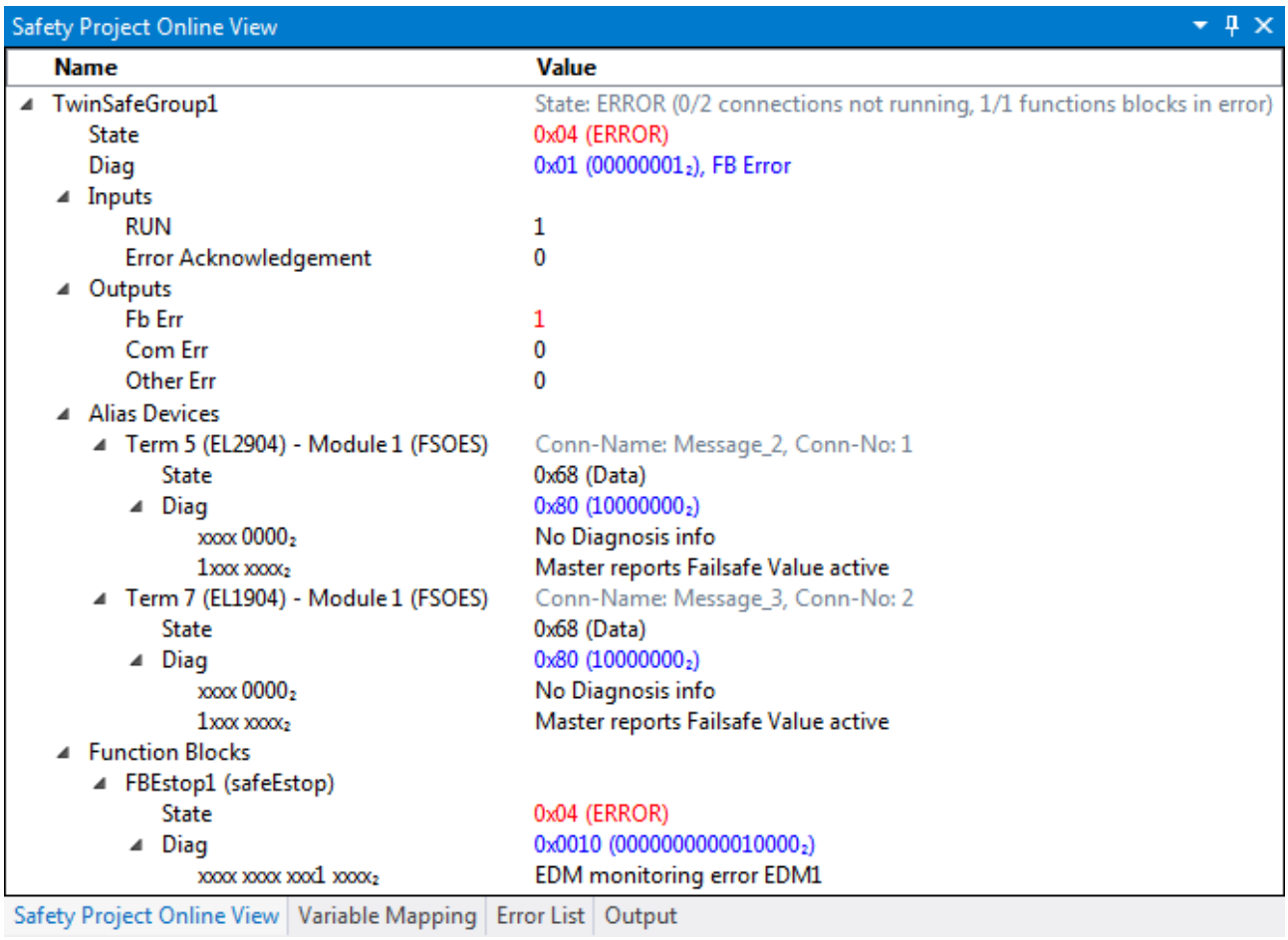


Fig. 64: The Safety Project Online View tab

5.3.7 New features in TC3.1 Build 4022

In the TwinCAT Version 3.1 Build 4022 some extensions have been implemented for the TwinSAFE editor. With the release of the TwinCAT version, these are available to the user. This chapter lists the new features.

5.3.7.1 Group status

The status of the TwinSAFE group is displayed as a color-coded frame in online mode.

The RUN state is marked with a green one, the ERROR state with a red frame, and all other states with a blue frame.

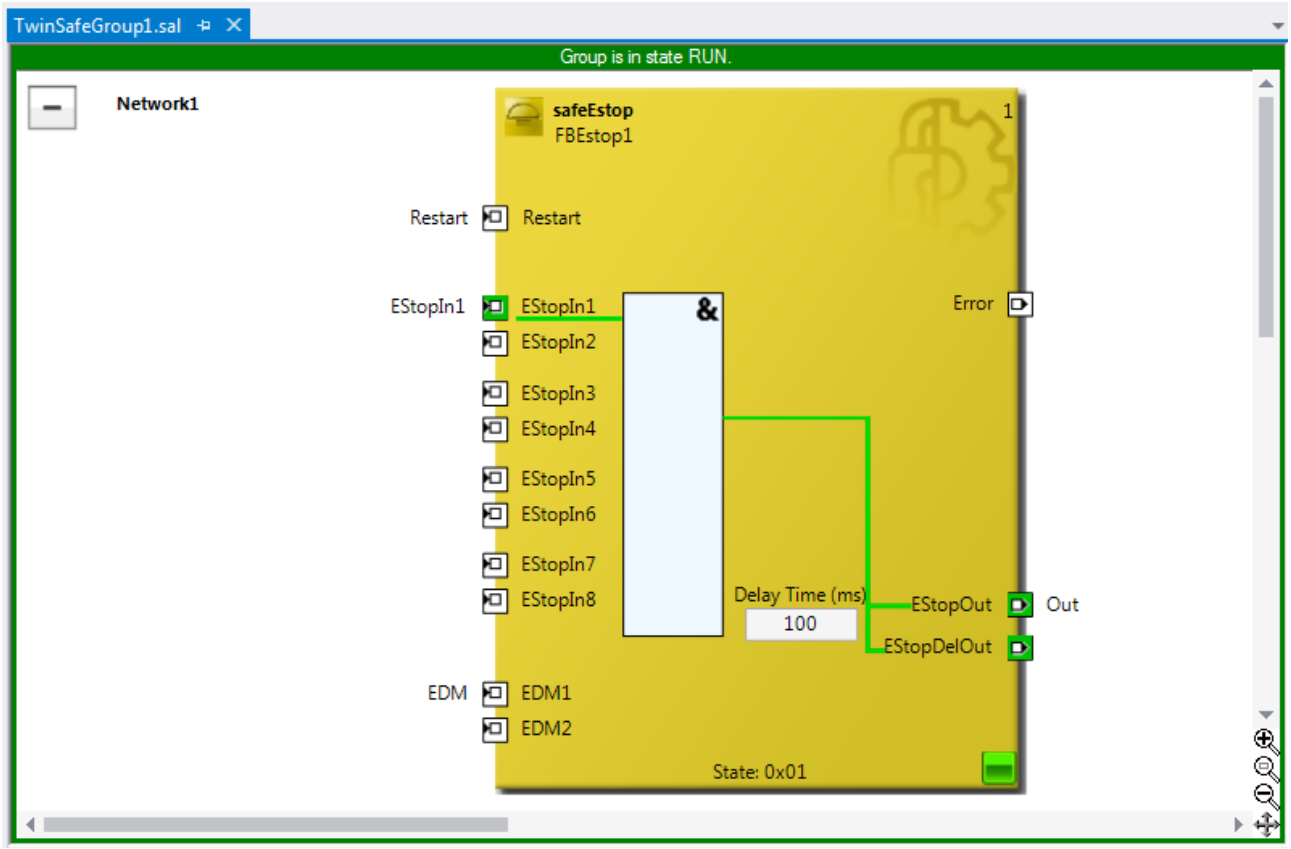


Fig. 65: Group Status Online RUN

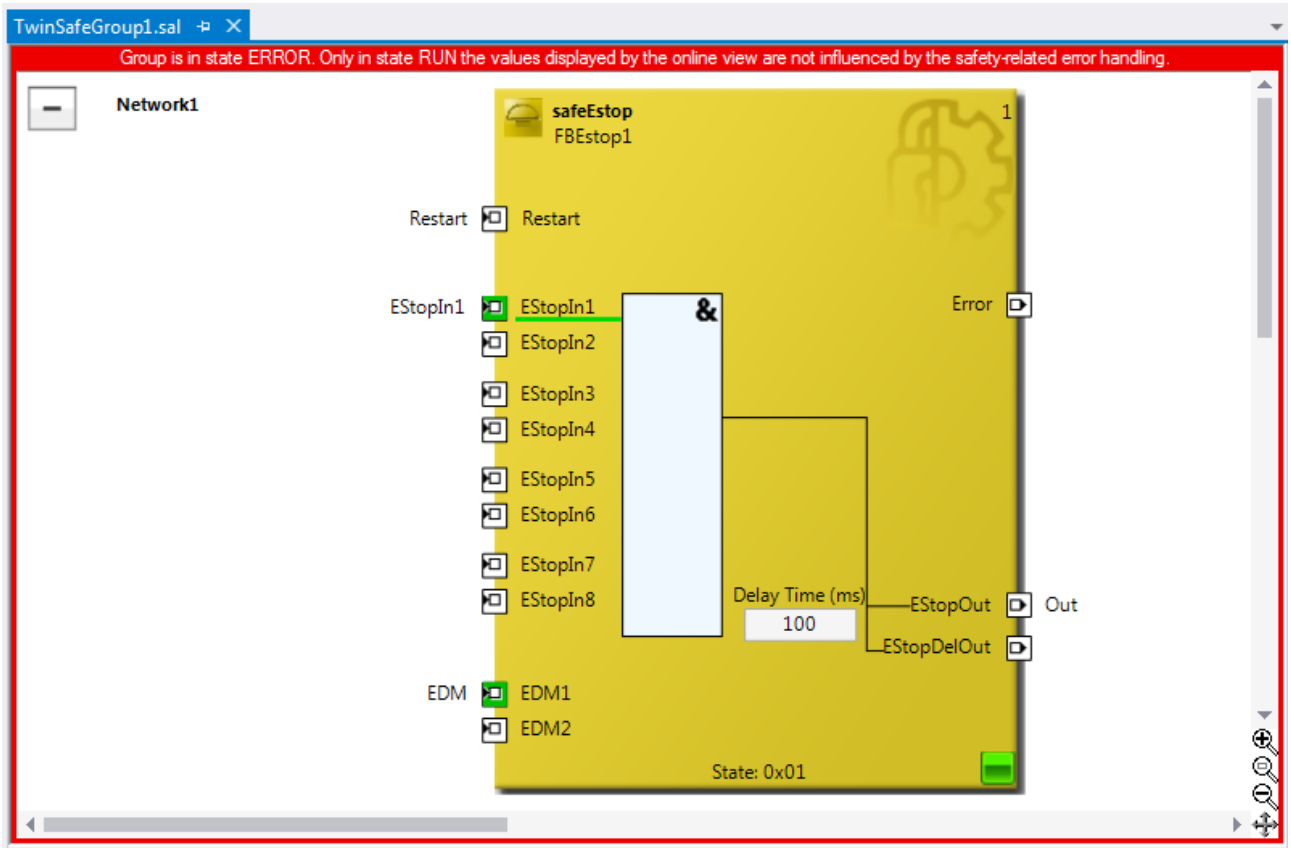


Fig. 66: Group Status Online ERROR

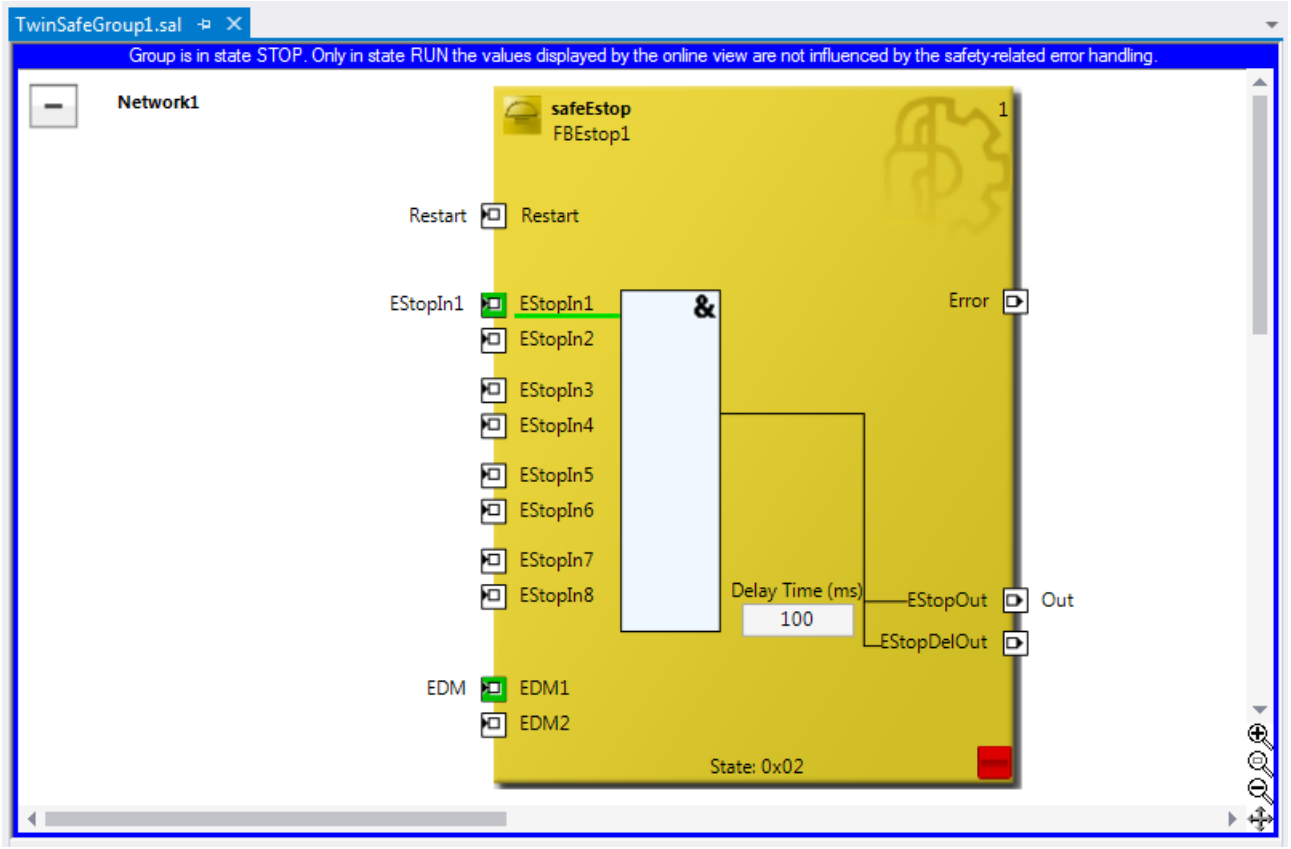


Fig. 67: Group Status Online STOP

5.3.7.2 Online view group ports

In online mode the group inputs and outputs are marked according to their signal status. A logical 1 of the signal is represented with a green background, a logical 0 with a white background. Error information is displayed with a red background.

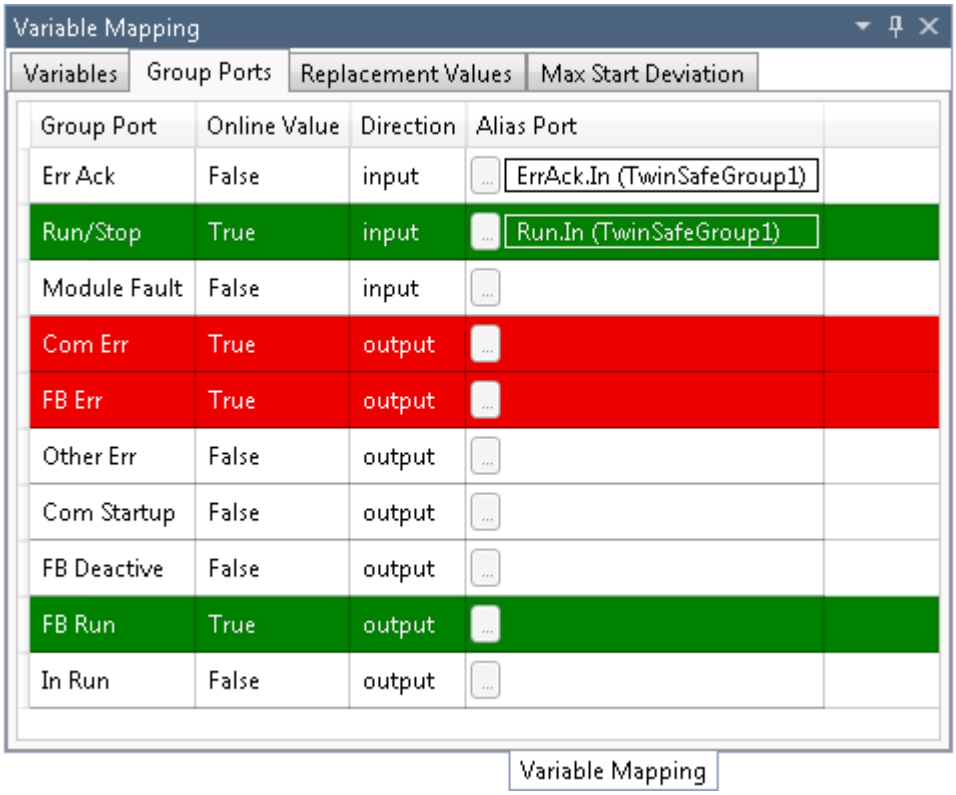


Fig. 68: Online View Group Ports

5.3.7.3 Group templates

The user has a choice between three templates.

The templates differ by the number of already existing links (none, ErrAck created and linked to group port, ErrAck and Run created and linked to group ports).

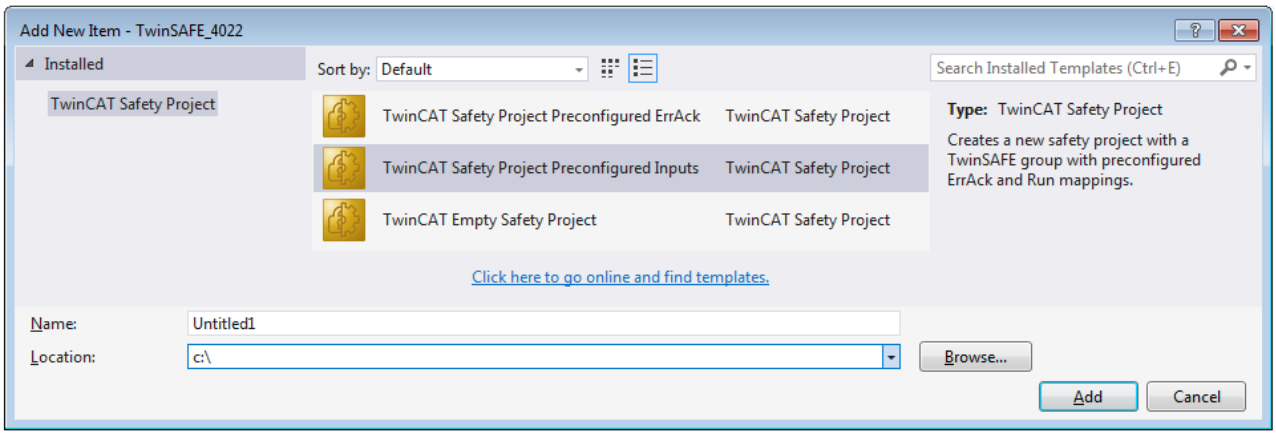


Fig. 69: Templates for Safety Projects

5.3.7.4 Networks collapsable

The networks defined in a TwinSAFE group can be collapsed.

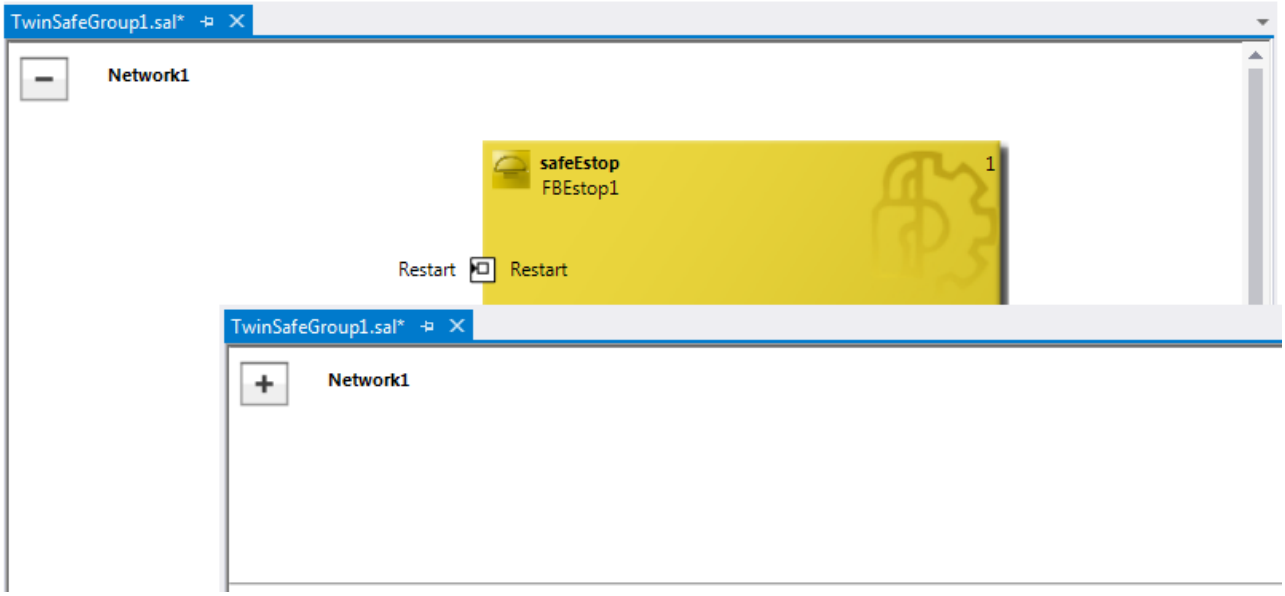


Fig. 70: Collapsing networks

5.3.7.5 Subfolder Alias Devices

Under the node *Alias Devices*, further subfolders can be created. After the subfolder has been created, it can be renamed, here for example to *Drives*.

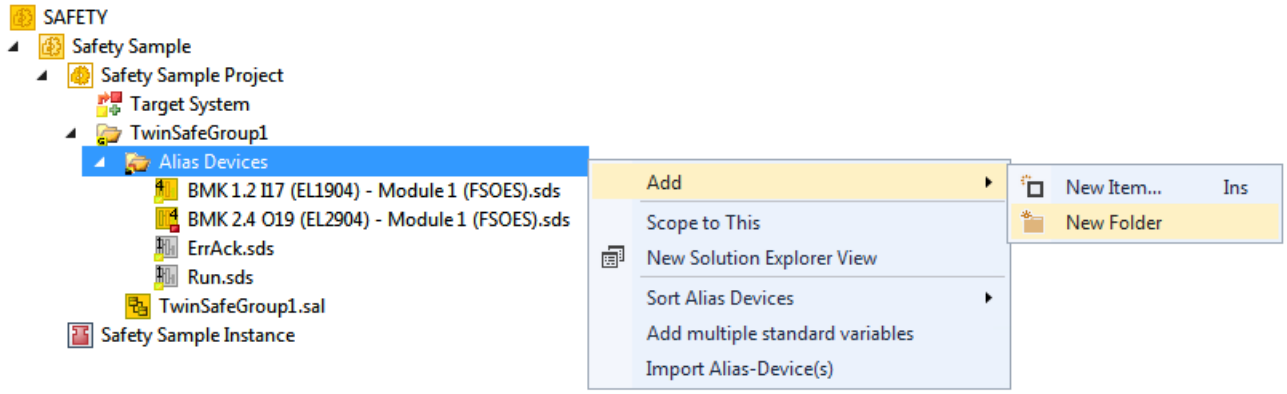


Fig. 71: Adding a subfolder

After adding a subfolder, *Alias Devices* can be added in this folder.

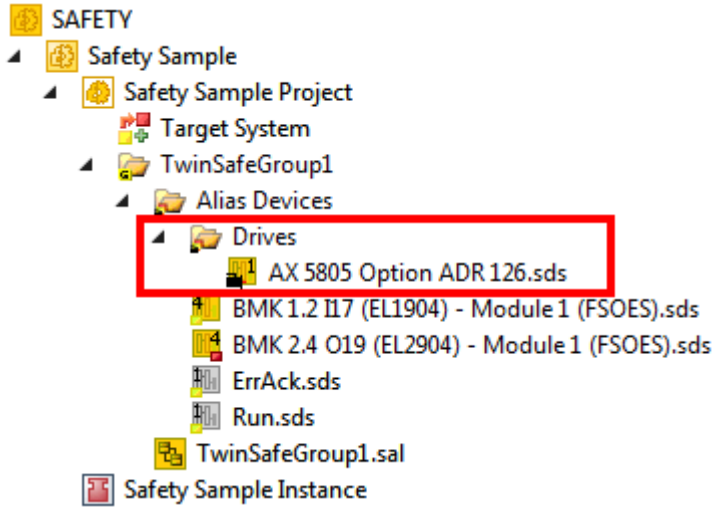


Fig. 72: Subfolder e.g. Drives

5.3.7.6 Goto linked element

The entry *Goto Linked Element* can be called via the context menu. All links and variables used on that port are listed. Selecting an entry triggers a jump to the corresponding position in the network, a TwinSAFE group or variable mapping.

