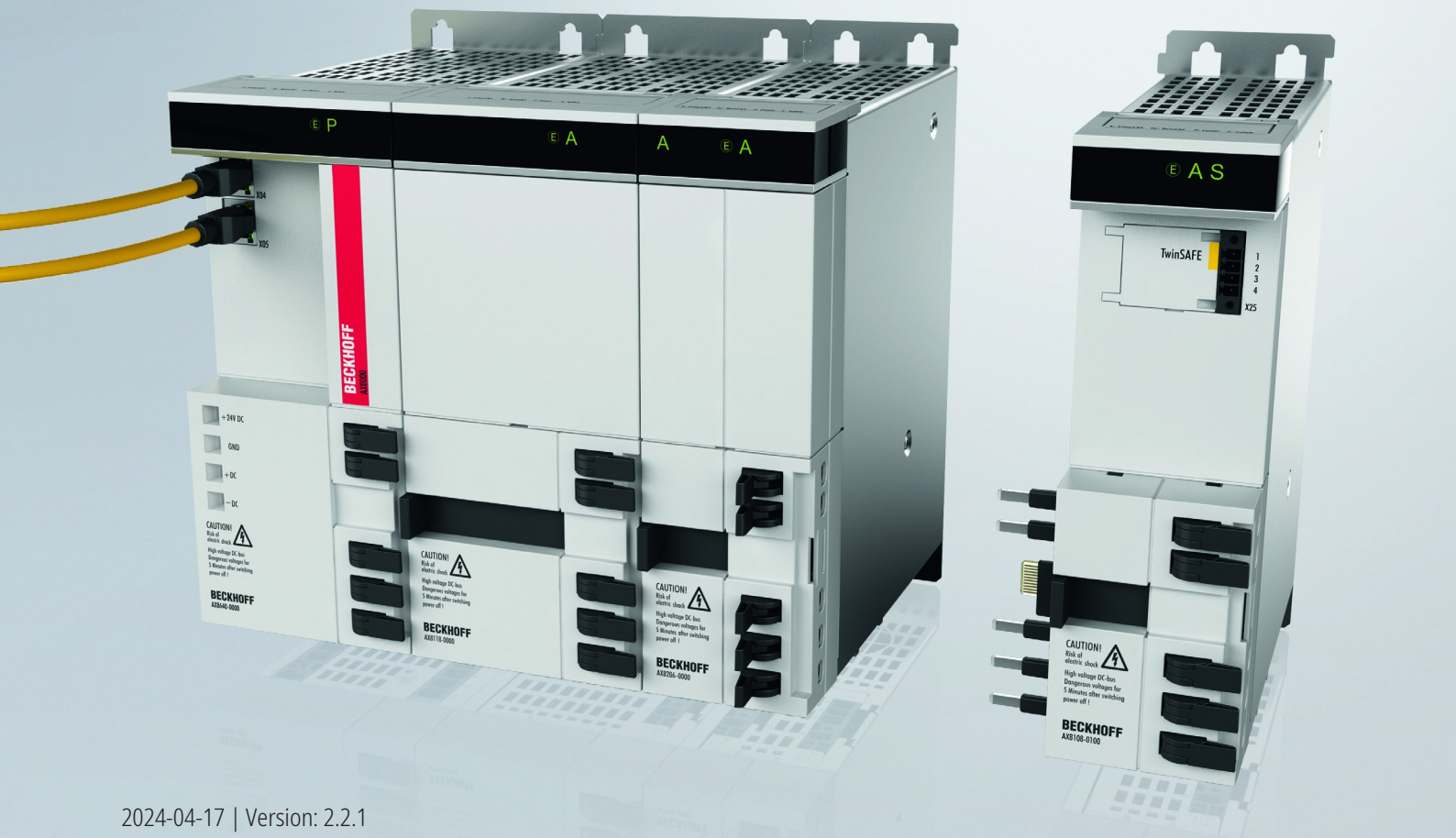
BECKHOFF New Automation Technology

Operating Instructions | EN

AX8911

TwinSAFE drive option card for servo drive AX8xxx-x2xx



2024-04-17 | Version: 2.2.1

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1 Notes on the documentation

1.1 Disclaimer

Beckhoff products are subject to continuous further development. We reserve the right to revise the operating instructions at any time and without prior announcement. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in these operating instructions.