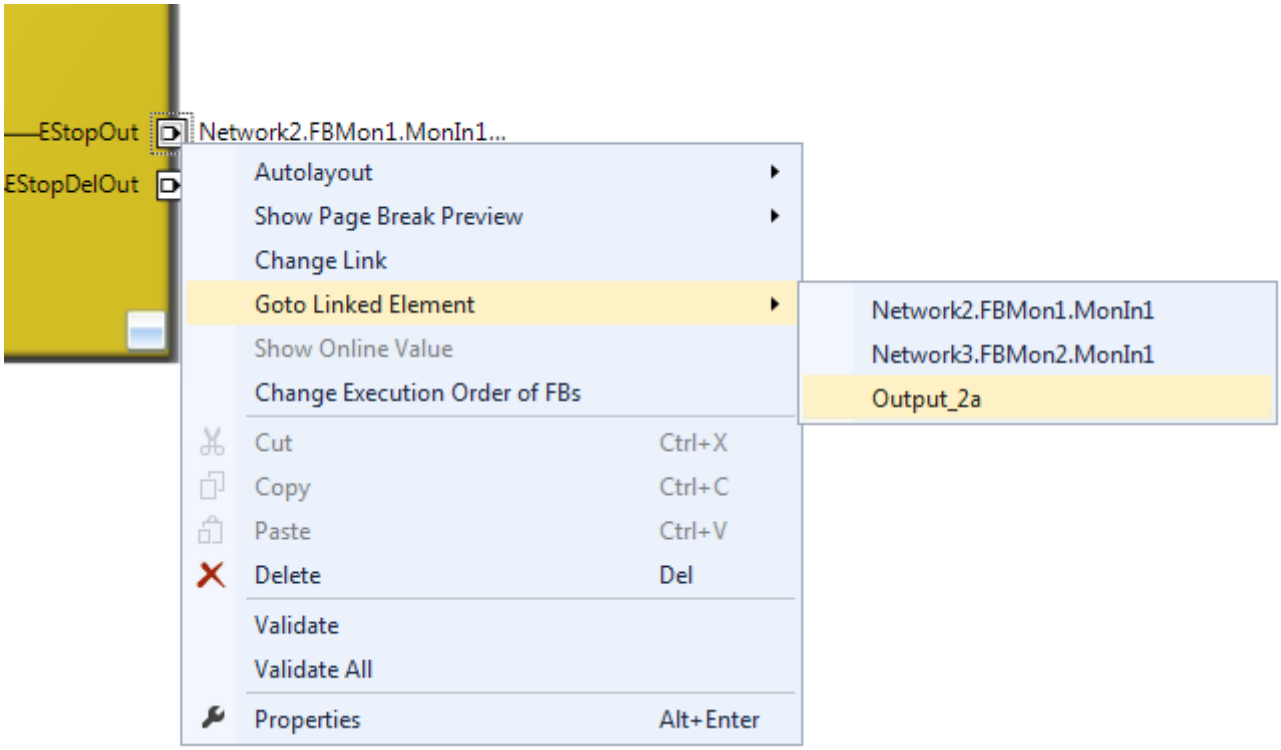


Fig. 73: Goto Linked Element

5.3.7.7 Path view to linked signal

The *Linking* tab of the *Alias Devices* displays the links to the PLC and to the I/O devices. The name in the process image of the TwinSAFE logic is displayed under the entry *Name*.

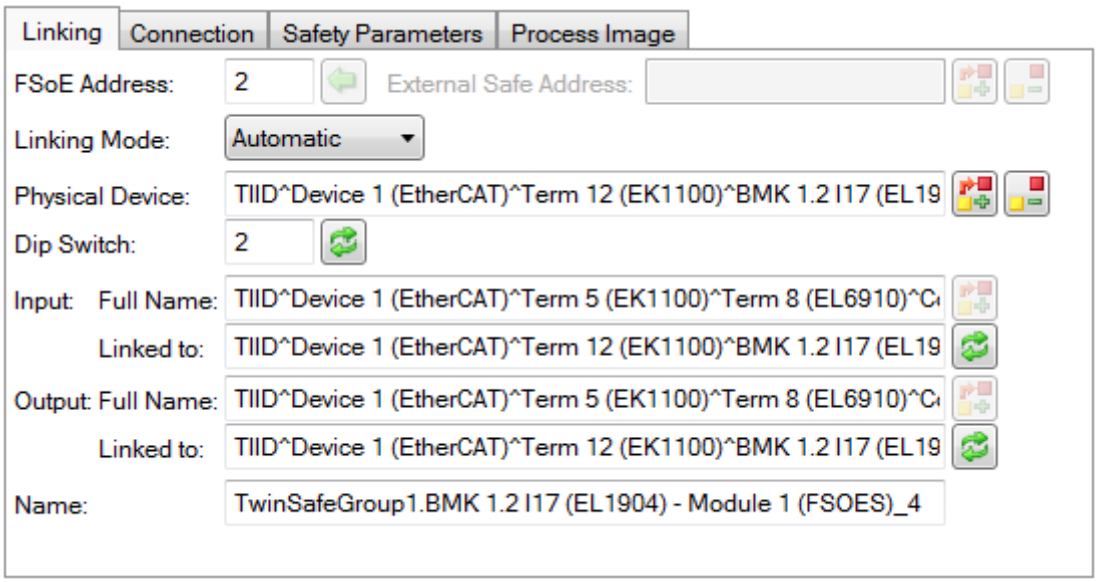


Fig. 74: Path view for safety Alias Devices

For the *Standard Alias Devices*, the path to the signal below the TwinSAFE logic (full name), the link to the PLC (Linked to), and the name in the process image of the TwinSAFE logic are displayed.

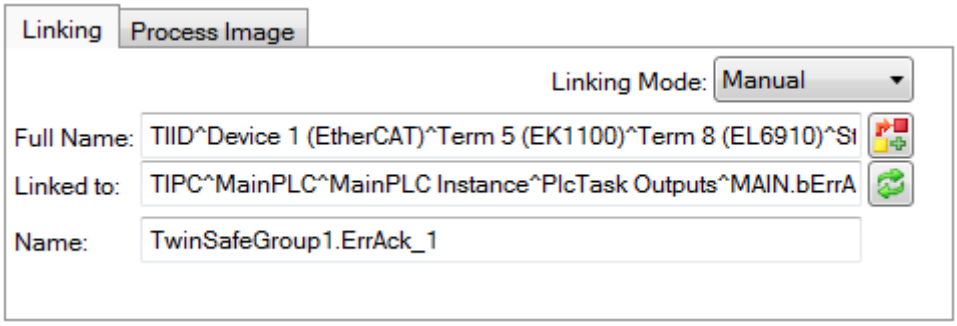


Fig. 75: Path view for Standard Alias Devices

5.3.7.8 Multiline comments

Comments in the TwinSAFE project may now be multiline.

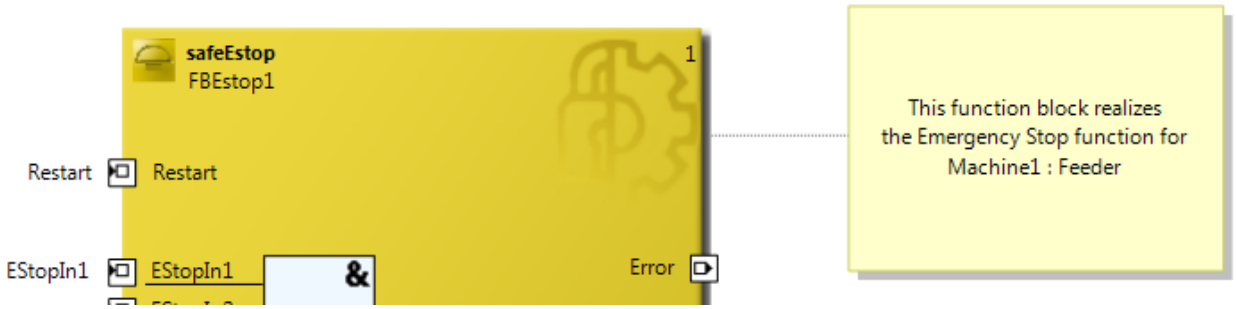


Fig. 76: Multiline comments

5.3.7.9 Names of Alias Devices in the process image

The user has now the option of adapting the naming of process data below the TwinSAFE logic in the I/O tree. For this purpose, checkboxes are available on the *Target System* dialog to accept the naming of TwinSAFE connections and standard inputs and outputs from the respective *Alias Device* names.

Fig. 77: Properties under Target System

After the checkboxes are set, the names of the alias devices are taken.

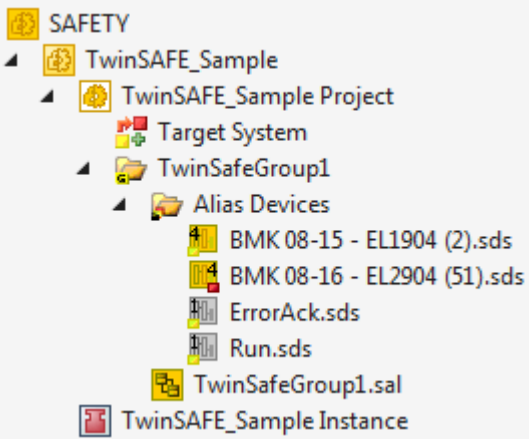


Fig. 78: Take Alias Device Name - Safety Project

In the I / O tree below the TwinSAFE logic, the project is shown in the following screenshot. The name consists of the group name, alias device name, and a running index.

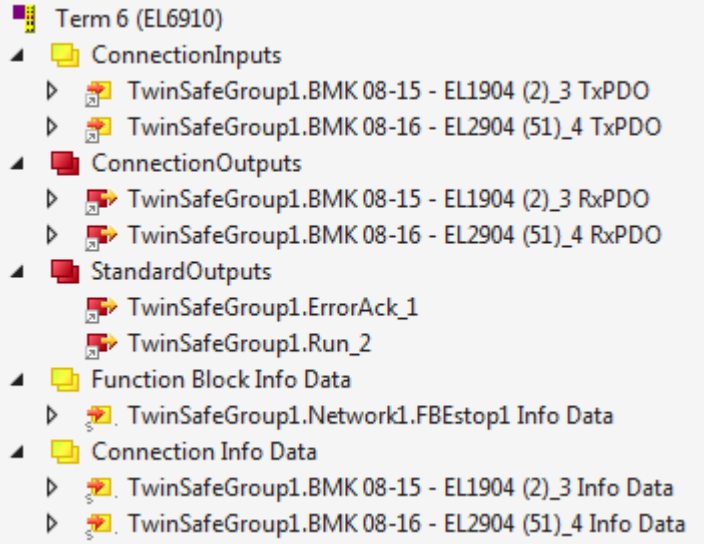


Fig. 79: Take Alias Device Name - TwinSAFE logic process image

5.3.7.10 Project settings - Verification

The project settings can be found below the target system.

Safe Address Verification

The *Safe Address Verification* entry is used to set how the safety addresses are checked.

- Project wide unique (recommended) - Unique safety addresses within the entire solution
- Similar to TwinCAT 2 - Unique addresses per TwinSAFE Logic
- Allow multiple usage - Multiple safety addresses are possible (user evaluation required)

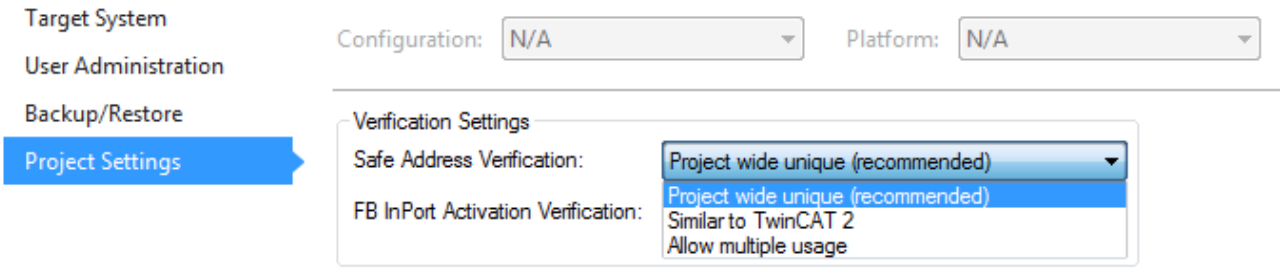


Fig. 80: Safe Address Verification

FB InPort Activation Verification

The *FB InPort Activation Verification* entry is used to set how the input ports of TwinSAFE FBs are checked.

- Strict activated & connected (recommended) - Each activated port must be connected, and each connected port must be activated.
- Activated or connected allowed - If a port is only activated or only connected, this does not lead to an error message.

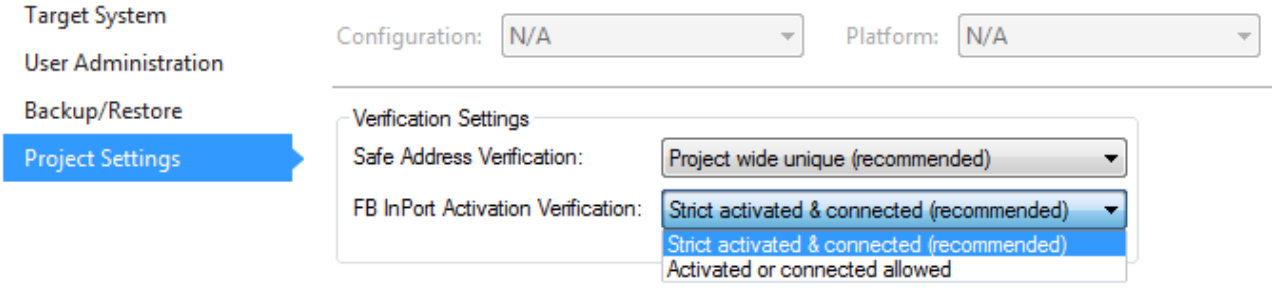


Fig. 81: FB InPort Activation Verification

NOTE

Support of project settings

The settings are supported from software version 03 of the EL6910 (SW03) and EK1960 (SW03). Furthermore, all newer logic components, such as the EL1918, are supported.

5.3.7.11 Displaying the project size

Diagnostic Properties of the project node

If the project node of the TwinSAFE project is selected, the properties under the entry Diagnostic show the current project parameters. These are e.g. the project size in bytes, the number of connections, the number of function blocks, or the number of TwinSAFE groups.

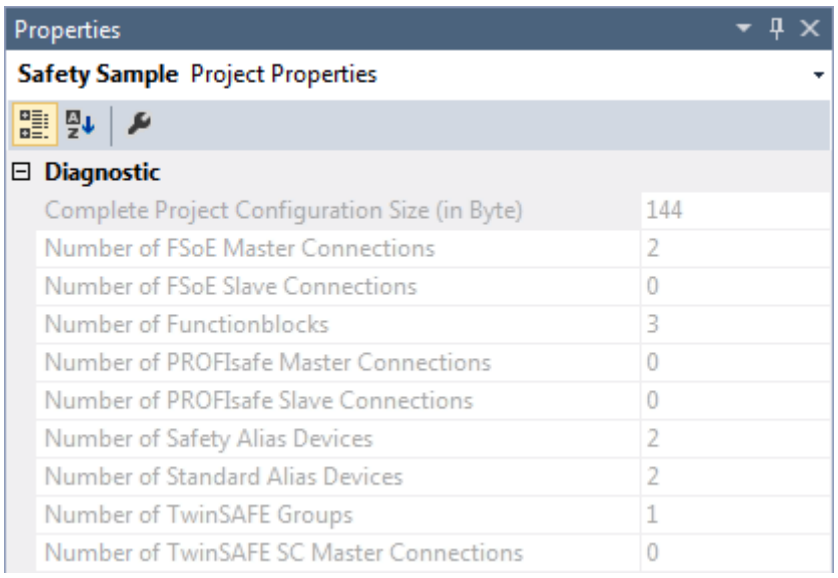


Fig. 82: Project Properties - Diagnostic

Diagnostic Properties of the group node

If the group node of the TwinSAFE project is selected, the properties under the entry Diagnostic display the current TwinSAFE group parameters. These are e.g. the number of connections, the number of function blocks, or the number of standard signals.

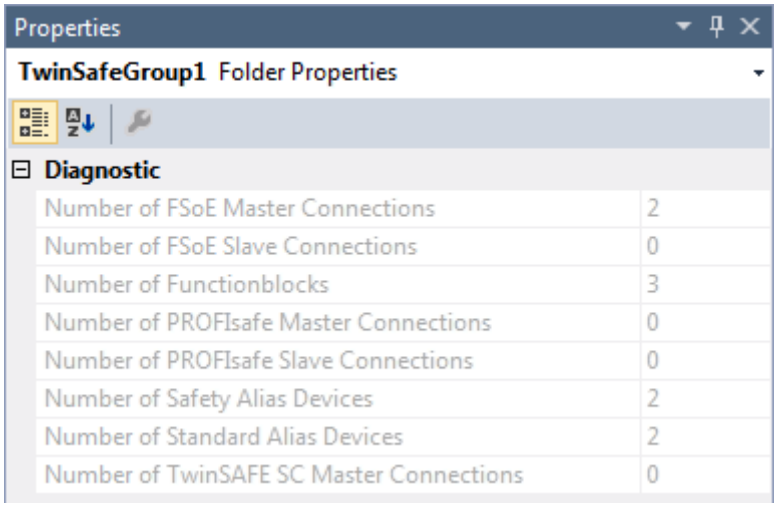


Fig. 83: Group Properties - Diagnostic

5.3.7.12 Copy and Paste for FBs and comments

The copy and paste function refers to function blocks, comments and connections between function blocks. The copied variable names and links remain unchanged, the FB instances are automatically incremented (here FBEstop1 becomes FBEstop2).

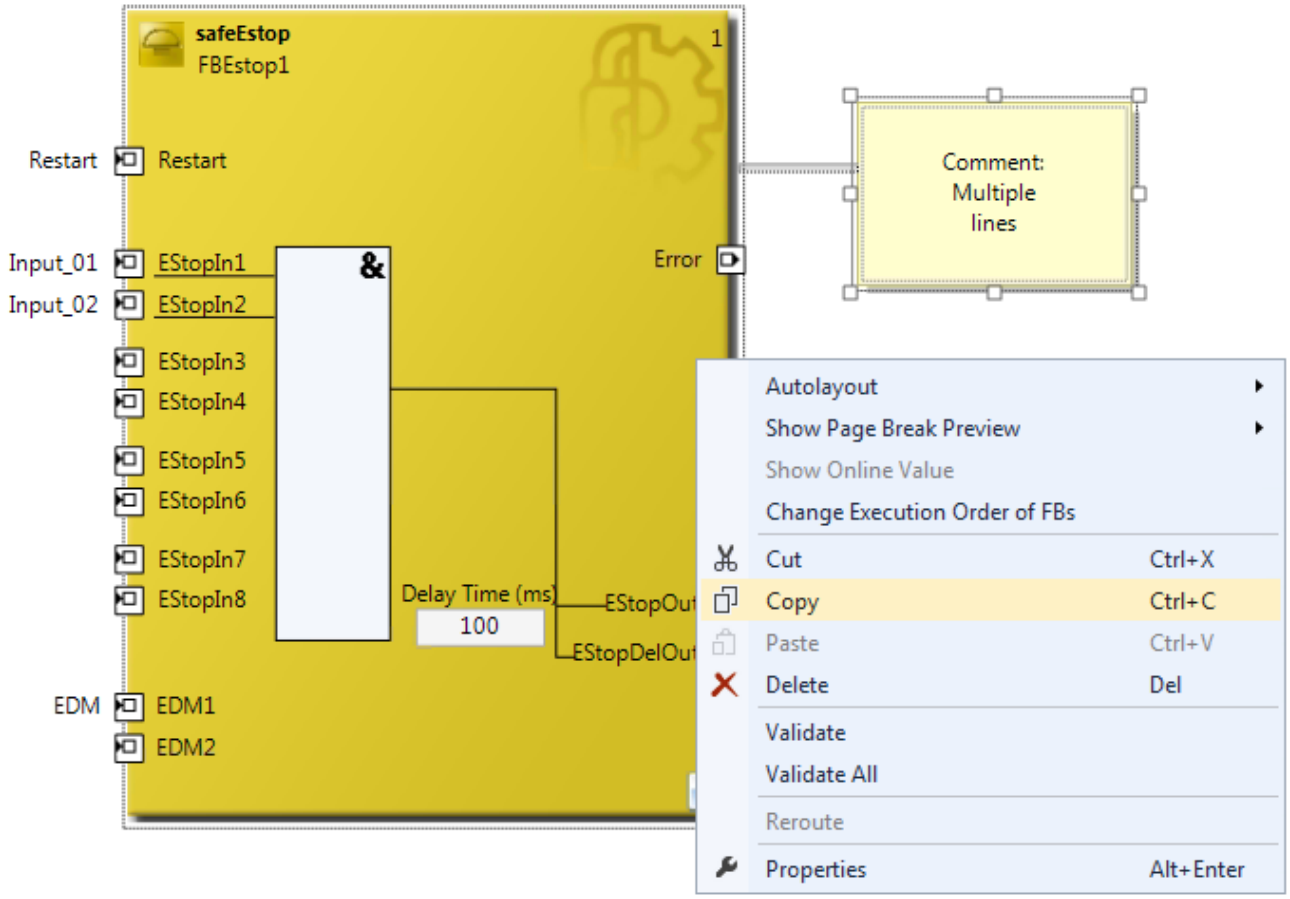


Fig. 84: Copying the data

After inserting the data, the following message appears. The user may have to adjust copied variable names.

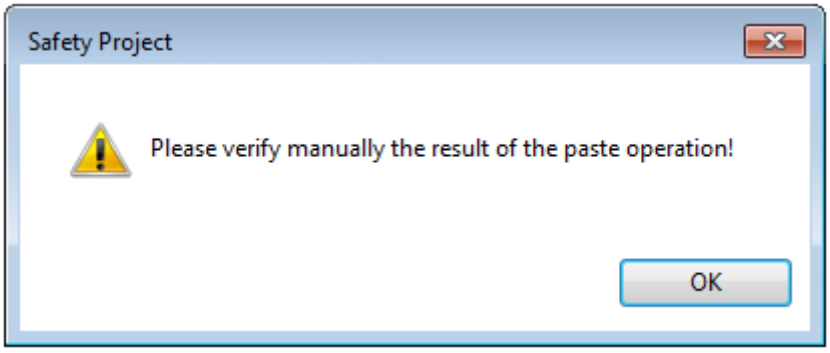


Fig. 85: Message box after inserting the data

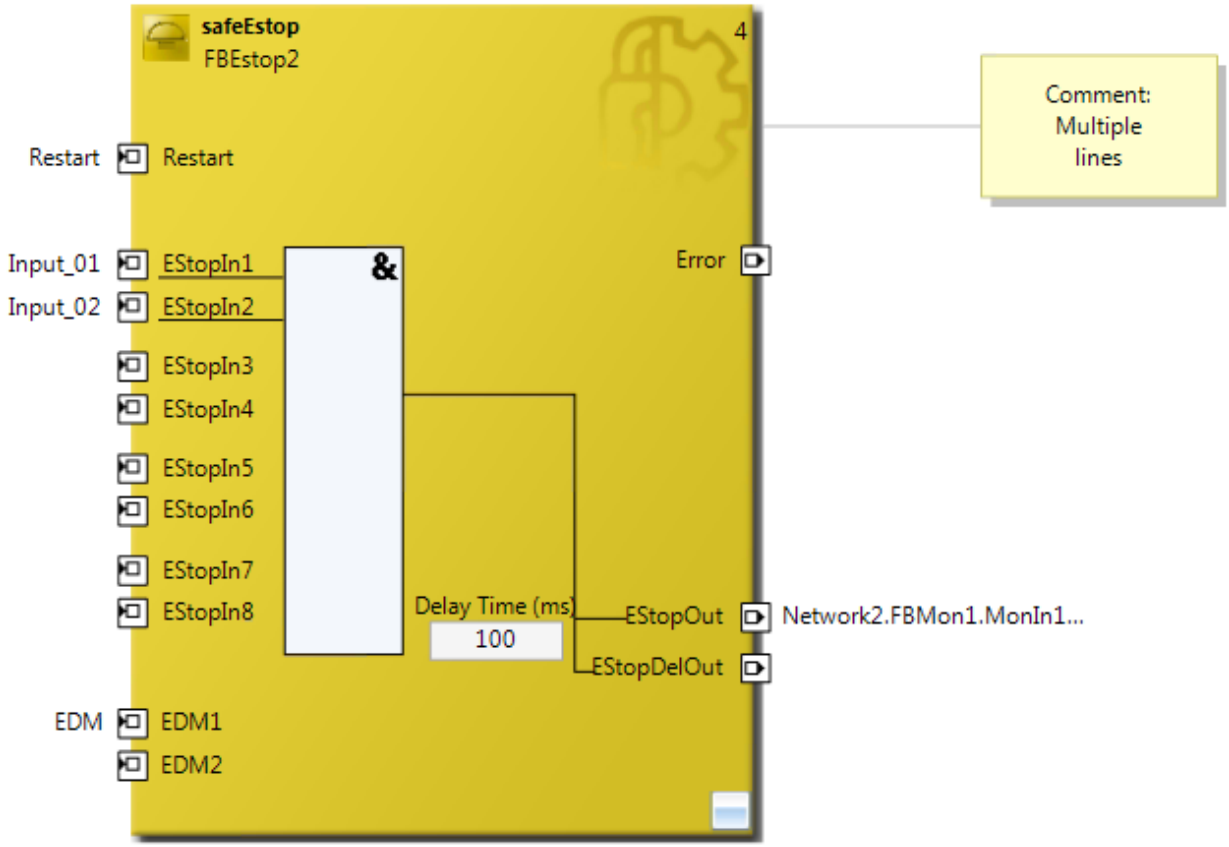


Fig. 86: Inserted data

Here, in the example, the user must adapt the links of the output EStopOut and change the variable names Restart, Input_01, Input_02 and EDM so that no duplicate names are assigned.

5.3.7.13 Global settings in Visual Studio

Options can be selected under the Tools menu in Visual Studio. In these options, settings for the TwinSAFE environment can be made.

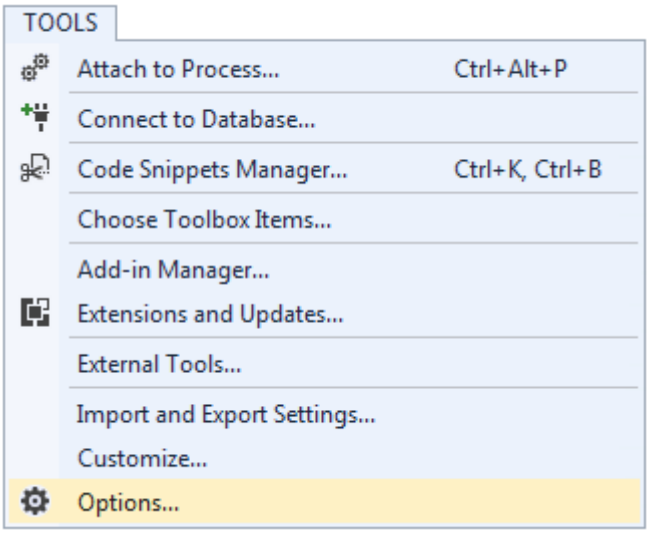


Fig. 87: Visual Studio - Menu Tools / Options

Under *TwinCAT / TwinSAFE Environment / Default Info Data* you can configure which info data should be activated automatically when TwinSAFE projects, groups, connections or FBs are created.

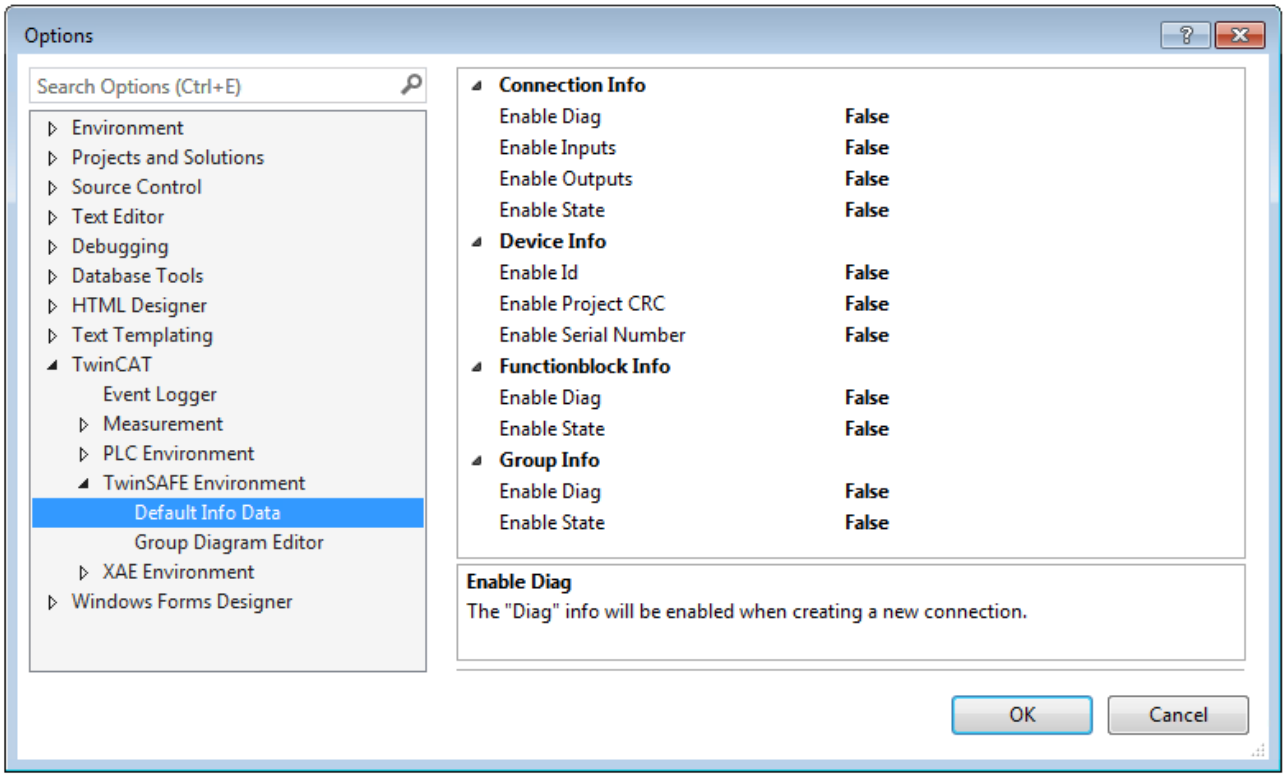


Fig. 88: Global setting - Default Info Data

Under *TwinCAT / TwinSAFE Environment / Group Diagram Editor* you can specify whether the Undo / Redo function should automatically zoom and scroll into the area that has changed.

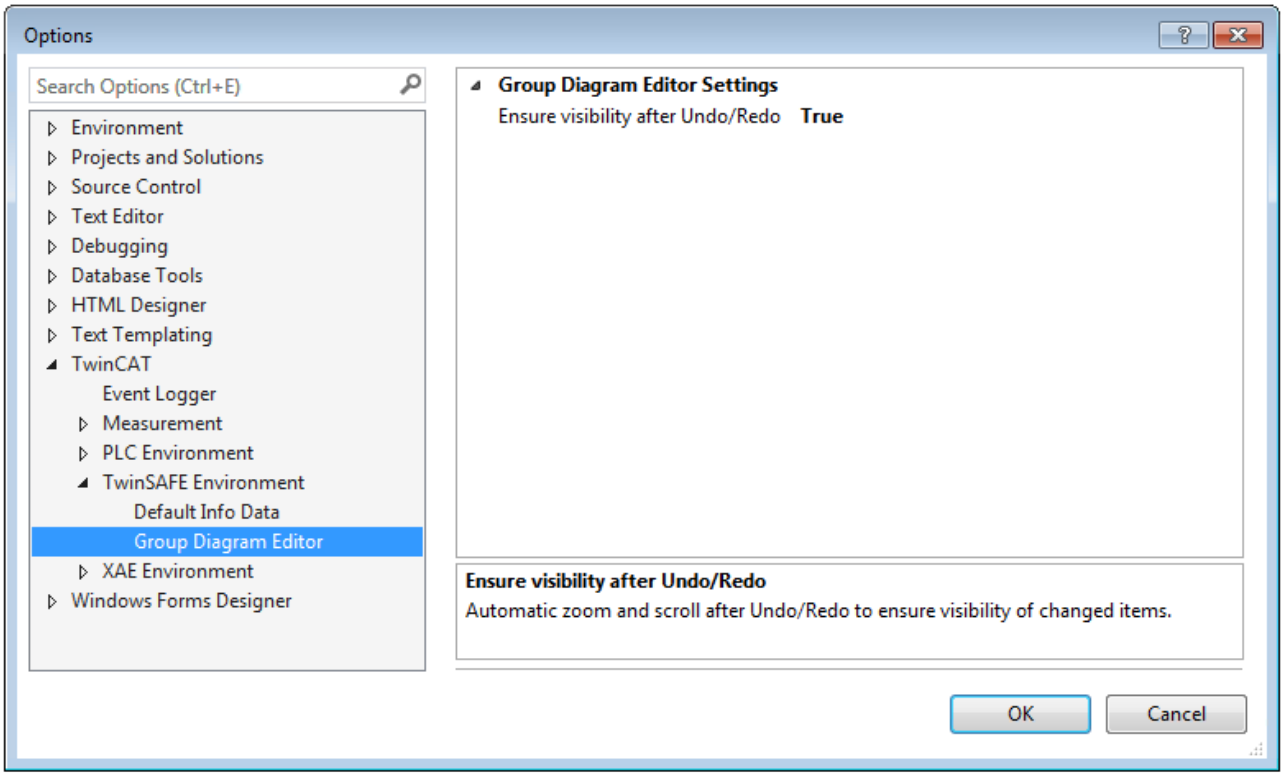


Fig. 89: Global Setting - Group Diagram Editor

5.3.7.14 Sorting

Setting the execution order of the groups via dialog

The context menu of the project node can be used to access the execution order of the TwinSAFE groups.

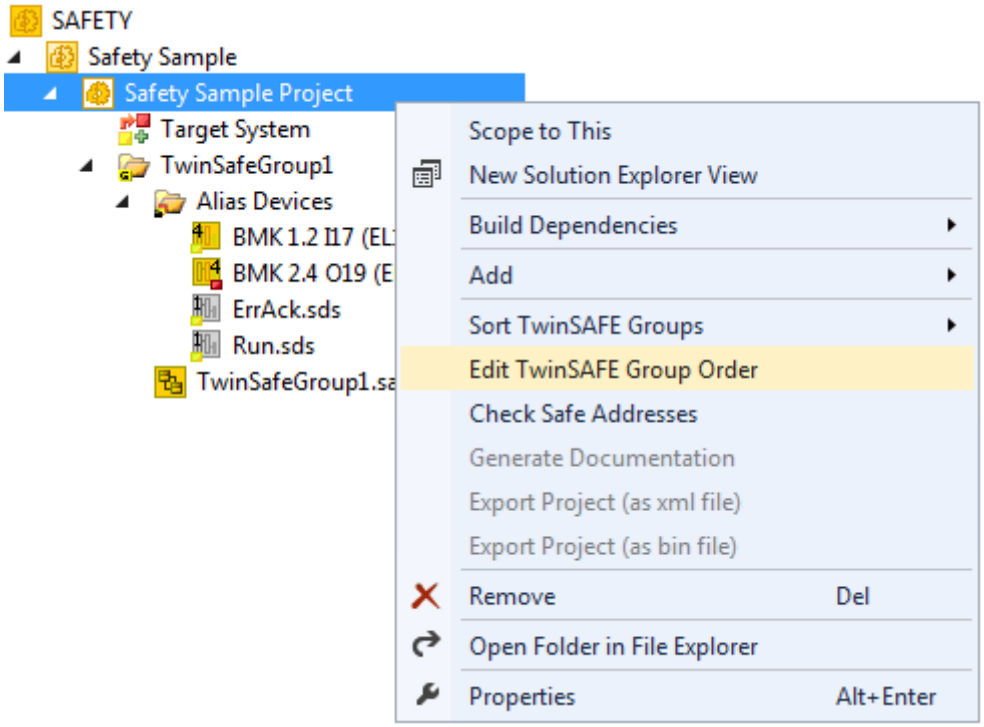


Fig. 90: Context menu - Edit TwinSAFE Group Order

By selecting a group and then holding and dragging an entry with the mouse, the execution order of the groups can be changed. The new order is accepted with the OK button.

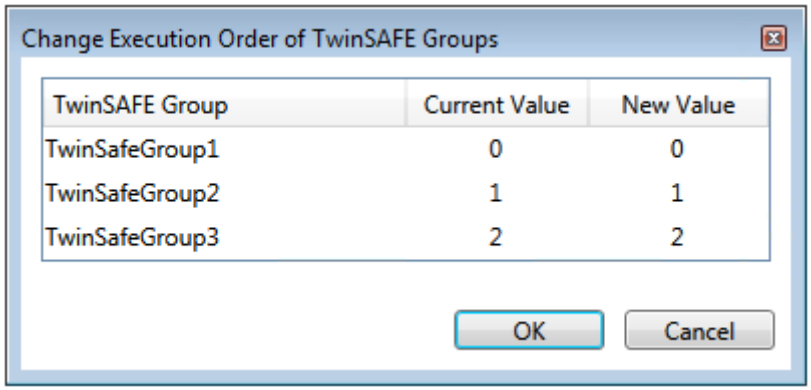


Fig. 91: Execution order for TwinSAFE groups

Sorting of Alias Devices

You can use the context menu of the Alias Devices node to configure the display order of the alias devices.

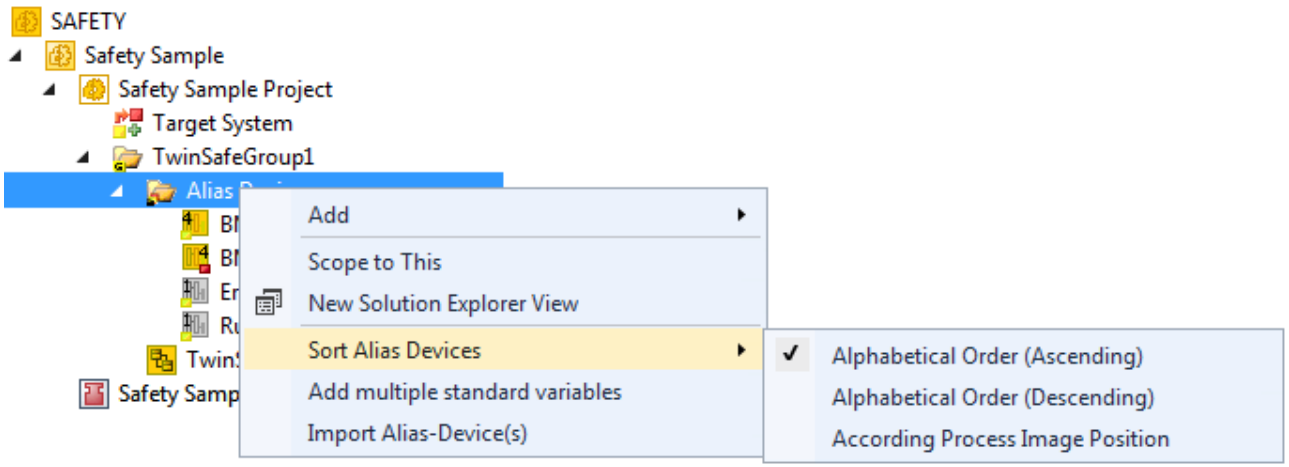


Fig. 92: Sorting of Alias Devices

Sorting of FBs (execution order)

The execution order of the function blocks can be accessed via the context menu within the graphical worksheet.

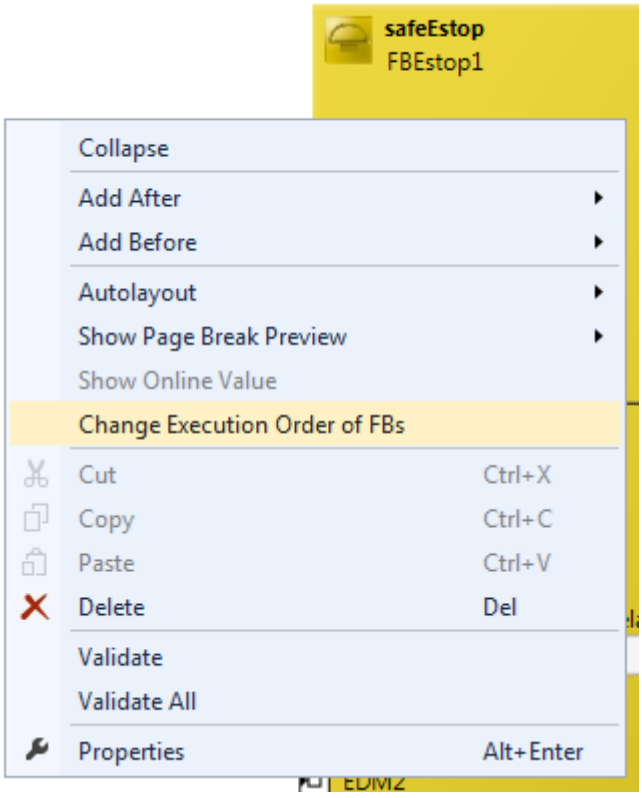


Fig. 93: Context Menu - Change Execution Order of FBs

By selecting an FB and then holding and dragging an entry with the mouse, the execution order of the function blocks can be changed. The new order is accepted with the OK button.

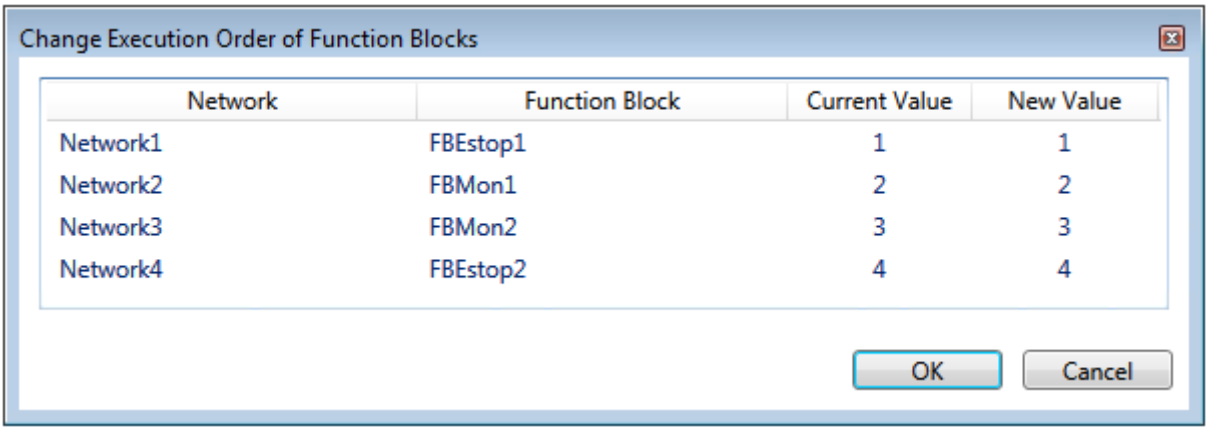


Fig. 94: Execution order FBs

5.3.7.15 Direct mapping of local I/Os

If a TwinSAFE Logic has local inputs and outputs, e.g. an EK1960, an assignment to safe and non-safe signals can be made by the user via the *Internal Direct Mapping* tab of the alias device. These direct assignments have the advantage that no logic program has to be created by the user for this purpose.

To be able to use the internal direct mapping, the Linking mode of the Alias Device must be set to *local*.

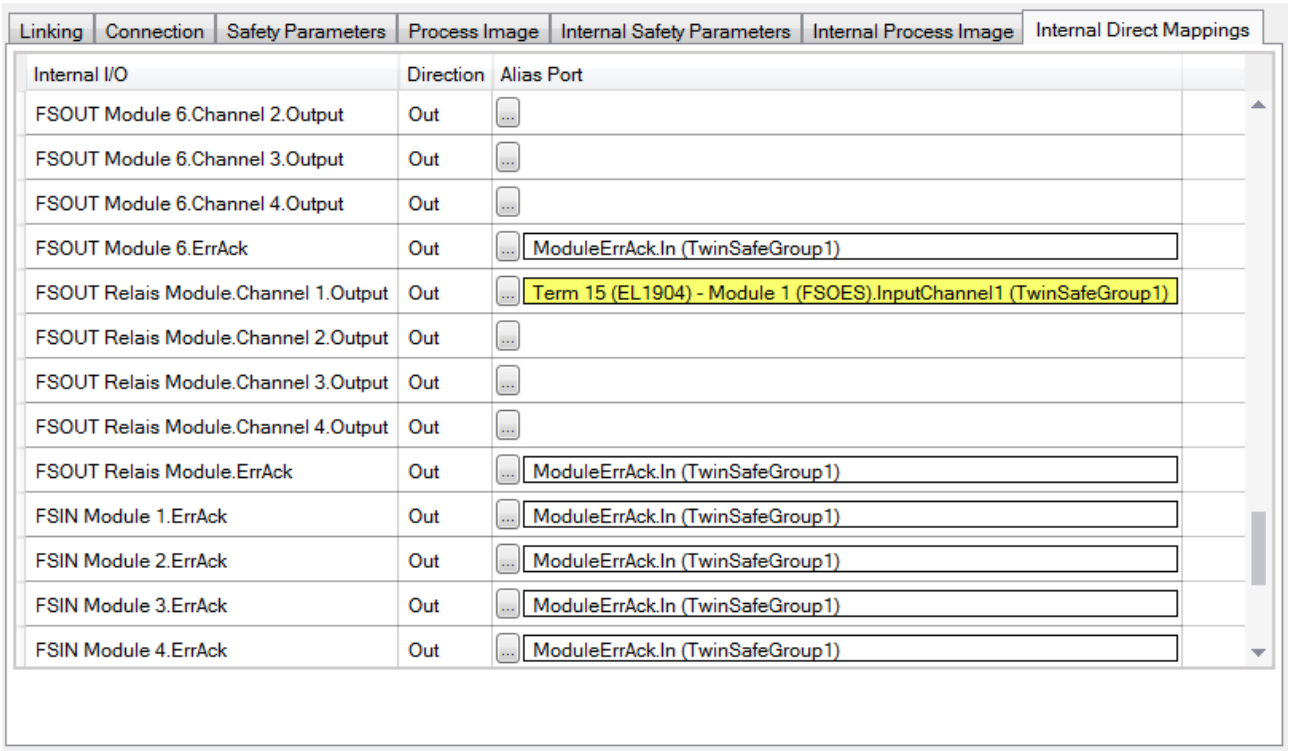


Fig. 95: Dialog - Internal Direct Mapping

Typical applications are linking the ErrAck signals of the modules with a Standard Alias Device or switching an output due to a safe input signal.

In the figure the relay output *FSOUT Relay Module Channel 1.Output* is switched by the safe input *Term(15) (EL1904) - Module 1 (FSOES) InputChannel 1*.

5.3.7.16 Backup/Restore settings

Backup/restore settings have been extended so that TwinSAFE logic components can also be used to store a TwinSAFE project CRC. The following table describes the settings for each TwinSAFE connection listed in the Backup/Restore dialog.

Checkbox	Desciption	Available in
Store Project CRC in Slave	Only active when FSoE Connection Type is set to Master. The CRC of the local project is stored on the target slave and can be used for the backup/ restore mechanism. Now, besides the EL1904 and EL2904, TwinSAFE logics are also supported for storing the CRC.	EL69xx, EL1904, EL2904, EP1908
Store Slave Project CRC in Master	Only active when FSoE Connection Type is set to Master. If the target slave is a logic component that uses the backup/restore mechanism, the project CRC of the logic project of the target slave must be entered manually here.	EL691x, EK1960, EJx9xx and newer products
Store Master Project CRC in Slave	Only active if FSoE Connection Type is set to Slave. The FSoE master sends a CRC to be stored on the local TwinSAFE component so that it can be used for a restore function on the remote FSoE master. This checkbox can be used even if the local backup/restore function is not active.	EL691x, EK1960, EJx9xx and newer products
Read Project CRC from Master	Only active if FSoE Connection Type is set to Slave. The CRC, which is entered on the FSoE master (see Store Slave Project CRC in Master), can be read by the FSoE slave for the local restore function.	EL691x, EK1960, EJx9xx and newer products

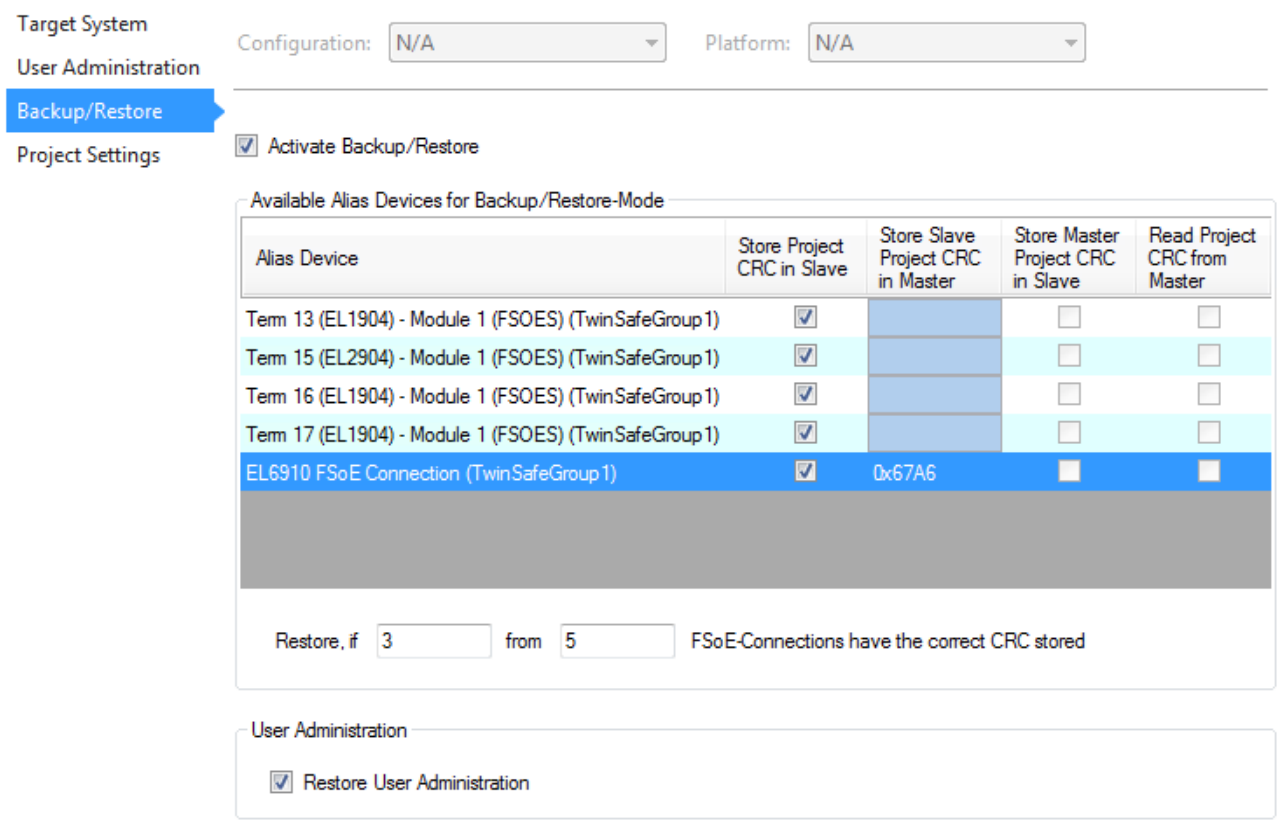


Fig. 96: Backup/Restore settings

5.3.7.17 Multiple download

New TwinSAFE products typically also support the use of a local logic function. Thus the number of necessary downloads can increase significantly. In TwinCAT 3.1 Build 4022 it is now also possible to load several safety projects simultaneously onto the corresponding logic components via the *Multiple Download* feature.