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

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1.1.2 Patents

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

- EP1590927
- EP1789857
- EP1456722
- EP2137893
- DE102015105702

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1.1.3 Limitation of liability

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

The following is excluded from the liability:

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

1.1.4 Copyright

1.2 Version numbers

Version	Comment
2.2.1	• Corrections • Chapter name changed to “Version numbers”
2.2.0	• Documentation name changed to “Operating Instructions” • “Lifetime” and “Target failure measures” renamed • Chapter “Notes on information security” added • Safety instruction on engineering tools revised • Chapters “Target failure measures” and “Environmental conditions” adapted
2.1.0	• Safety parameters and SS1-d removed from chapter ”Type key” • Chapter “Safe Motion functions with integrated encoder” added • Warning added in chapter “SBC” • Chapter “Brake control” added • Chapter “Safe Motion” revised and warning removed
2.0.0	• Title page updated • Editorially revised • Chapter “Signal words” revised • Warning added: Certification for third-party motors invalid • Division of the AX8911 documentation into ◦ AX8911 for AX8xxx-x1xx ◦ AX8911 for AX8xxx-x2xx ◦ TwinSAFE Safe Motion functions
1.2.0	• General revision
1.1.0	• Description of the Safe Motion functions added • Safety instructions adapted to IEC 82079-1 • Illustration of the safety parameters updated
1.0.0	• Certificate added • Description of the safe inputs and outputs added
0.4.0	• Safety parameters for the STO and SS1 functions added
0.3.0	• Description of the Safe Motion functions updated
0.2.0	• Preliminary (internal only)
0.1.0	• Preliminary (internal only)

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.

Currentness

Please check whether you are using the current and valid version of this document. The current version can be downloaded from the Beckhoff homepage at http://www.beckhoff.com/twinsafe. In case of doubt, please contact Technical Support (see Beckhoff Support and Service [▶ 11]).

1.3 References

No	Version	Title / description
[1]	1.0 or newer	**Functional description AX8000 – multi-axis servo system** The function description contains information about the configuration in the TC3 Drive Manager 2 and the functions included.
[2]	1.0 or newer	**Original operating instructions AX8000 – Multi-axis servo system** The original operating instructions contain a description of the mechanical and electrical characteristics, as well as all the information necessary for using the AX8000 servo drive.
[3]	1.9.0 or newer	**Operating instructions for EL6910 TwinSAFE Logic module** The document contains a description of the logic functions of the EL6910, and thus also of the TwinSAFE drive option card, and their programming
[4]	3.1.0 or newer	**Documentation TwinSAFE Logic FB** The document describes the safety function blocks that are available in the EL6910, and thus also in the TwinSAFE drive option card, and form the safety application.
[5]	1.8.0 or newer	**TwinSAFE Application Guide** The Application Guide provides the user with examples for the calculation of target failure measures for safety functions according to the standards DIN EN ISO 13849-1 and EN 62061 or EN 61508, such as are typically used on machines.
[6]	2006/42/EC	**Directive 2006/42/EC of the European Parliament and of the Council of 17. May 2006 on machinery, and amending Directive 95/16-7/EC (revised) of 29 June 2006** This directive, also known as the Machinery Directive, defines requirements for the placing on the market of machines and machine-like components, such as safety components.
[7]	2.0.0 or newer	**TwinSAFE Safe Motion functions** Description of the TwinSAFE Safe Motion functions

1.3.1 Document classification in the overall documentation

This documentation applies exclusively to AX8000 variants with integrated safety technology, in accordance with the Type key [▶ 18].

This TwinSAFE drive option card is a permanently installed part of a multi-axis servo system with integrated safety technology. For this reason, some life phases, such as decommissioning and disposal, apply exclusively to the servo system as an overall system and are not listed in this documentation.

⚠ WARNING

Observe TwinSAFE drive option card documentation as a matter of priority

The values and specifications defined in these operating instructions apply in addition and primarily to the documents [1] and [2] at References [▶ 8]. Observe these operating instructions as a matter of priority.

Non-observance can endanger safety.

1.4 Version history

This version history lists the output states of the firmware versions with the supported encoder protocols. You will also find an overview of the available ModuleIdents and which firmware supports which ModuleIdents. See the following table.

Date	Encoder protocol	ModuleIdent	AX8911 firmware version	AX8000 firmware version
12.05.2020	Safe Motion (OCT)	#x00670071	01 (V0109)	**AX8xxx FW 0103**, AX8xxx FW 0104, AX8xxx FW 0105, AX8xxx FW 0106
18.05.2021	Safe Motion (OCT, ENDAT, motor replacement)	#x00680071	03 (V0113)	**AX8xxxFW 0104**, AX8xxx FW 0105, AX8xxx FW 0106
		#x00690071		**AX8xxx FW 0105**, AX8xxx FW 0106
11.06.2023	Safe Motion (OCT (HIPERFACE DSL), ENDAT2.2, ENDAT 3, motor replacement)	#x006a0071	04 (V0116)	**AX8xxx FW 0106**

You can use the firmware of the AX8911 TwinSAFE drive option card in a backward-compatible manner in older AX8xxx firmware versions.