This feature can be selected in the toolbar and via the TwinSAFE menu.

Fig. 97: Multiple Download - Toolbar

After selecting the function, select the projects for which a simultaneous download of the safety project is to be carried out and confirm the selection with the *Next* button.

NOTE

Multiple downloads for different users

If safety projects are to be loaded onto logic components with different users, the multiple download with selection of the respective suitable logic components must be carried out several times.

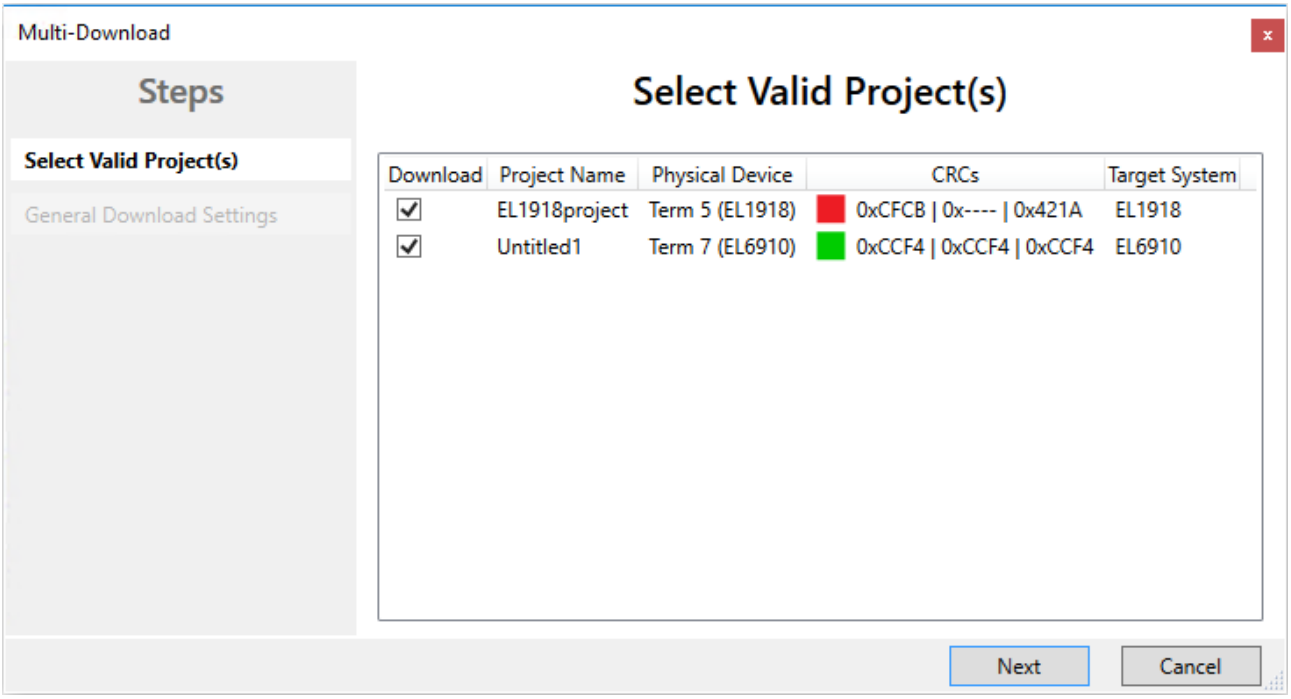


Fig. 98: Multiple Download - Selection of projects

In the general settings, enter the user name and password and check the displayed serial numbers of the logic components. Use the *Verified* checkbox to confirm that the correct serial numbers are displayed and used. Click the *Next* button to start the download.

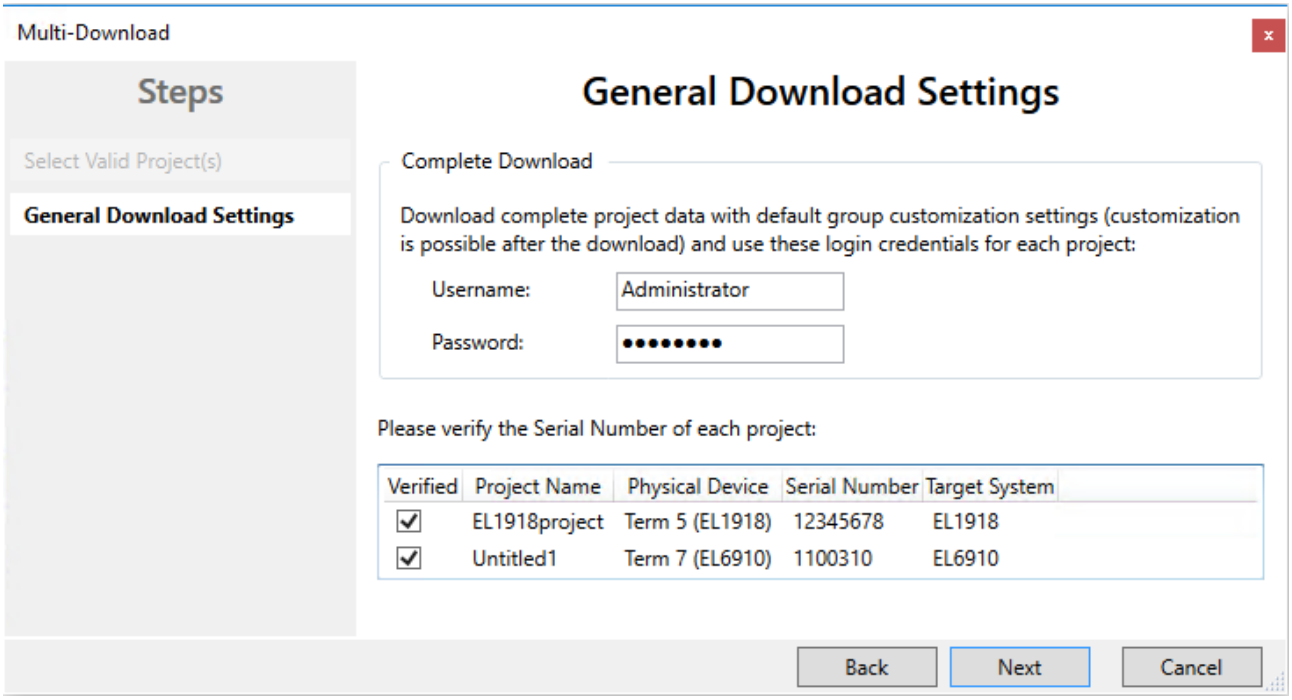


Fig. 99: Multiple Download - general settings

In the Final Verification dialog confirm the correctness of the online and calculated CRCs by checking the checkbox. Click the *Next* button to switch to the Activation dialog.

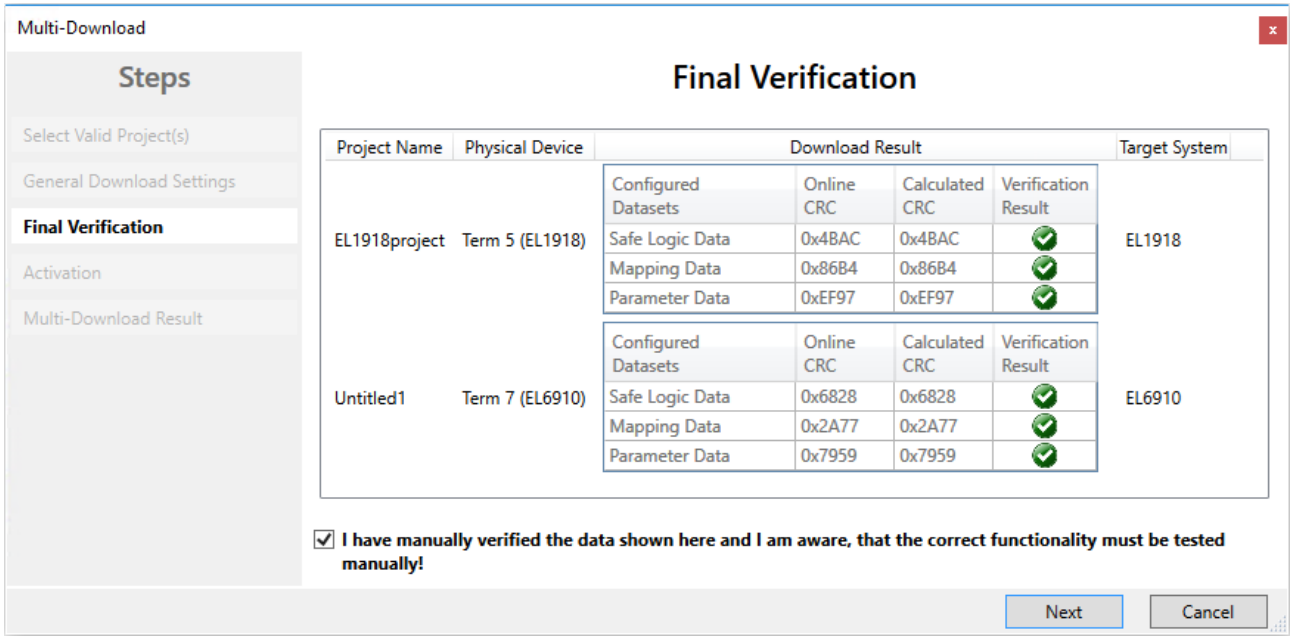


Fig. 100: Multiple Download - Final Verification

To activate the safety projects, enter the password for the current user again and confirm with the *Next* button.

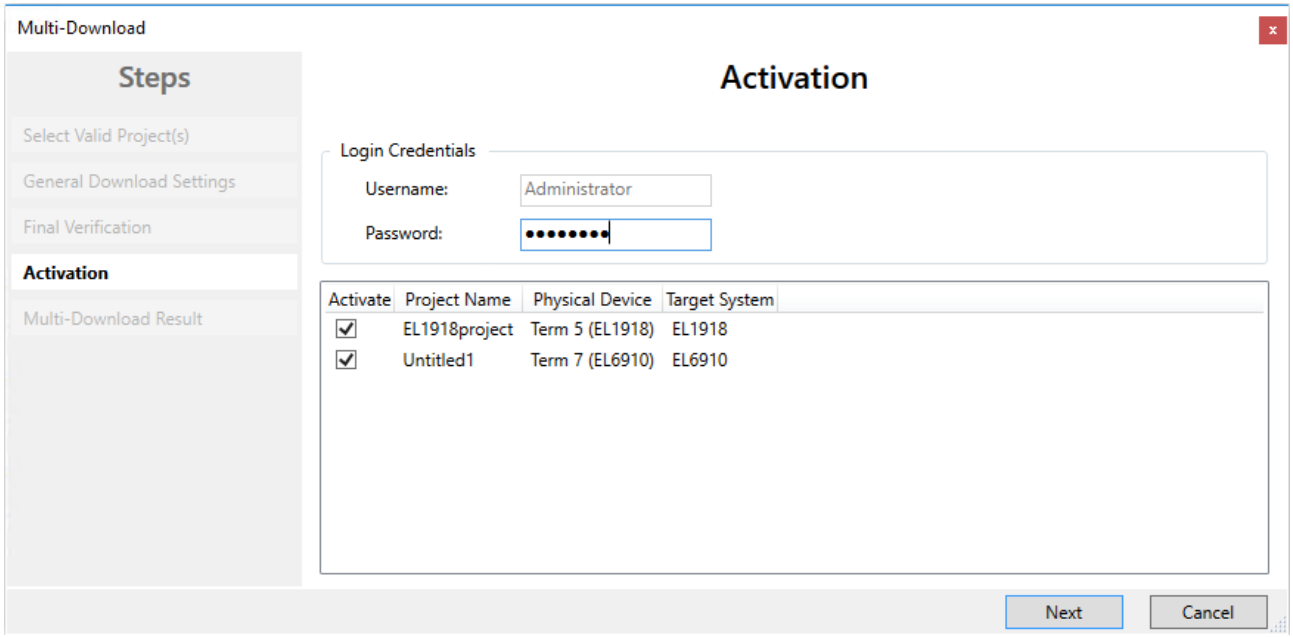


Fig. 101: Multiple Download - Activation

The Result dialog lists all safety projects with the status *Activated* and *Downloaded*. Click the *Finish* button to finish the multiple download.

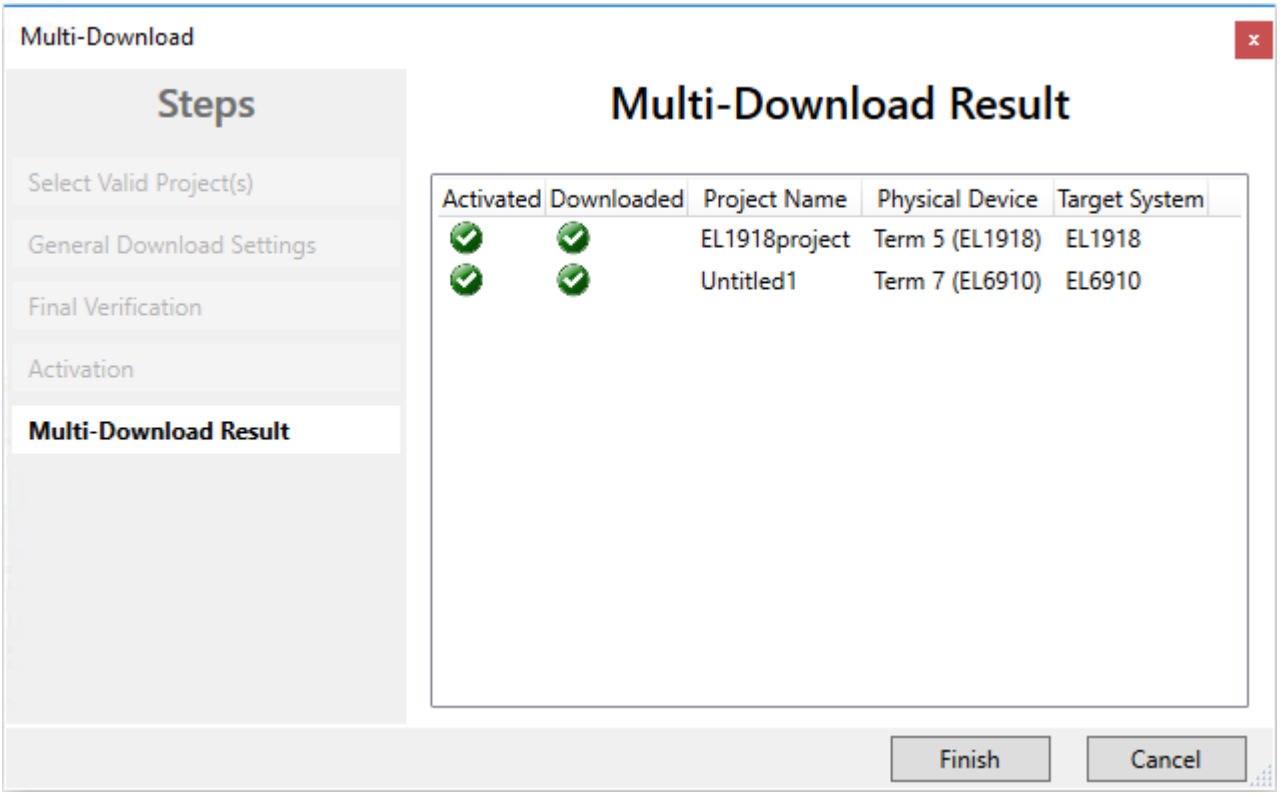


Fig. 102: Multiple Download - Result

5.4 Info Data

5.4.1 Info data for the connection

Info data for connections can be enabled on the *Connection* tab of the alias device.

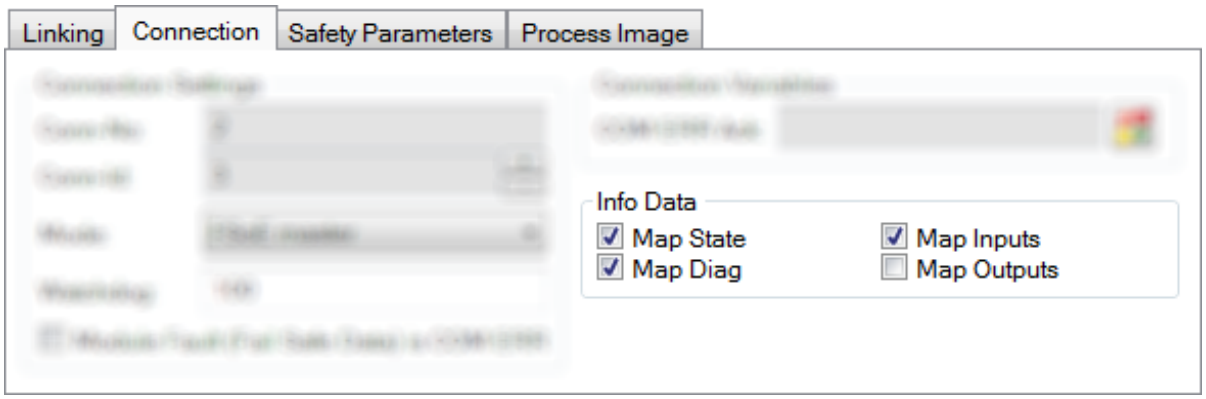


Fig. 103: Enabling the info data for connections

The info data are shown in the I/O tree structure below the EJ6910 in the process image. From here, these signals can be linked with PLC variables. Further information on the included data can be found in the documentation for *TwinCAT function blocks for TwinSAFE logic terminals*.

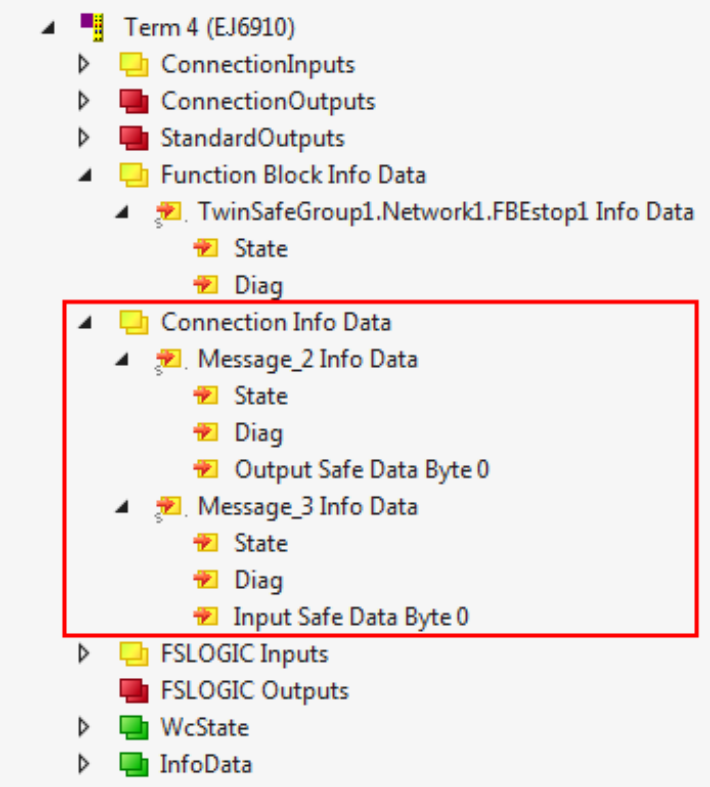


Fig. 104: Info data for the connection in the I/O tree structure

5.4.2 Info data for function blocks

Info data for function blocks can be enabled in the properties of the function block.

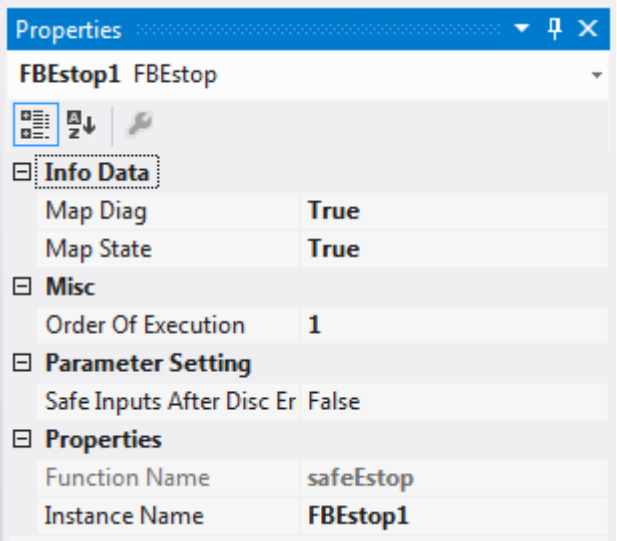


Fig. 105: Enabling the info data for function blocks

The info data are shown in the I/O tree structure below the EJ6910 in the process image. From here, these signals can be linked with PLC variables. Further information on the included data can be found in the documentation for *TwinCAT function blocks for TwinSAFE logic terminals*.

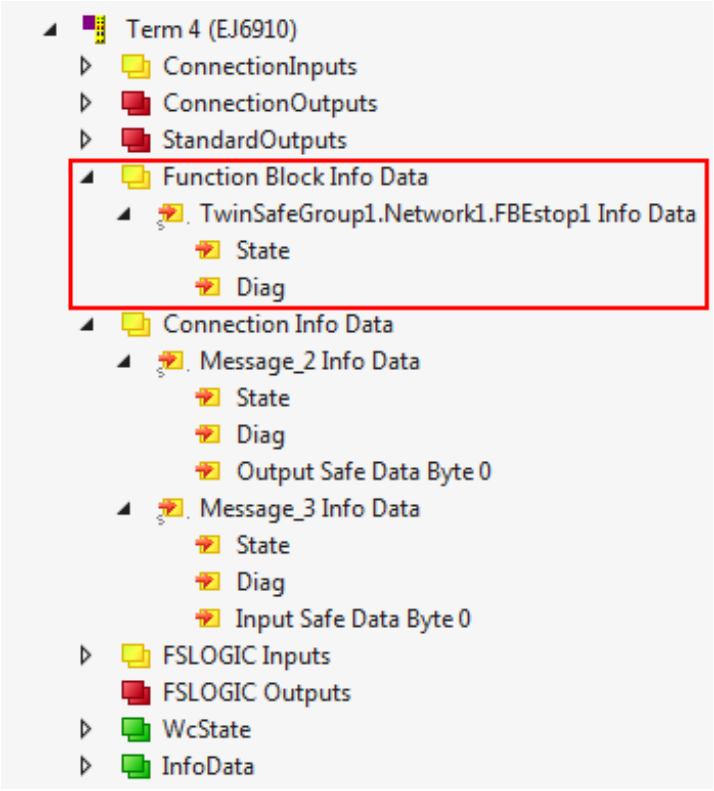


Fig. 106: Info data for the function block in the I/O tree structure

5.4.3 Info data for the TwinSAFE group

Info data for TwinSAFE groups can be enabled via the properties of the TwinSAFE group.

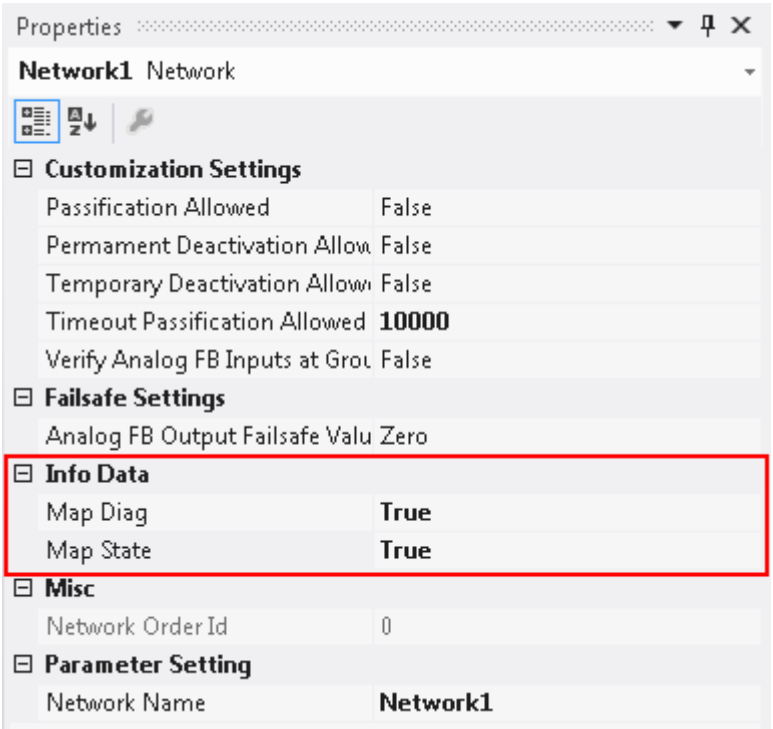


Fig. 107: Enabling the info data in the properties of the TwinSAFE group

The info data are shown in the I/O tree structure below the EJ6910 in the process image. From here, these signals can be linked with PLC variables. Further information on the included data can be found in the documentation for *TwinCAT function blocks for TwinSAFE logic terminals*.

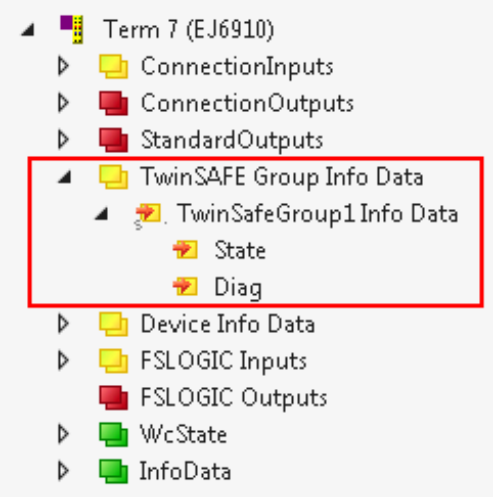


Fig. 108: Info data for the TwinSAFE group in the tree structure

5.4.4 Info data for the device

The info data for the EJ6910 can be enabled on the *Target System* tab. These are the serial number of the EJ6910 and the current online CRC of the safety project.

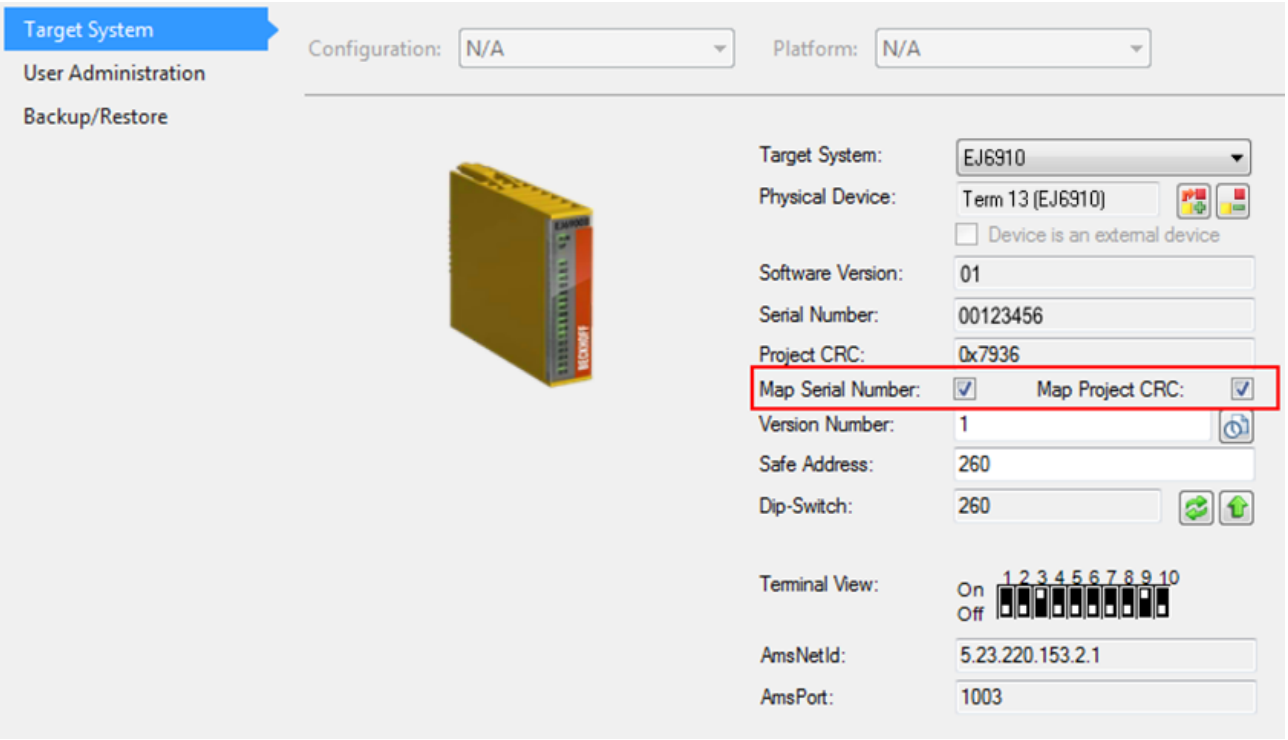


Fig. 109: Enabling the info data for the EL6910

The info data are shown in the I/O tree structure below the EJ6910 in the process image. From here, these signals can be linked with PLC variables.

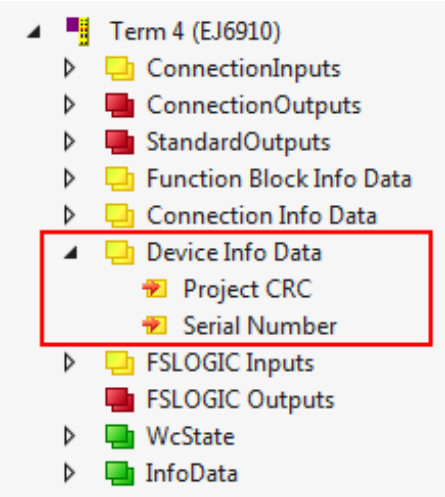


Fig. 110: Info data of the EJ6910 in the tree structure

5.5 Version history

The *version history* button under *Target System* can be used to read the version history of the EL6910, EJ6910 or EK1960. It includes the user, the date, the version and the CRC of the safety projects loaded on the EL6910, EJ6910 or EK1960.

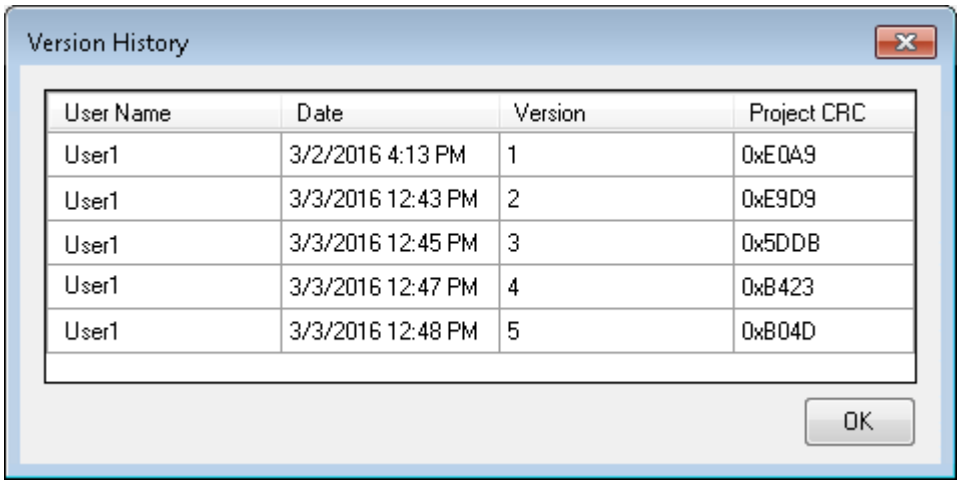


Fig. 111: Version History

5.6 User Administration

User administration is called up via the *Target System* tree item. Use *Get User List* to read the current list of users of the EL6910, EJ6910 or EK1960. The user *Administrator* cannot be deleted. The default password can and should be replaced with a customer-specific password. This is done via the *Change Password* button. The default password is *TwinSAFE*. The password must be at least 6 characters long. A maximum of 40 users can be created.

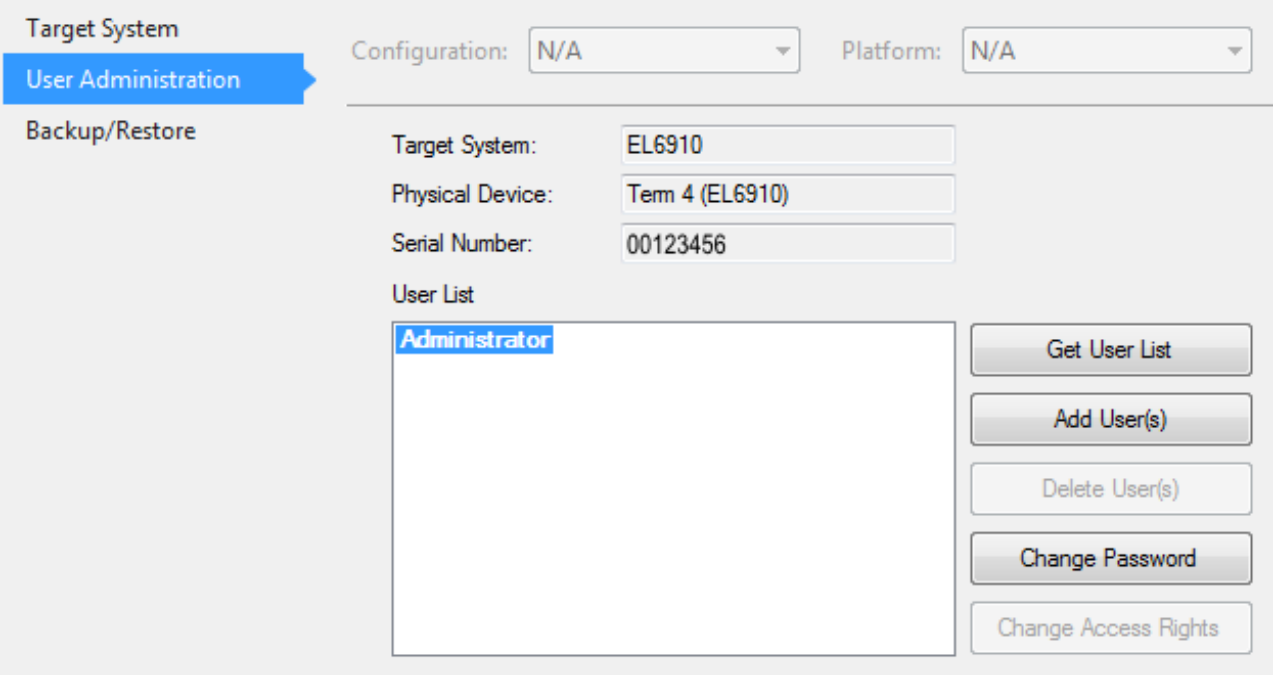


Fig. 112: User Administration

The administrator password is required to create or delete users. Open the *Login* dialog by left-clicking on *Add User(s)*.

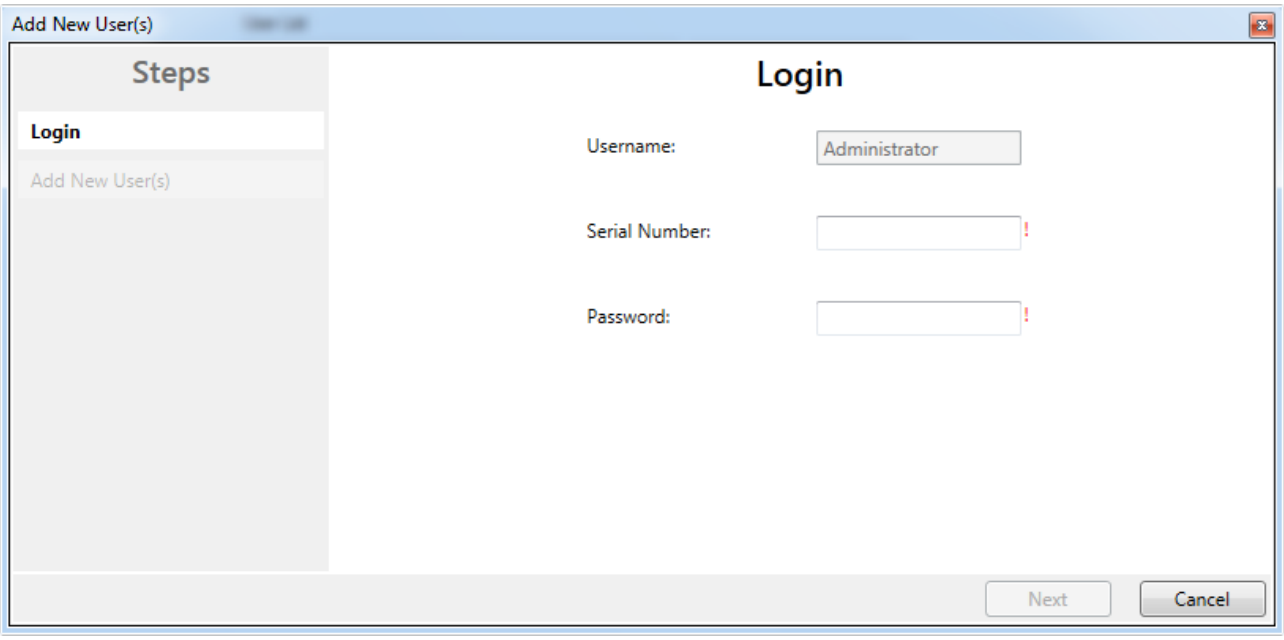


Fig. 113: User Administration - Login

The *Add User* dialog opens once the correct serial number and administrator password have been entered.

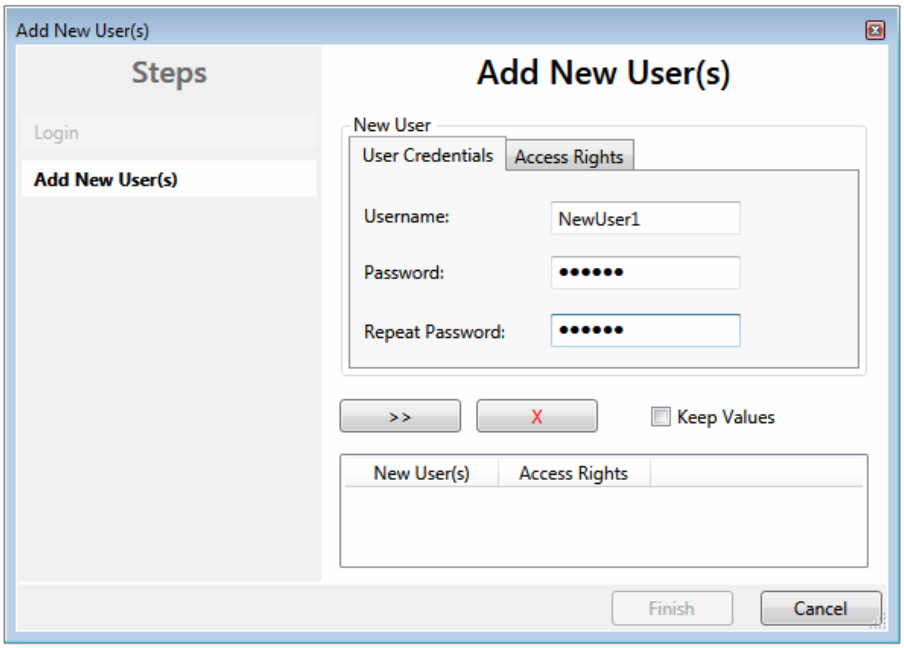


Fig. 114: User Administration - Add New User(s) - User Credentials

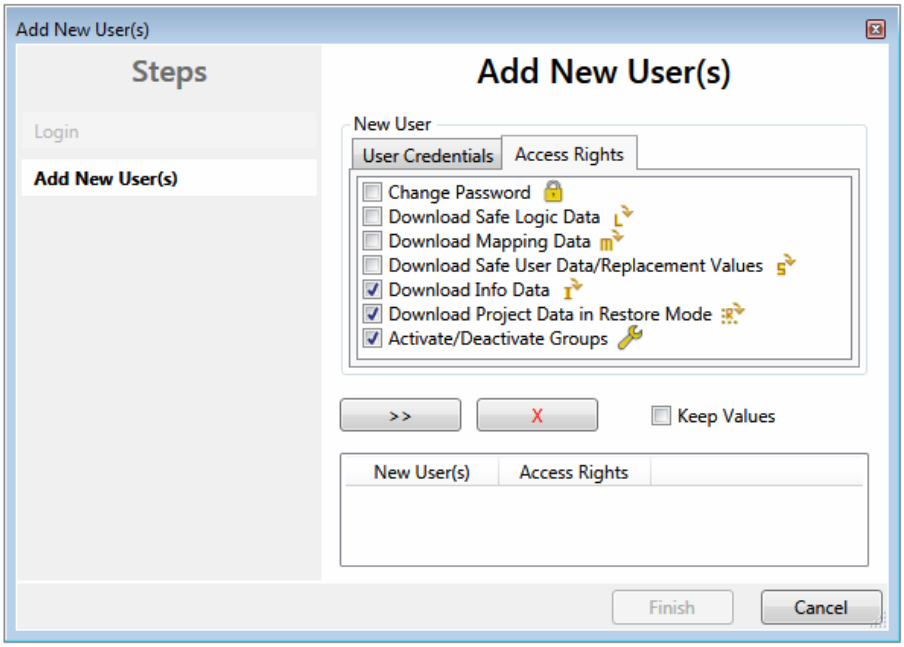
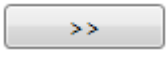


Fig. 115: User Administration - Add New User(s) - Access Rights

Enter the new user and the corresponding password (twice). The password must be at least 6 characters long. In addition, select the rights for the new user. Use the  button to apply these data and display them in the New User list.

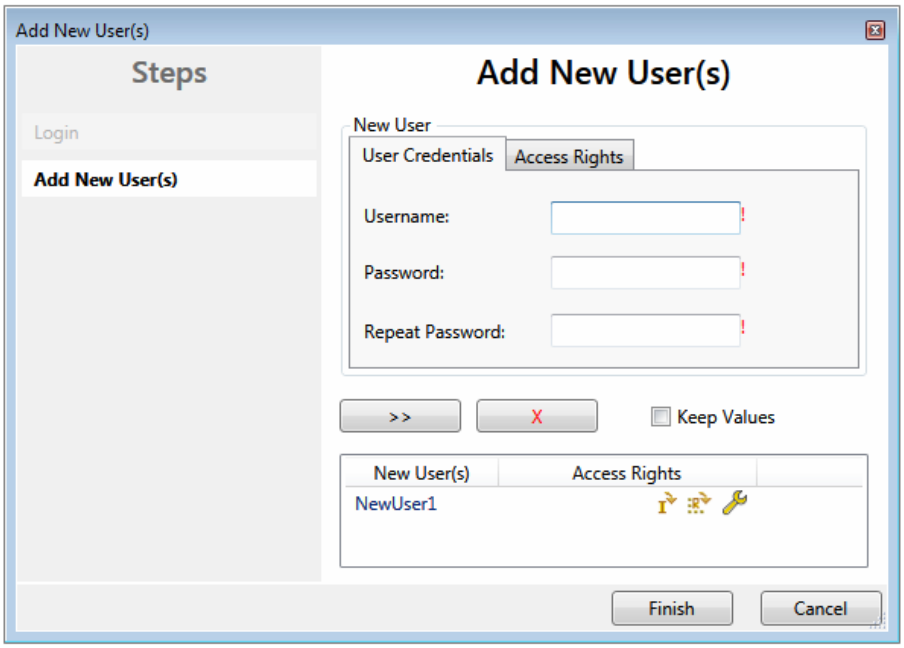


Fig. 116: User Administration - New User added

Several users can be created before leaving the dialog via the *Finish* button.

Access Rights	Description
Change Password	Users can change their password.
Download Safe Logic Data	The user can load the safety-related program onto the EL6910, EJ6910 or EK1960.
Download Mapping Data	The user can load the mapping data for inputs, outputs, FBs etc. onto the EL6910, EJ6910 or EK1960.
Download Safe User Data / Replacement Values	The user can change safe user parameters on the EL6910, EJ6910 or EK1960 and also change and load safe substitute values
Download Info Data	The user can activate and load the info data for connections and FBs on the EL6910, EJ6910 or EK1960.
Download Project Data in Restore Mode	The user can perform a restore. Not currently supported.
Activate / Deactivate Groups	The user can execute Customizing (enable and disable TwinSAFE groups) on the EL6910, EJ6910 or EK1960.

5.7 Backup/Restore

Following the exchange of an EL6910, EJ6910 or EK1960, the previous project can be loaded to the new device using the *Backup/Restore* mechanism.

In order to be able to use this functionality, the *Backup/Restore* mechanism must be enabled in the safety project, and the terminals must be selected, on which the current CRC of the safety project is to be stored.

For a restore operation the user can specify the minimum number of selected terminals on which the correct CRC must be stored.

Using the checkbox *Restore User Administration* the user can specify whether the user administration should be transferred to the new device via the restore mechanism.

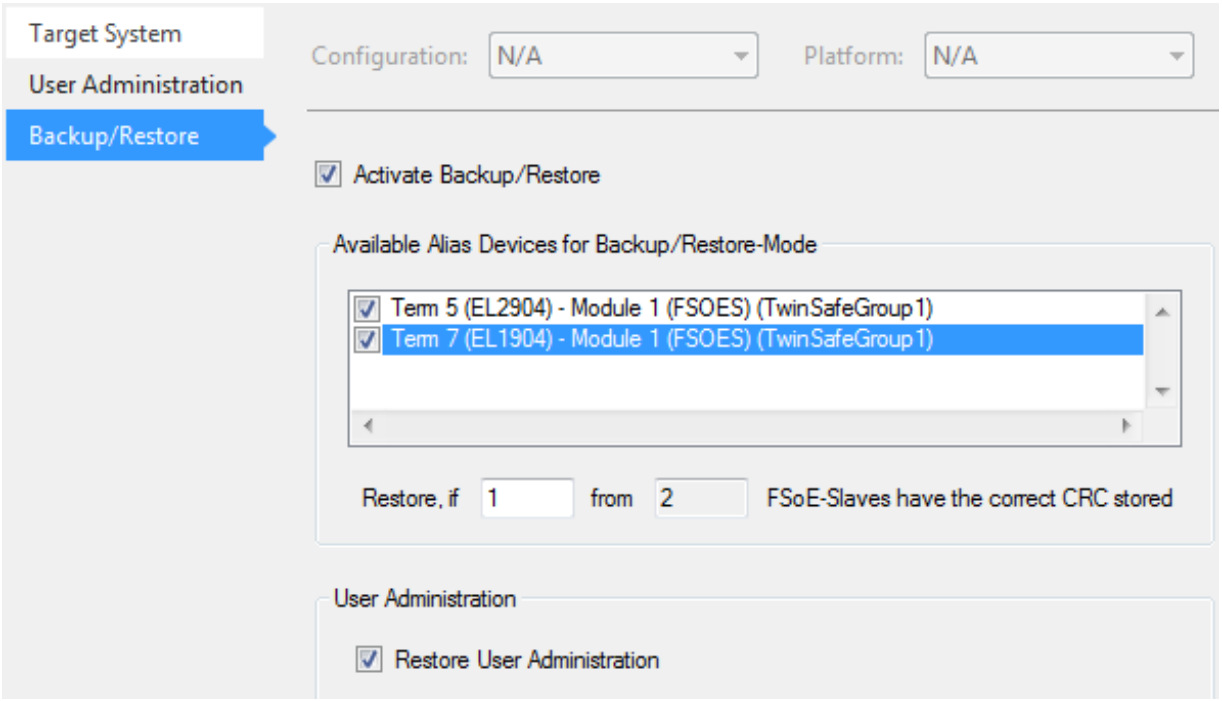


Fig. 117: Backup/Restore

In order to be able to use the *Backup/Restore* mechanism, create a backup of the current safety project and store it on the hard disk of the controller, for sample. To carry out a restore, the user can either check when starting the controller whether the serial number of the EL6910, EJ6910 or EK1960 has changed, or start the restore manually via a service menu, e.g. in the visualization.

Restore

If a project that doesn't match the system is loaded during a *restore*, this will only be detected when the distributed CRCs are checked. The previous project is then deleted from the logic terminal. This cannot be undone.

One possible sequence for checking whether a restore is carried out is shown in the following sequence chart.

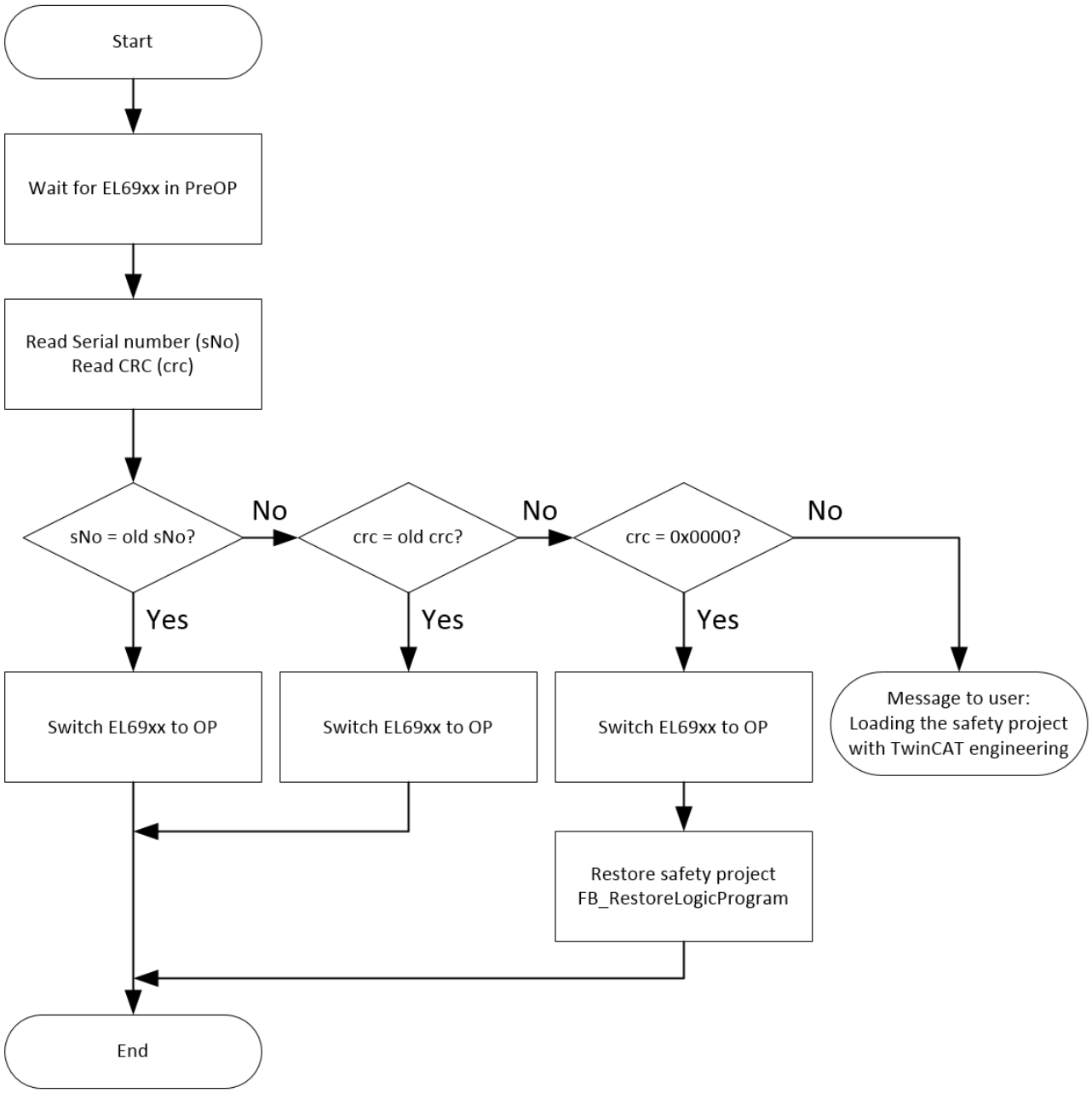


Fig. 118: Restore check sequence chart

Function blocks for backup/restore

The PLC function blocks with which a backup and restore can be performed on a TwinSAFE logic component (currently EL6910, EJ6910 or EK1960), can be found on the Beckhoff homepage. This is a compiled library that can be installed in the TwinCAT Library Repository.

The TC3_EL6910_Backup_Restore library contains 2 PLC function blocks. FB_SAVELOGICPROGRAM and FB_RESTORELOGICPROGRAM.

FB_SAVELOGICPROGRAM

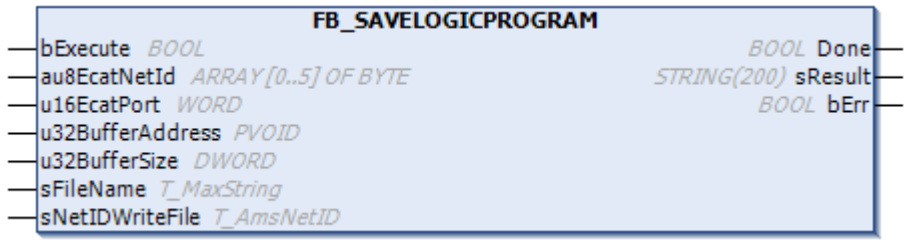


Fig. 119: FB_SAVELOGICPROGRAM illustration

FUNCTION_BLOCK **FB_SAVELOGICPROGRAM**

Name	Type	Inherited from	Address	Initial	Comment
bExecute	BOOL			FALSE	Positive edge starts the backup process
au8EcatNetId	ARRAY [0..5] OF BYTE				EtherCAT Net-ID of the TwinSAFE Logic - link to e.g. EL6910/InfoData/AdsAddr/netId
u16EcatPort	WORD				Port of TwinSAFE-Logic - link to e.g. EL6910/InfoData/AdsAddr/port
u32BufferAddress	PVOID				Address of buffer, in which the TwinSAFE Logic program should be stored temporarily - buffer e.g. ARRAY[0..16#FFFF] OF BYTE
u32BufferSize	DWORD				size of buffer
sFileName	T_MaxString				File, in which the TwinSAFE Logic program should be stored
sNetIDWriteFile	T_AmsNetID				AmsNetID of device where the file should be written to
Done	BOOL			FALSE	User information that the FB finished the operation
sResult	STRING(200)				FB Result
bErr	BOOL				An error occured during operation, details in sResult

Fig. 120: FB_SAVELOGICPROGRAM parameters

FB_RESTORELOGICPROGRAM

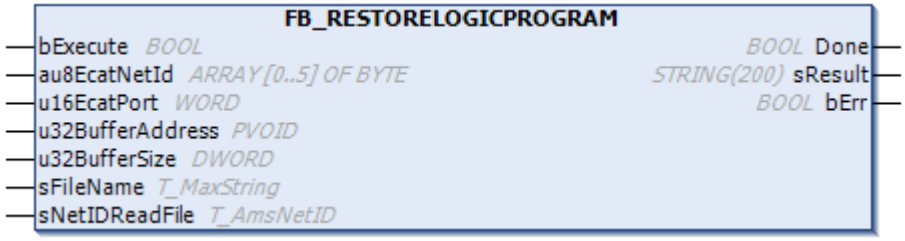


Fig. 121: FB_RESTORELOGICPROGRAM illustration

FUNCTION_BLOCK **FB_RESTORELOGICPROGRAM**

Name	Type	Inherited from	Address	Initial	Comment
bExecute	BOOL			FALSE	Positive edge starts the restore process
au8EcatNetId	ARRAY [0..5] OF BYTE				EtherCAT-Net-ID of the TwinSAFE Logic - link to e.g. EL6910/InfoData/AdsAddr/netId
u16EcatPort	WORD				Port of TwinSAFE-Logic - link to e.g. EL6910/InfoData/AdsAddr/port
u32BufferAddress	PVOID				Address to buffer, in which the TwinSAFE Logic program should be stored - buffer e.g. ARRAY[0..16#FFFF] OF BYTE
u32BufferSize	DWORD				size of buffer
sFileName	T_MaxString				File which contains the TwinSAFE logic program and should be restored
sNetIDReadFile	T_AmsNetID				AmsNetID of device where the file is stored
Done	BOOL			FALSE	User information that the FB finished the operation
sResult	STRING(200)				FB result
bErr	BOOL				An error occured during operation, details in Result

Fig. 122: FB_RESTORELOGICPROGRAM parameters

Sample

```
PROGRAM MAIN
VAR
	fb_save: FB_SAVELOGICPROGRAM;
	fb_restore: FB_RESTORELOGICPROGRAM;
	StartBackup: BOOL;
	EL6910AmsNetID AT %I*: ARRAY [0..5] OF BYTE;
	EL6910port AT %I*: WORD;
	internalBuffer: array[0..16#FFFF] of byte;
	FileString: T_MaxString := 'c:\temp\safety\complibTest_EL6910.bin';
	LocalAmsNetID: T_AmsNetID := '172.55.76.53.1.1';
	SaveDone: BOOL;
	SaveResult: STRING(200);
	SaveErr: BOOL;
	StartRestore: BOOL;
	internalbuffer2: array[0..16#FFFF] of Byte;
	RestoreDone: BOOL;
```

```
      RestoreResult: STRING(200);
      RestoreErr: BOOL;
END_VAR
```

```
// Backup of the TwinSAFE logic program
fb_save(
      bExecute:=           StartBackup,
      au8EcatNetId:=       EL6910AmsNetID,
      u16EcatPort:=        EL6910port,
      u32BufferAddress:=   ADR(internalBuffer),
      u32BufferSize:=      SIZEOF(internalBuffer),
      sFileName:=          FileString,
      sNetIDWriteFile:=    LocalAmsNetID,
      Done=>               SaveDone,
      sResult=>            SaveResult,
      bErr=>               SaveErr);
```

```
// Restore of the TwinSAFE logic program
fb_restore(
      bExecute:=           StartRestore,
      au8EcatNetId:=       EL6910AmsNetID,
      u16EcatPort:=        EL6910port,
      u32BufferAddress:=   ADR(internalbuffer2),
      u32BufferSize:=      SIZEOF(internalBuffer2),
      sFileName:=          FileString,
      sNetIDReadFile:=     LocalAmsNetID,
      Done=>               RestoreDone,
      sResult=>            RestoreResult,
      bErr=>               RestoreErr);
```

5.8 Export/import of the safety project

The safety project can be archived via the context menu of the safety project. The data type of this archive is *.tfzip.

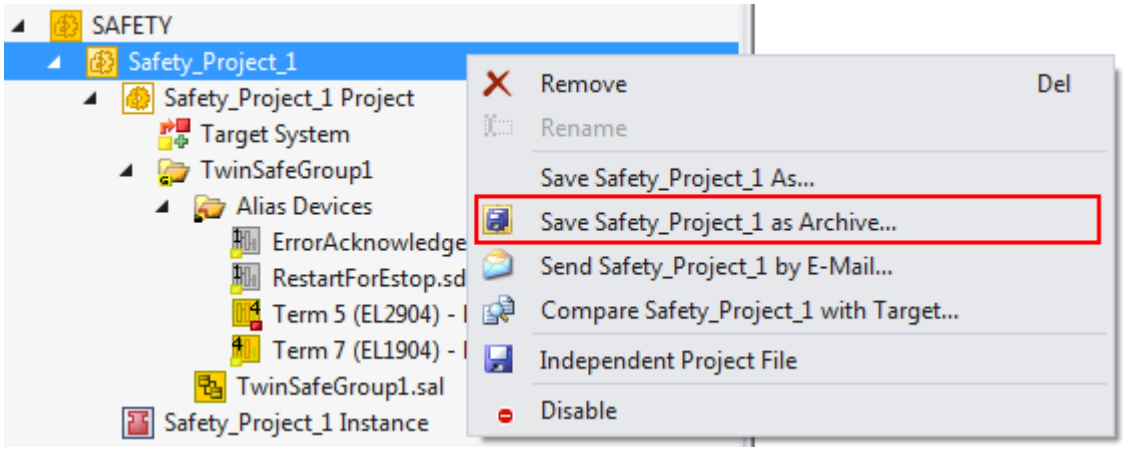


Fig. 123: Archiving the safety project

The safety project can be exported to XML format one level below the safety project node. This XML format can be used for exchange between TwinCAT 3 and TwinCAT 2.

The menu item *Export project (as bin file)* can be used to save the safety project in a binary format, so that it can be used by the TwinSAFE loader, for sample.

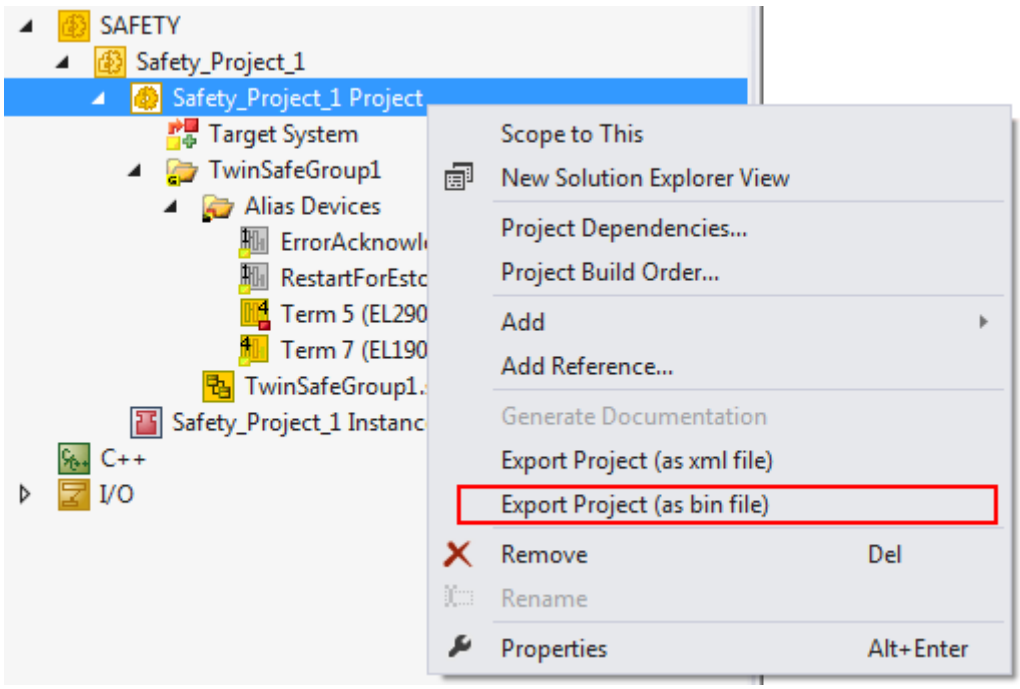


Fig. 124: Saving the safety project in a binary format (e.g. for the TwinSAFE loader)

A previously exported safety project can be imported via the context menu of the main Safety entry in the TwinCAT project structure. *Add Existing Item…* can be used to select the file type for the import.

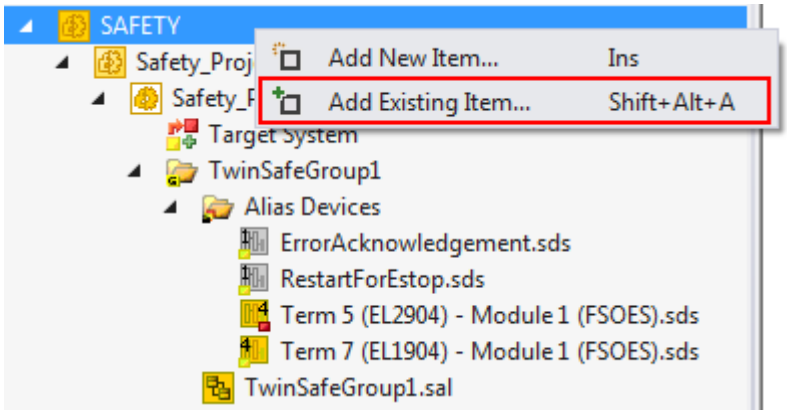


Fig. 125: Selecting the file type for importing a safety project

The following file types are supported:

- Safety project files *.splc,
- Safety project archives *.tfzip
- Safety projects in XML format

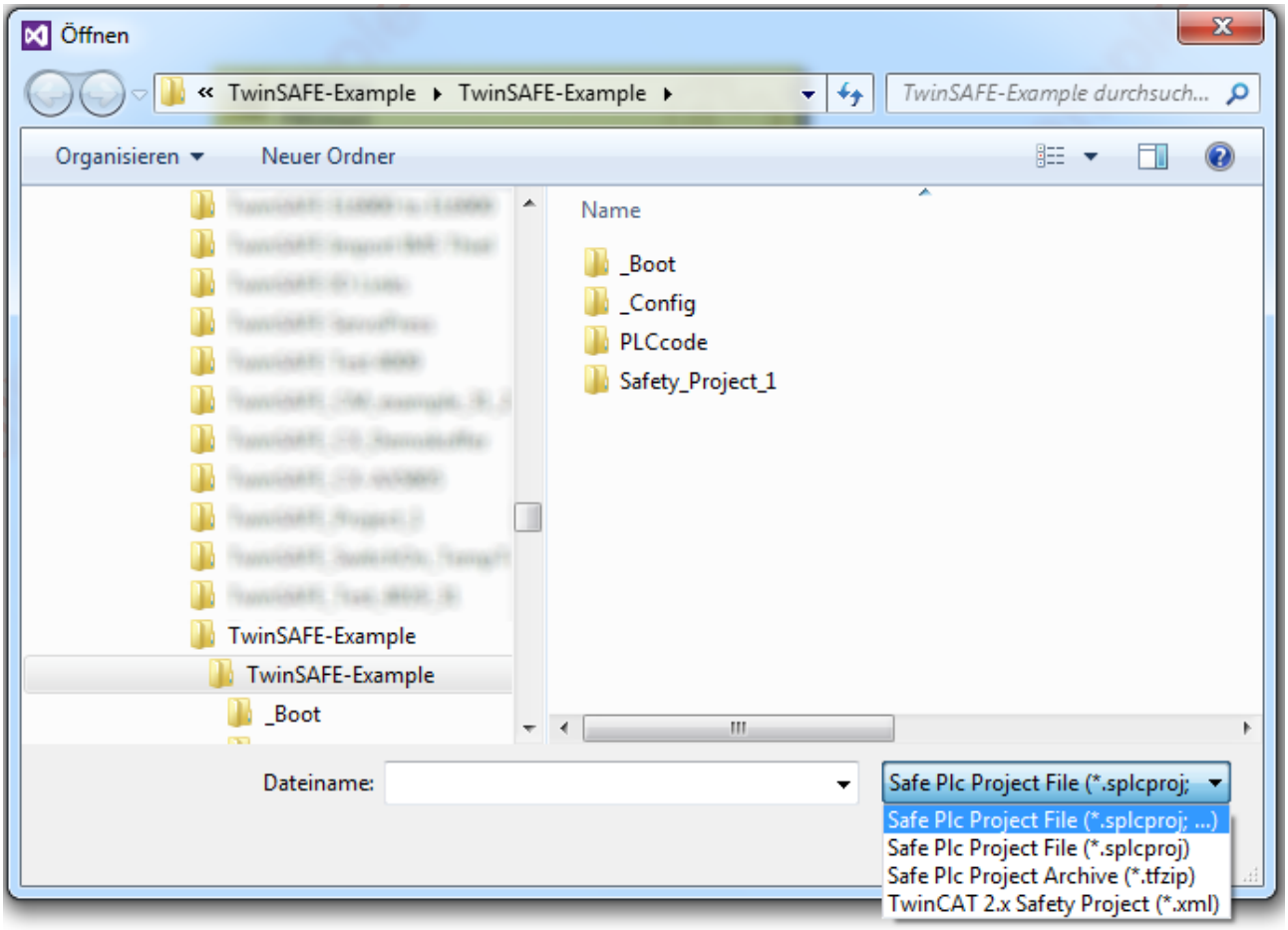


Fig. 126: Importing a safety project

5.9 Diag History tab

Any errors that occur in the EL6910, EJ6910 or EK1960 are stored in the their diag history. The diag history can be viewed by selecting the EL6910, EJ6910 or EK1960 in the I/O tree structure and then selecting the *Diag History* tab. Use the *Update History* button to fetch the current from the EL6910, EJ6910 or EK1960. Error within the logic; the function blocks and the connections are stored with a corresponding timestamp.

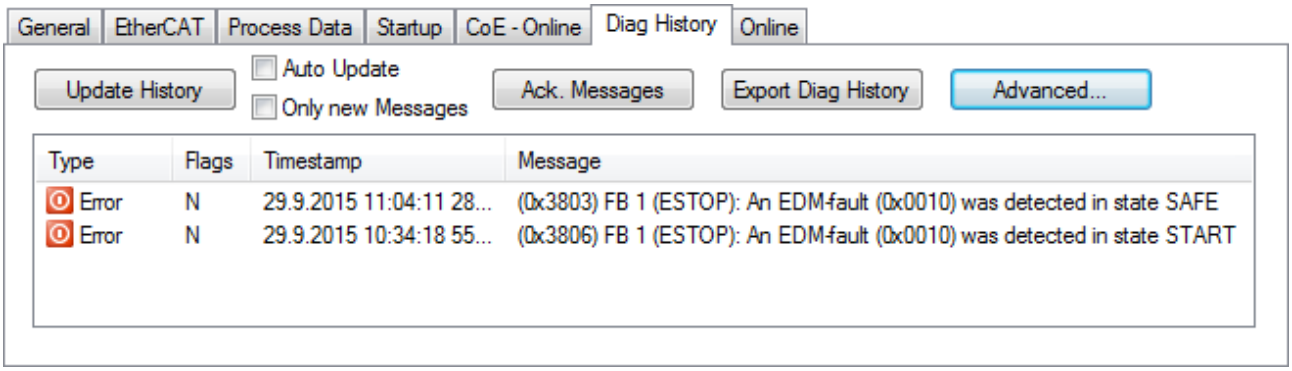


Fig. 127: Diag History

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

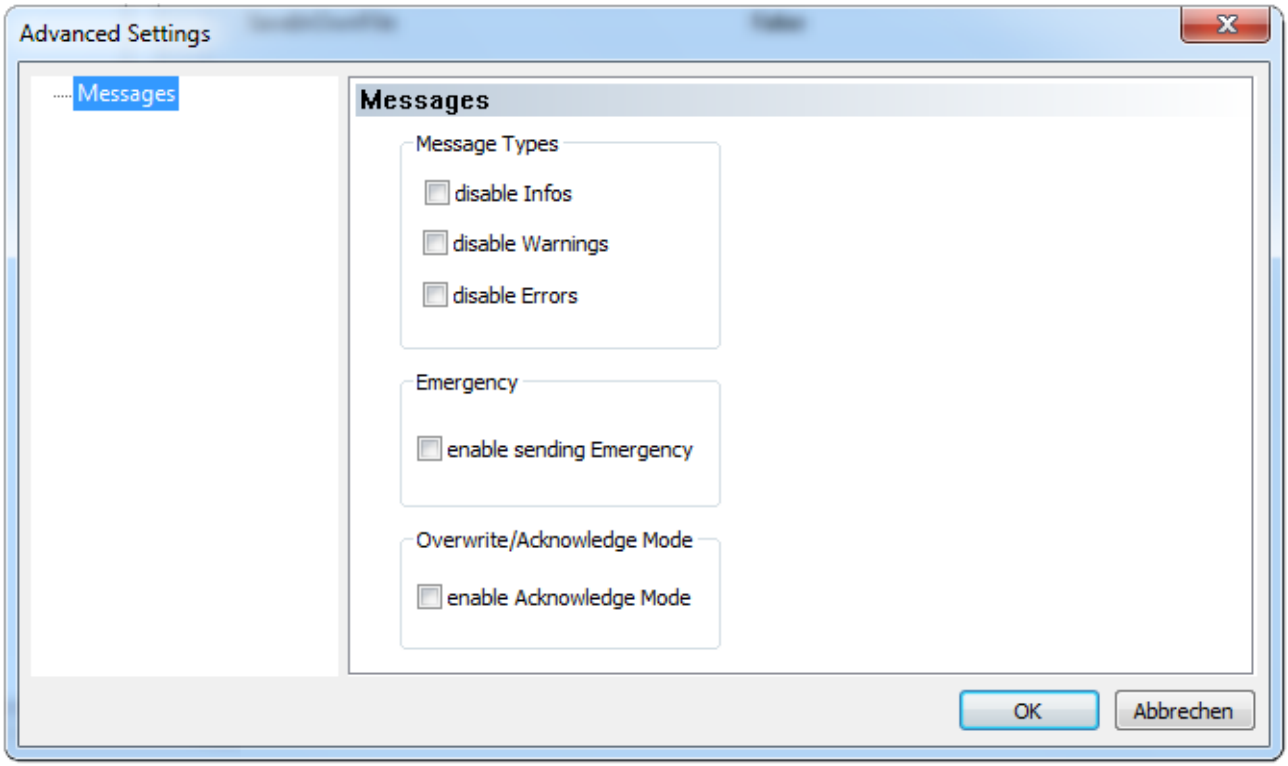


Fig. 128: Diag History - Advanced Settings

Advanced Settings

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

5.10 TwinSAFE SC - configuration

The TwinSAFE SC technology enables communication with standard EtherCAT terminals via the Safety over EtherCAT protocol. These connections use another checksum, in order to be able to distinguish between TwinSAFE SC and TwinSAFE. Eight fixed CRCs can be selected, or a free CRC can be entered by the user.

By default the TwinSAFE SC communication channel of the respective TwinSAFE SC component is not enabled. In order to be able to use the data transfer, the corresponding TwinSAFE SC module must first be added under the Slots tab. Only then is it possible to link to a corresponding alias device.

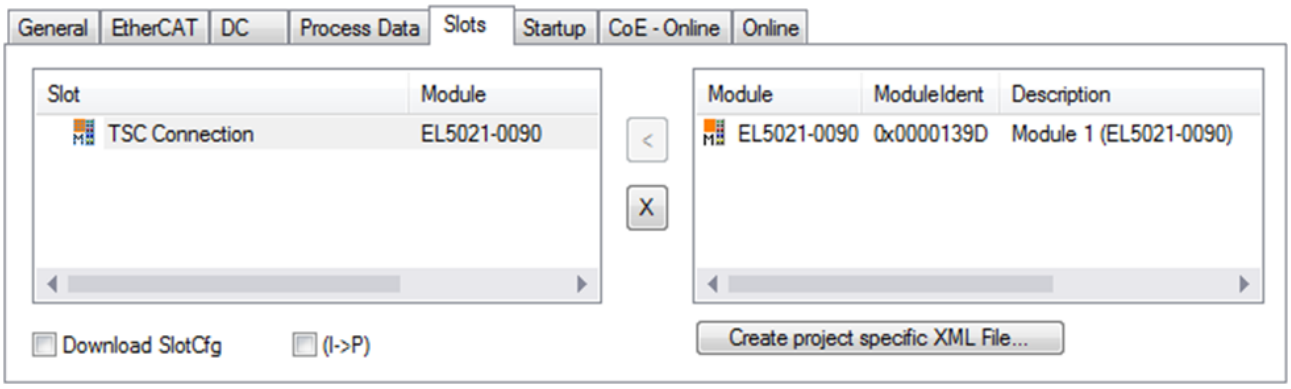


Fig. 129: Adding the TwinSAFE SC process data under the component, e.g. EL5021-0090

Additional process data with the ID TSC Inputs, TSC Outputs are generated (TSC - TwinSAFE Single Channel).

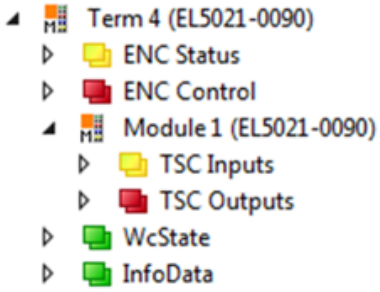


Fig. 130: TwinSAFE SC component process data, example EL5021-0090

A TwinSAFE SC connection is added by adding an alias devices in the safety project and selecting TSC (*TwinSAFE Single Channel*)

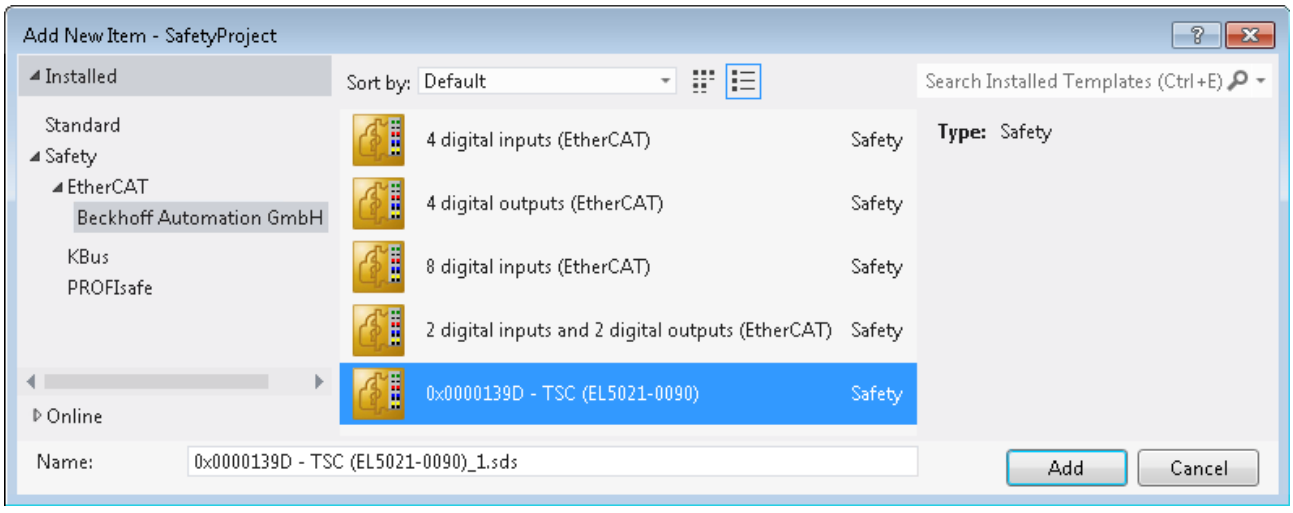


Fig. 131: Adding a TwinSAFE SC connection

After opening the alias device by double-clicking, select the Link button next to *Physical Device,* in order to create the link to a TwinSAFE SC terminal. Only suitable TwinSAFE SC terminals are offered in the selection dialog.

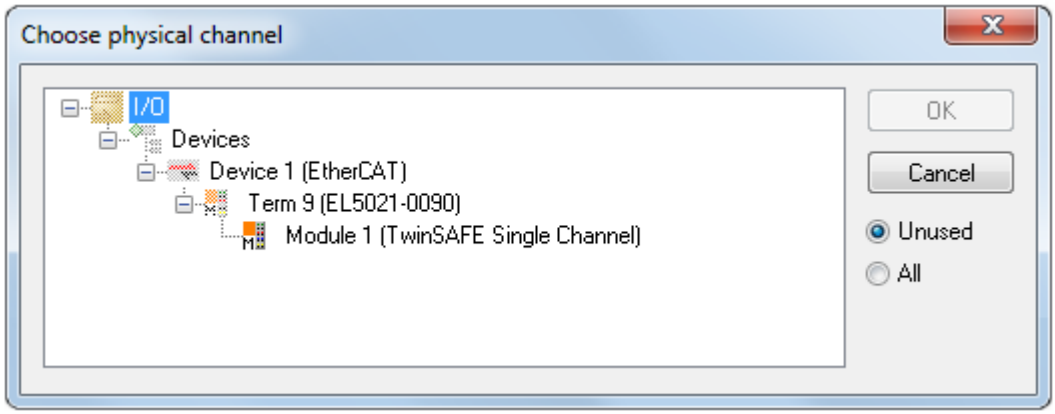


Fig. 132: Creating a link to TwinSAFE SC terminal

The CRC to be used can be selected or a free CRC can be entered under the Connection tab of the alias device.

Entry Mode	Used CRCs
TwinSAFE SC CRC 1 master	0x17B0F
TwinSAFE SC CRC 2 master	0x1571F
TwinSAFE SC CRC 3 master	0x11F95
TwinSAFE SC CRC 4 master	0x153F1
TwinSAFE SC CRC 5 master	0x1F1D5
TwinSAFE SC CRC 6 master	0x1663B
TwinSAFE SC CRC 7 master	0x1B8CD
TwinSAFE SC CRC 8 master	0x1E1BD

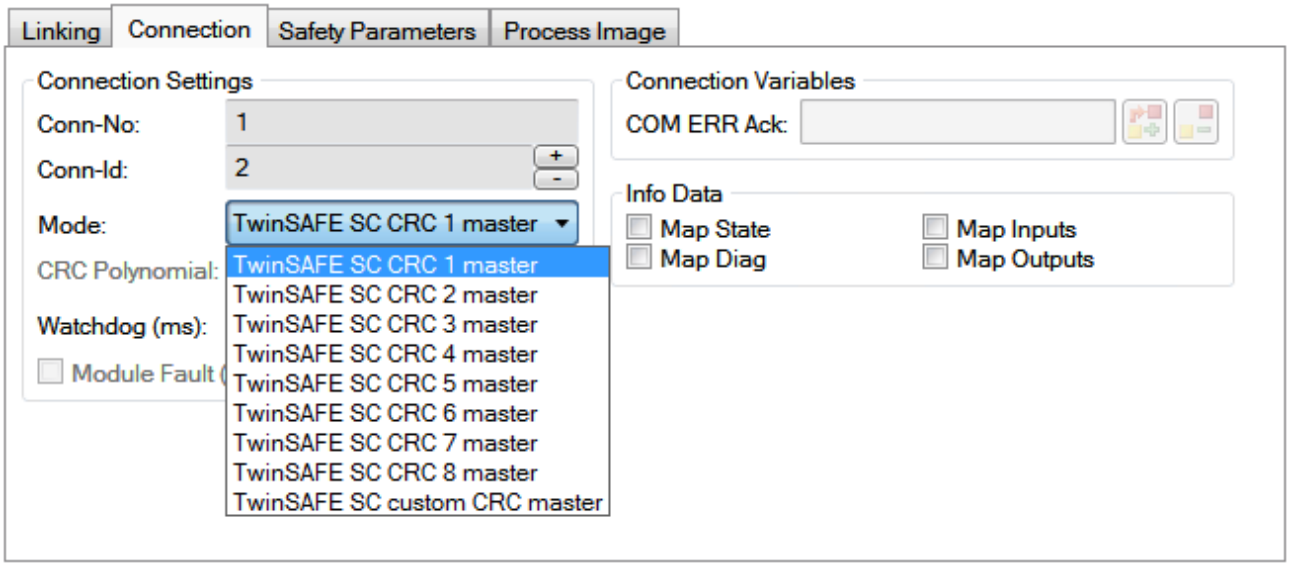


Fig. 133: Selecting a free CRC

These settings must match the settings in the CoE objects of the TwinSAFE SC component.
The TwinSAFE SC component initially makes all available process data available. The *Safety Parameters* tab typically contains no parameters. The process data size and the process data themselves can be selected under the *Process Image* tab.

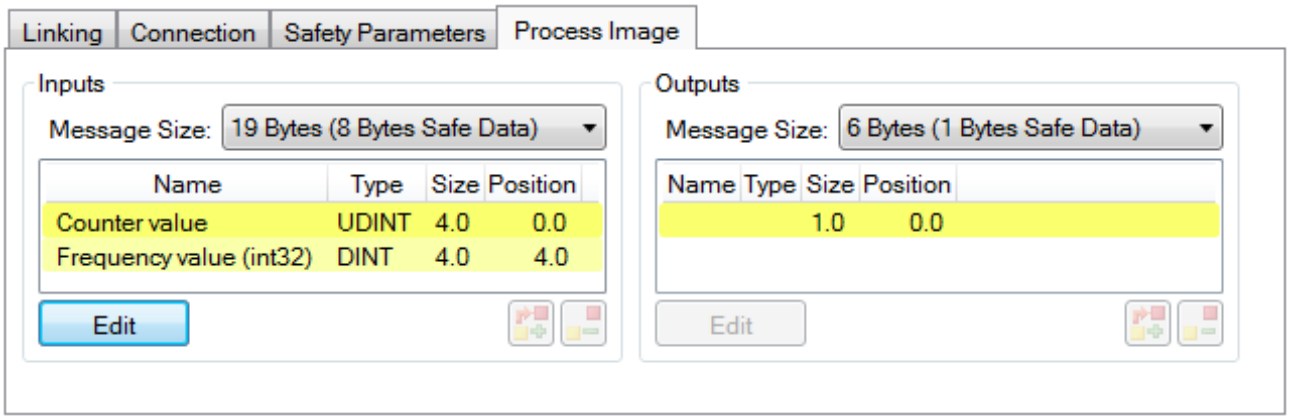


Fig. 134: Selecting the process data size and the process data

The process data (defined in the ESI file) can be adjusted to user requirements by selecting the *Edit* button in the dialog *Configure I/O element(s)*.

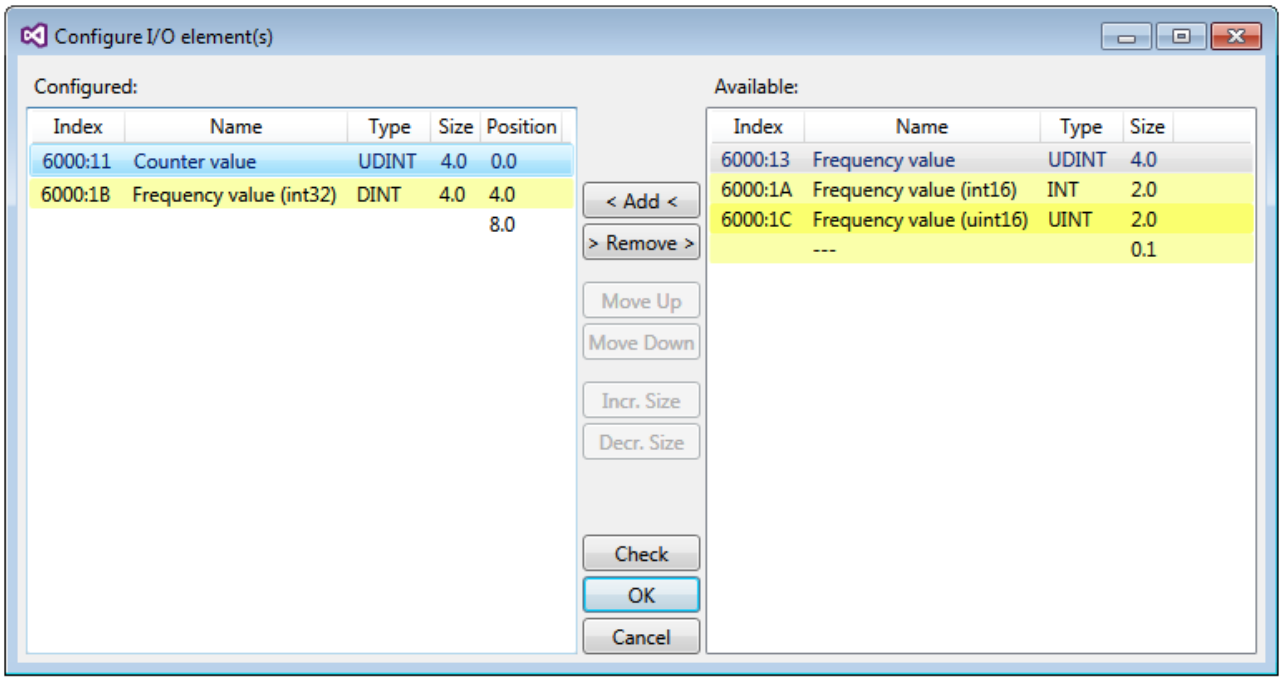


Fig. 135: Selection of the process data

The safety address together with the CRC must be entered on the TwinSAFE SC slave side. This is done via the CoE objects under *TSC settings* of the corresponding TwinSAFE SC component (here, for example, EL5021-0090, 0x8010: 01 and 0x8010: 02). The address set here must also be set in the *alias device* as *FSoE* address under the *Linking* tab.

Under the object 0x80n0:02 Connection Mode the CRC to be used is selected or a free CRC is entered. A total of 8 CRCs are available. A free CRC must start with 0x00ff in the high word.

8010:0	TSC Settings	RW	> 2 <
8010:01	Address	RW	0x0000 (0)
8010:02	Connection Mode	RW	TwinSAFE SC CRC1 master (97039)

Fig. 136: CoE objects 0x8010:01 and 0x8010:02

Object *TSC Settings*

Depending on the terminal, the index designation of the configuration object *TSC Settings* can vary. Example:
- EL3214-0090 and EL3314-0090, TSC Settings, Index 8040
- EL5021-0090, TSC Settings, Index 8010
- EL6224-0090, TSC Settings, Index 800F

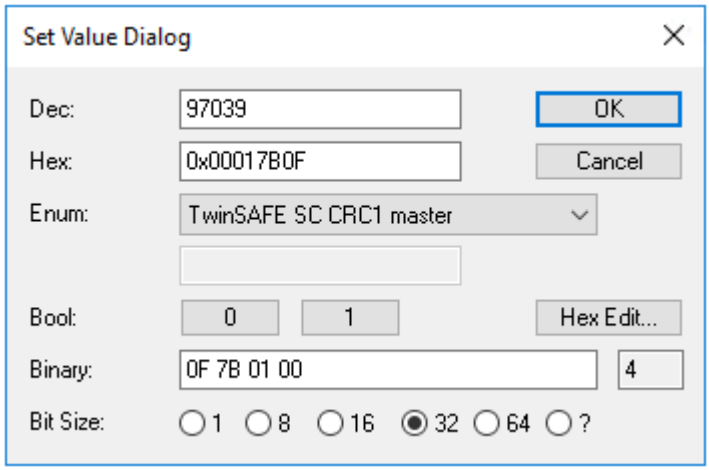


Fig. 137: Entering the safety address and the CRC

TwinSAFE SC connections

If several TwinSAFE SC connections are used within a configuration, a different CRC must be selected for each TwinSAFE SC connection.

5.11 Customizing / disabling TwinSAFE groups

The function Customizing can be selected in the safety toolbars or via the TwinSAFE menu. It can be used to enable and disable groups. There are different deactivation methods, as shown in the following table.

Deactivation	Description
Permanent deactivation	The TwinSAFE group is permanently disabled by the user. The substitute values parameterized for the group are set for the group outputs. If this group is enabled again, the RUN signal for this group must change from 0 to 1, in order for the group to start. Parameter: *Permanent Deactivation Allowed*: TRUE/FALSE
Deactivation until the EL6910 is switched off and back on again	The TwinSAFE group is disabled until the EL6910 is switched on again. The substitute values parameterized for the group are set for the group outputs. This setting cannot be used as default setting for the safety program download. If this group is enabled again (other than by switching off and on again), the RUN signal for this group must change from 0 to 1, in order for the group to start. Parameter: *Temporary Deactivation Allowed*: TRUE/FALSE
Deactivation of manual control unit	After starting the deactivation, the connection defined in the group must report a COM error after a period of 10 seconds, for sample (default setting). If this is not the case, a group error set and corresponding diagnostic message is generated. Only one connection may be defined in the group, which must be a master connection. Parameter: *Passification Allowed* : TRUE/FALSE *Timeout Passification Allowed*: Time in ms

The customization can also be carried out during the download of the safety application.

In order to be able to perform a customization, the groups must be set accordingly. This is done via the group properties.

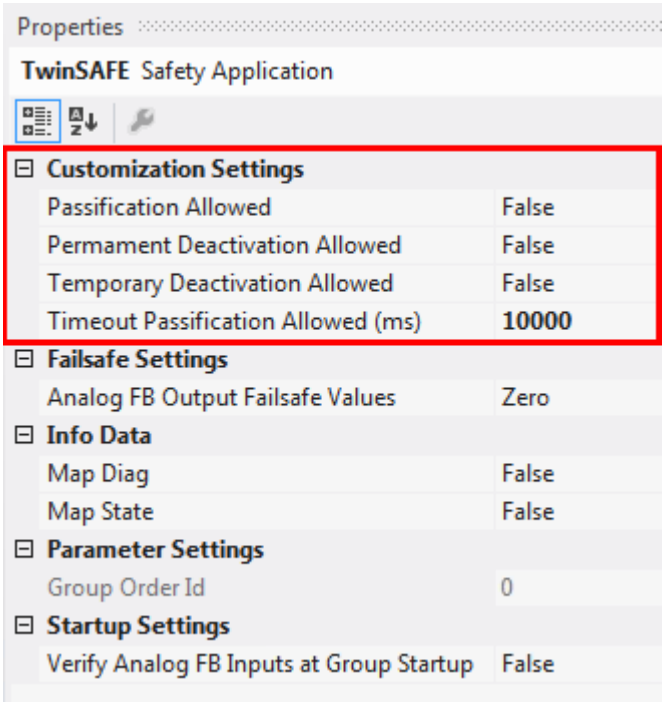


Fig. 138: Properties of the TwinSAFE group

If one of the Customizing parameters (*Passification Allowed, Permanent Deactivation Allowed* or *Temporary Deactivation Allowed*) is set to TRUE, all outputs of the TwinSAFE group that are not Safety Alias Devices are listed in the list of *Replacement Values*. Here you can parameterize the substitute values to be written to the output in the event of deactivation of the group.

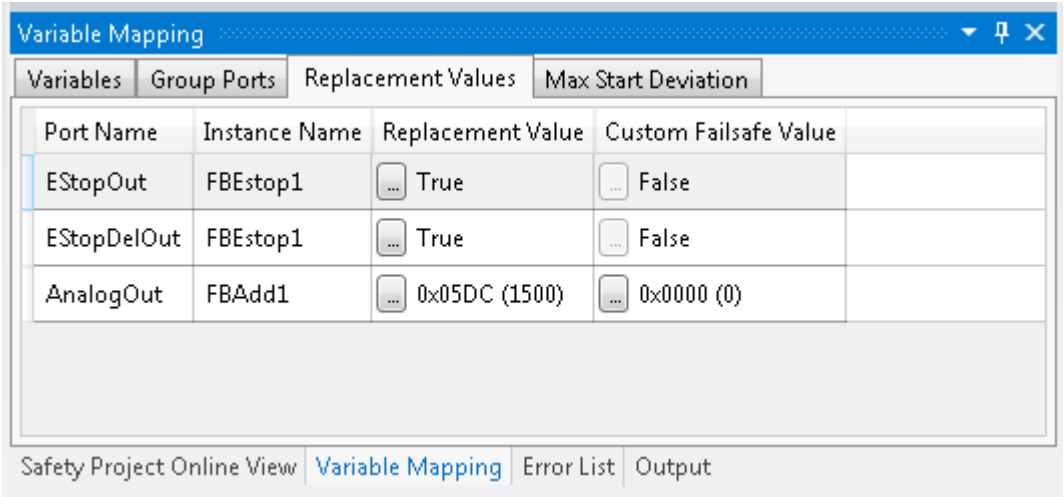


Fig. 139: Replacement values for the TwinSAFE group

When the Customizing function is selected, the login dialog opens for the user to enter their login data. This login must give permission for customizing.

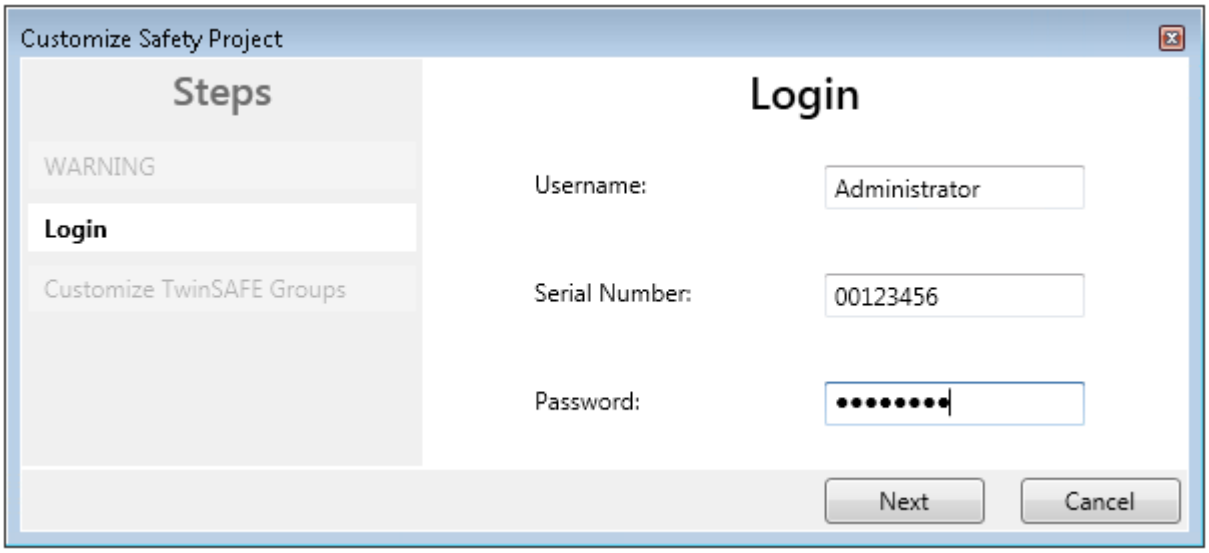


Fig. 140: Login

The Customizing dialog opens once the user has entered the data and selected *Next*.

The current group status is indicated with a green background.

Fig. 141: Customizing TwinSAFE Groups

The user can select the new status via the option area. In the sample below *Deactivate Temporarily* is selected. Use the *Finish* button to close the dialog and execute the required option.

Fig. 142: Customized TwinSAFE Group

TwinSAFE Logic in PreOP state

If Customizing is carried out on a TwinSAFE Logic with EtherCAT status PreOP, the customizing of a group does not become active. Customizing must be carried out again if the TwinSAFE Logic is in the EtherCAT status SafeOP or OP.

5.12 Saving the analog group inputs persistently

EL6910, EJ6910 and EK1960 support persistent saving of analog input values in an internal memory. When the group starts up, the stored data are compared with the current data. Under the tab *Max Start Deviation,* a corresponding deviation can be specified for each defined analog input value of the group.

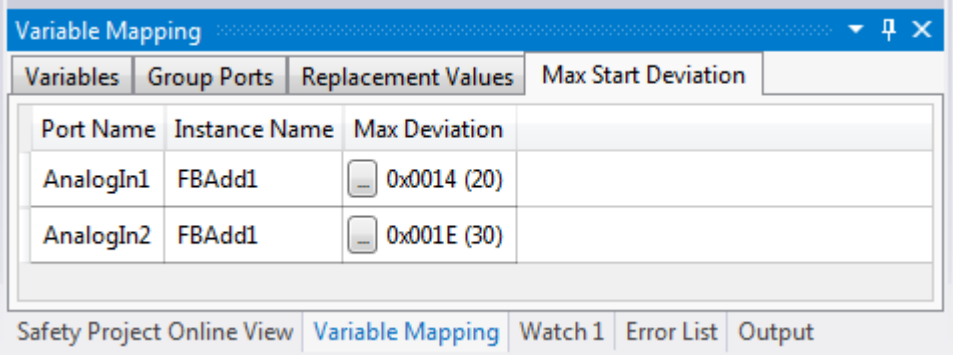


Fig. 143: Specifying deviations for analog input values

In the group properties the general settings for setting substitute values and checking the analog values on group startup can be parameterized. Setting the parameter *Verify Analog FB Inputs at Group Startup* to TRUE activates saving of all analog group inputs.

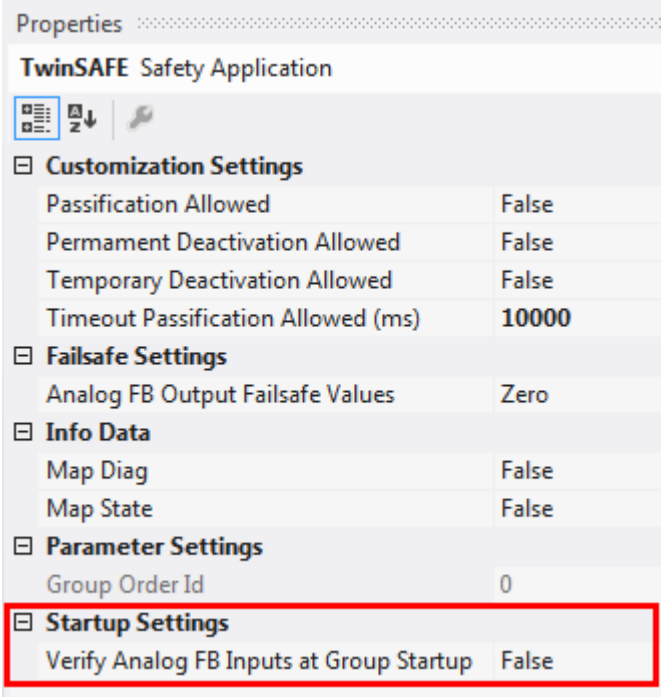


Fig. 144: Activate saving of all analog group inputs

5.13 Project design limits of EL6910/EJ6910

Project design limits

The maximum project design size for EL6910/EJ6910 is determined by the available memory. This is managed dynamically. The values specified in the following table are therefore only guide values and may differ from the actual values, depending on the safety project.

Process image size	max. 1486 bytes per data direction (max. memory size 0x1E00 for three buffers, i.e. with identical input and output process data sizes, the maximum size is 1280 bytes per data direction. Only even start addresses are possible, therefore fill bytes may have to be considered)
TwinSAFE connections	maximum 212 (up to 255 CRCs in total; 1 CRC is required for a TwinSAFE connection with 1 or 2 byte safe data.)
Supported hardware for TwinSAFE connections of the EL6910/EJ6910	EL1904 (all) EL2904 (all) EL2902 (all) EL6900 (all - max. 14 byte safe data) EL6930 (all - max. 14 byte safe data) EL6910 (all - max. 126 byte safe data) EL6910 (all - max. 126 byte safe data) KL1904 (from 2008) KL2904 (from 2008) KL6904 as slave (from 2008) AX5805 (all) AX5806 (all)
Safe data per TwinSAFE connection	maximum 126 byte (telegram length 255 byte)
PROFIsafe telegram length	4 to 16 byte PROFIsafe telegram length (user data 0 - 12 byte)
TwinSAFE function blocks	maximum 512 (ESTOP with complete input and output mapping)
TwinSAFE groups	maximum 128
TwinSAFE user	maximum 40
Standard PLC inputs	dynamic (memory-dependent), max. 1024 byte
Standard PLC outputs	dynamic (memory-dependent), max. 1024 byte

TwinSAFE connection

Only one TwinSAFE connection between two TwinSAFE terminals is possible. For communication with a EL6900, for sample, a connection with up to 14 bytes safe user data can be used.

5.14 Sync-Manager Configuration

Depending on the size of the TwinSAFE project on the TwinSAFE logic, it may be necessary to adjust the sync manager configuration.

As soon as the following message appears during the saving or downloading of the project, the sync manager configuration for the device has to be adapted.

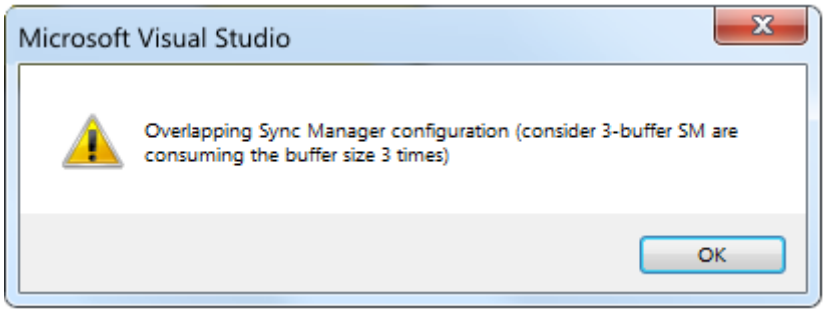


Fig. 145: Overlapping Sync Manager

Adapting the Sync-Manager configuration

The Sync Manager settings can be made via the *Advanced Settings...* of the TwinSAFE logic.

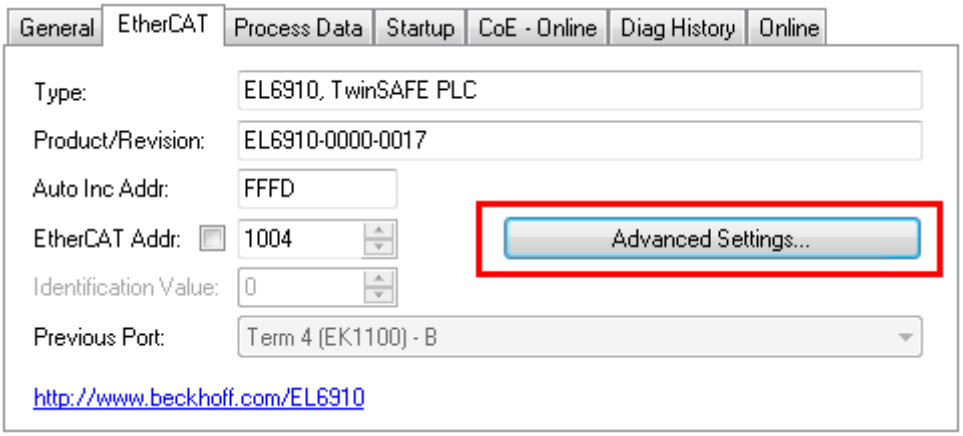


Fig. 146: EtherCAT Advanced Settings

To calculate the smallest start address of SM3, the length of SM2 is multiplied by 3 and added to the start address of SM2.

Start SM3 >= Start SM2 + 3* Length SM2

In addition, the starting address, together with 3 times the length of SM3, must not be larger than the address 0x3000.

Start SM3 + 3* Length SM3 <= 0x3000

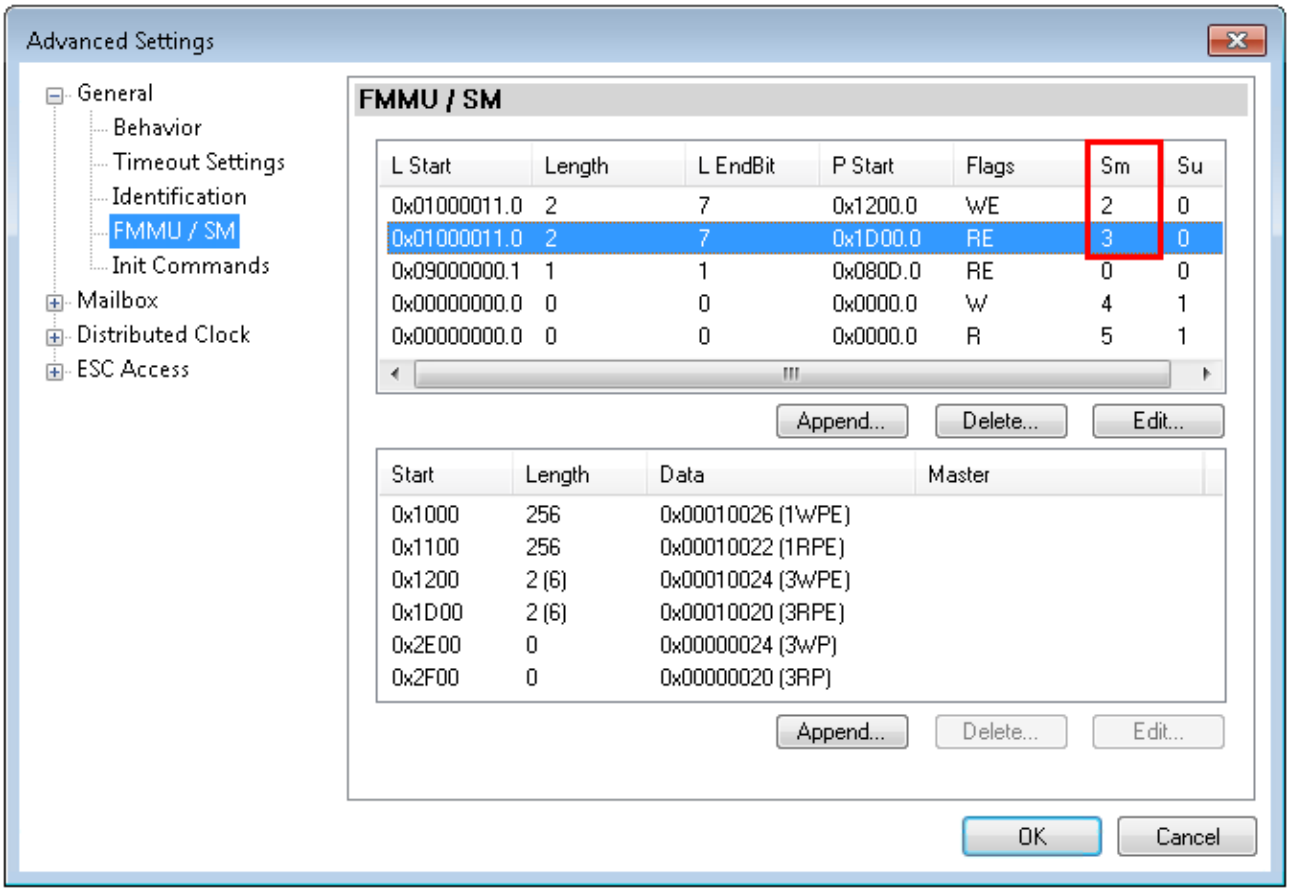


Fig. 147: Sync Manager settings

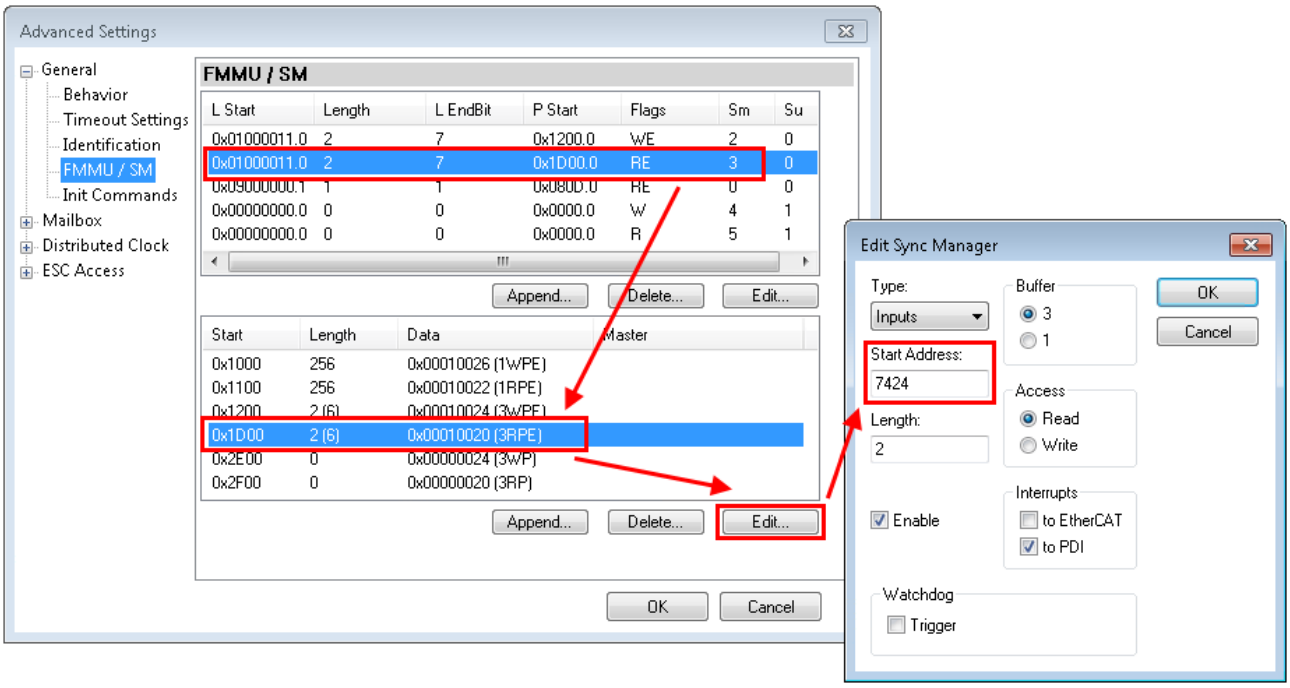


Fig. 148: Setting the start address for SM3

After changing the start address, all dialogs are closed with OK, the TwinCAT project is saved and the configuration is activated. If the calculation was carried out correctly, no error message should now be displayed and the project should be executed without errors.

5.15 TwinSAFE reaction times

The TwinSAFE terminals form a modular safety system that exchanges safety-oriented data via the Safety-over-EtherCAT protocol. This chapter is intended to help you determine the system's reaction time from the change of signal at the sensor to the reaction at the actuator.

5.15.1 Typical reaction time

The typical reaction time is the time that is required to transmit information from the sensor to the actuator, if the overall system is working without error in normal operation.

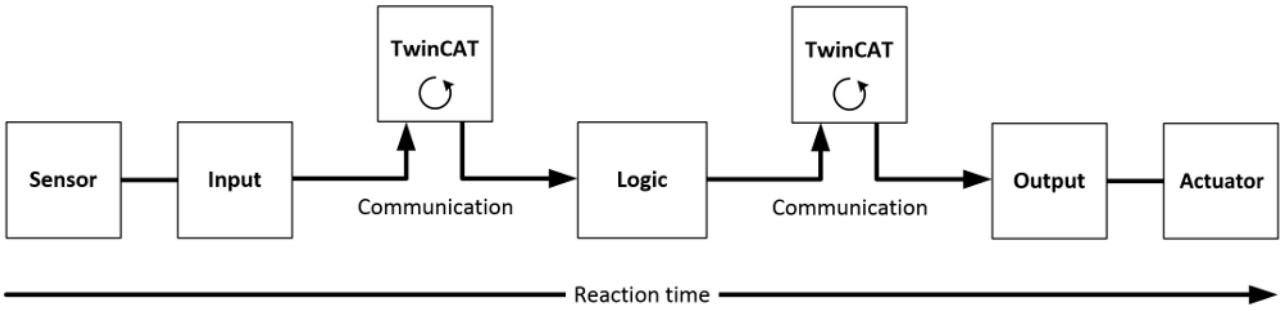


Fig. 149: Typical reaction time

Definition	Description
RTSensor	Reaction time of the sensor until the signal is provided at the interface. Typically supplied by the sensor manufacturer.
RTInput	Reaction time of the safe input, such as EL1904 or EP1908. This time can be found in the technical data. In the case of the EL1904 it is 4 ms.
RTComm	Reaction time of the communication This is typically 3x the EtherCAT cycle time, because new data can only be sent in a new Safety-over-EtherCAT telegram. These times depend directly on the higher-level standard controller (cycle time of the PLC/NC).
RTLogic	Reaction time of the logic terminal. This is the cycle time of the logic terminal and typically ranges from 500 µs to 10 ms for the TwinSAFE Logic Terminal, depending on the size of the safety project. The actual cycle time can be read from the terminal.
RTOutput	Reaction time of the output terminal. This typically lies within the range of 2 to 3 ms.
RTActor	Reaction time of the actuator. This information is typically supplied by the actuator manufacturer
WDComm	Watchdog time of the communication

This results in the following equation for the typical reaction time:

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

with, for example

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

5.15.2 Worst-case reaction time

The worst case reaction time is the maximum time required to switch off the actuator in the case of an error.

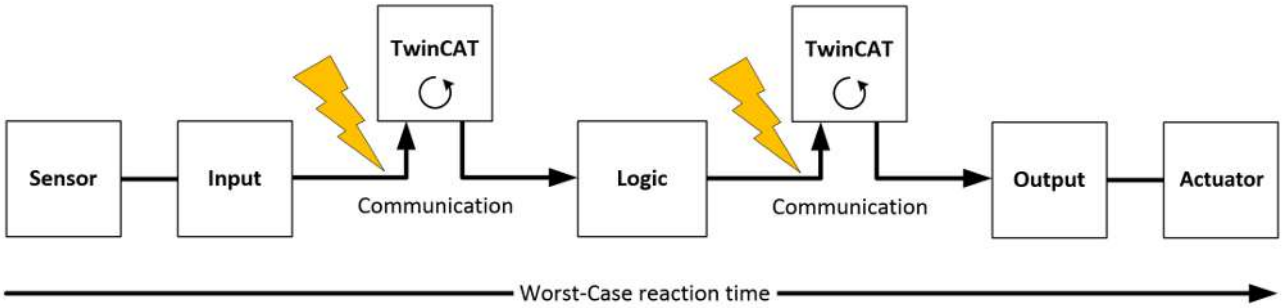


Fig. 150: Worst-case reaction time

This assumes that a signal change occurs at the sensor and is transmitted to the input. A communication error occurs at precisely the moment when the signal is to be transferred to the communication interface. This is detected by the logic following the watchdog time of the communication link. This information should then be transferred to the output, but a further communication error occurs here. This error is detected at the output following the expiry of the watchdog time and leads to the switch-off.

This results in the following equation for the worst-case reaction:

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

with, for example

$$ReactionTime_{max} = 15\,ms + 15\,ms + 20\,ms = 50\,ms$$

5.16 Diagnostics

5.16.1 Diagnostic LEDs

The LEDs Diag 1 to Diag 4 display diagnostic information for the EJ6910.

Fig. 151: EJ6910 diagnostic LEDs

5.16.1.1 LED indicators

Diagnostic LEDs

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

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

Logic error codes of LED Diag 2 (if LED Diag 1 is lit)

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

Environment error codes of LED Diag 2 (if LED Diag 1 is off)

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

5.16.1.2 Flash code display

LED	Display	Description
flashing		400 ms ON / 400 ms OFF 1 second pause between the flash codes
flickering		50 ms ON / 50 ms OFF

5.16.2 Status LEDs

The LEDs State 1 to State 4 indicate the current status of the EJ6910.

Fig. 152: EJ6910 status LEDs

LED Display

State 1	State 2	State 3	State 4	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

5.16.3 Diagnostic objects

⚠ CAUTION

Do not change CoE objects!

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

Index $F984_{hex}$: Device Info Data C1

The CoE object $F984_{hex}$ displays current internal temperature and voltage values of the TwinSAFE components.

Index	Name	Meaning	Flags	Default
F984:01	Voltage C2	Voltage µC2	RO	0_{dec}
F984:02	Temperature C1	Temperature µC1	RO	0_{dec}
F984:03	Firmware CRC C1	CRC Firmware µC1	RO	0_{dec}
F984:04	Vendor data CRC C1	CRC Vendor data µC1	RO	0_{dec}

Index $F985_{hex}$: Device Info Data C2

The CoE object $F985_{hex}$ displays current internal temperature and voltage values of the TwinSAFE components.

Index	Name	Meaning	Flags	Default
F985:01	Voltage C1	Voltage µC1	RO	0_{dec}
F985:02	Temperature C2	Temperature µC2	RO	0_{dec}
F985:03	Firmware CRC C2	CRC Firmware µC2	RO	0_{dec}
F985:04	Vendor data CRC C2	CRC Vendor data µC2	RO	0_{dec}

Diagnostics history

Errors occurring during the operation of the TwinSAFE components, such as overtemperature or undervoltage, are entered in the diagnostic history with a corresponding timestamp.

Index $F100_{hex}$: FSLOGIC status

The CoE object $F100_{hex}$ shows the current status of the TwinSAFE component.

Index	Name	Meaning	Flags	Default
F100:01	Safe Logic State	Status of the internal logic: 0: OFFLINE 1: RUN 3: SAFE 6: START 8: PREPARE 10: RESTORE 11: PROJECT-CRC-OK	RO	0_{bin}
F100:02	Cycle Counter	Life cycle counter, which is incremented with each TwinSAFE logic cycle.	RO	0_{bin}

The following table contains a description of all values of the index $F100_{hex}$ SubIndex 01.

Index	Value	Description
F100:01	0: OFFLINE	In the OFFLINE state no TwinSAFE logic program is loaded. No TwinSAFE groups and no TwinSAFE connections are processed.
	1: RUN	In the RUN state all TwinSAFE groups and all TwinSAFE connections configured in the TwinSAFE logic program are processed.
	3: SAFE	The SAFE state is assumed from the RUN state when the TwinSAFE logic program is stopped. If the TwinSAFE logic program is restarted without a new TwinSAFE logic program having been transferred, the TwinSAFE logic should switch again from SAFE to RUN. All TwinSAFE groups should be initialized with the initial state STOPERROR, so that an error acknowledgement occurs before safe outputs are connected again. In the SAFE state no TwinSAFE groups and no TwinSAFE connections are processed.
	6: START	The START state is assumed if the TwinSAFE logic program is loaded but the standard communication channel (e.g. EtherCAT) is not yet in process data exchange or the process data lengths configured via the standard communication channel do not match the process data lengths calculated using the TwinSAFE logic program. The START state is also assumed when a user is logged in for the purpose of deleting the current TwinSAFE logic program or transferring the user list. In the START state no TwinSAFE groups and no TwinSAFE connections are processed.
	8: PREPARE	The PREPARE state is assumed at the transition from START to RUN or from SAFE to RUN. In the PREPARE state, the stored data read in from the FRAM is checked and then the RUN state is assumed. If an error is detected during checking of the stored data, all TwinSAFE groups assume the initial state STOPERROR. If no error is detected during checking of the stored data, all TwinSAFE groups assume the initial state STOP.
	10: RESTORE	In the RESTORE state the loaded TwinSAFE restore program is to be checked by comparing its project CRC with the project CRCs read in via the corresponding TwinSAFE connections. In the RESTORE state all TwinSAFE connections configured in the TwinSAFE Restore program are processed.

Index	Value	Description
	11: PROJECT-CRC-OK	The PROJECT-CRC-OK state is assumed once the project CRC of the loaded TwinSAFE restore program has been successfully checked via the TwinSAFE connections. In the PROJECT-CRC-OK state no TwinSAFE groups and no TwinSAFE connections are processed.

This CoE object is additionally copied into the cyclic process image of the TwinSAFE component. From there, this information can be directly linked into the PLC.

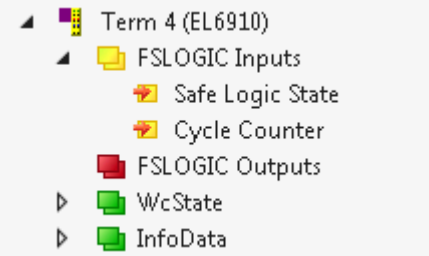


Fig. 153: Diagnostic object - FSLOGIC Status ($F100_{hex}$) in the process image of the TwinSAFE component

5.16.4 Cycle time of the safety project

The processing time of the EL6910/EJ6910 can be obtained from the CoE objects below. To determine the cycle time, it has to be multiplied with 1.25, because this is the factor used internally for generating a delay time before the next cycle.

5.16.4.1 Index FEA0hex: CTRL Diag Data

Index	Name	Meaning	Flags	Default
FEA0:09	Actual Safety Control Task Execution Time	Current processing time of the EL6910/EJ6910 when logic state = 1 (RUN) cycle time = 1.25 * value (average value of 64 cycles)	RO	0_{hex}
FEA0:0A	Min Safety Control Task Execution Time	Minimum processing time of the EL6910/EJ6910 when logic state = 1 (RUN) cycle time = 1.25 * value	RO	0_{hex}
FEA0:0B	Actual Safety Control Task Execution Time	Maximum processing time of the EL6910/EJ6910 when logic state = 1 (RUN) cycle time = 1.25 * value	RO	0_{hex}
FEA0:15	Actual Safety Control Task Execution Time	Current processing time of the EL6910/EJ6910 when logic state <> 1 cycle time = 1.25 * value (average value of 64 cycles)	RO	0_{hex}
FEA0:16	Min Safety Control Task Execution Time	Minimum processing time of the EL6910/EJ6910 when logic state <> 1 cycle time = 1.25 * value	RO	0_{hex}
FEA0:17	Actual Safety Control Task Execution Time	Maximum processing time of the EL6910/EJ6910 when logic state <> 1 cycle time = 1.25 * value	RO	0_{hex}

The minimum and maximum values can be reset by writing a value to CoE object 0x1C32:08.

6 Service life

The TwinSAFE EJ modules are designed for a service life of 20 years.

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

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

Date code: CW YY SW HW

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

In addition the TwinSAFE EJ modules bear a unique serial number.

Fig. 154: Unique serial number of a TwinSAFE EJ module

7 Maintenance and cleaning

Cleaning by the manufacturer only

Do not operate the TwinSAFE component if it is impermissibly dirty according to protection class IP20. Send impermissibly dirty TwinSAFE components to the manufacturer for cleaning.

TwinSAFE components are basically maintenance-free.

8 Decommissioning

8.1 Disposal

NOTE

Correct disposal

Observe the applicable national laws and guidelines for disposal.

Incorrect disposal may result in environmental damage.

Remove the TwinSAFE component for disposal.

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

Cast iron and metal

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

Cardboard, wood and polystyrene

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

Plastic and hard plastic

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

Oils and lubricants

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

Batteries and accumulators

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

8.1.1 Returning to the vendor

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

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

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

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

9 Appendix

9.1 Volatility

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

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

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

9.2 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.

СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFIC

Product Service

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

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

9.3 Certificate

BECKHOFF New Automation Technology

Originalerklärung
Original declaration

EG-Konformitätserklärung
EC Declaration of Conformity

Nummer: 2017043EJ6910-2, Datum: 19.12.2022
Number, Date

Hersteller *Manufacturer*	**Beckhoff Automation GmbH & Co. KG** Hülshorstweg 20, 33415 Verl, Germany
erklärt, dass das Produkt *declares that the product*	**TwinSAFE EJ6910** TwinSAFE Logic *TwinSAFE logic*

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

2006/42/EG *2006/42/EC*	**Richtlinie 2006/42/EG des Europäischen Parlaments und des Rates vom 17. Mai 2006 über Maschinen und zur Änderung der Richtlinie 95/16/EG (Neufassung)** *Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)*
2014/30/EU *2014/30/EU*	**Richtlinie 2014/30/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit (Neufassung)** *Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast)*
2011/65/EU *2011/65/EU*	**Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates vom 8. Juni 2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten** *Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)*

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

EN ISO 13849-1:2015	**EN IEC 63000**:2018	**EN 61131-2**:2007
EN 62061:2005/A2:2015		**EN 61000-6-2**:2005
		EN 61000-6-4:2007

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

Richtlinie *Directive*	**Benannte Stelle** *Notified Body*	**Baumusterprüfbescheinigung** *type examination certificate*
2006/42/EG *2006/42/EC*	**TÜV SÜD Product Service GmbH** Ridlerstraße 65, 80339 München, Germany	**M6A 062386 0043 Rev. 01** 2022-12-12

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

Bevollmächtigter
Authorised person

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20, 33415 Verl, Germany

Verl, 19.12.2022

Ort / Datum
Place / Date

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

Fig. 155: EJ6910 EC Declaration of Conformity

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