1.5 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.

1.6 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 in the operating instructions.

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

1.6.1 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.

1.6.1.1 Signal words

The signal words used in the documentation are classified below.

Warning of personal injuries

⚠ DANGER

Hazard with high risk of death or serious injury.

⚠ WARNING

Hazard with medium risk of death or serious injury.

⚠ CAUTION

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

Warning of damage to property or environment

NOTICE

Notes

The environment, equipment, or data may be damaged.

Information on handling the product

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

1.7 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

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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

Headquarters

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

Phone:	+49 5246/963-0
E-mail:	info@beckhoff.com
Web:	www.beckhoff.com

For the addresses of our worldwide locations, please visit our website at Global Presence.

1.8 Notes on information security

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

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

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

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

2 For your safety

2.1 Due diligence

Read and observe the complete documentation of the TwinSAFE drive option card

In addition to this document, the complete documentation for the TwinSAFE drive option card includes documents [1] to [5], which are listed in chapter References.

Read and observe these documents.

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 drive option card 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 drive option card.
- do not remove the safety markings attached to the overall system and maintain their legibility.

2.2 General safety instructions

2.2.1 Before operation

Use in machines according to the Machinery Directive

Only use the overall system in machines in accordance with the Machinery Directive to ensure safe operation.

Certification for third-party motors invalid

The TÜV SÜD certificate applies to the list of approved motors. Other motors are not covered by the certificate. When using a third-party motor, you are responsible for the attachment and FMEA.

Non-observance may endanger product safety.

Traceability

Ensure traceability of the TwinSAFE drive option card via the serial number of the overall system.

Use of SELV/PELV power supply unit

To supply the overall system with 24 V_{DC}, use a SELV/PELV power supply unit with an output voltage limitation of U_{max} = 36 V_{DC} in the event of a fault.

Implement protected cable laying

If no test pulses are used on the signals between the outputs of the safety controller and the STO inputs of the servo system, implement the wiring as cable laying. See the EN ISO 13849-2 standard for more information.

Use of permissible engineering tools and procedures

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

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

Commissioning test

Before commissioning, application errors and wiring faults must be excluded. Before commissioning, carry out a commissioning test. After a successful commissioning test, you can use the TwinSAFE drive option card for the intended safety-related task.

Control of the parameterization of the TwinSAFE drive option card

The TwinSAFE drive option card determines errors in the parameterization, but no logical testing of the parameters or the loaded safety program can take place. Ensure by means of an acceptance test that the parameterization and the safety program are correct for the use case. This test must be performed by the machine manufacturer.

The combination of AX8000 and AX8911 may be used in production only when this test has produced a positive result for all safety-relevant functions.

External safety measures

External safety measures are required in the following cases:

- In the event of incorrect parameterization of the servo drive, which can lead to switch-off, for example because the current controller is too sluggish or oscillates
- For loads that cannot be braked by the AX8000 servo drive because the AX8000 servo drive is under-dimensioned
- When executing the safety function STO
- The STO error reaction is executed if the TwinSAFE drive option card determines an error
- Line interruptions leading to switch-off
- Faults and interruptions in the EtherCAT communication leading to switch-off
- Activation or restart of a project in TwinCAT, which can lead to switch-off
- Downloading the safety project to the TwinSAFE logic or the AX8911 leading to switch-off

As a result, the motors are not braked, but switched torque-free. This leads to the motors coasting to a halt. The duration of this coasting depends on how much kinetic energy is present in the system. With suspended or pulling loads the motors may also accelerate.

To prevent this, observe the following measures:

- Provide appropriate external safety measures, such as mechanical service brakes.
- Avoid incorrect parameterization or dimensioning of the servo drive.
- Avoid line interruptions as well as faults and interruptions in the EtherCAT communication.

Caution: possible motor movements

Even if STO is triggered with interrupted PWM control, a jerky movement (with a maximum of 180° per pole pair) on the motor can occur, for example due to faults in the power circuit.

Consider this in your risk and hazard analysis.

2.2.2 During operation

Caution - Risk of injury!

Basically, electronic devices are not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a voltage outage in the overall system.

Impairment due to interference emissions

Do not operate the following devices in the vicinity of the overall system: mobile phones, radio equipment, transmitters or high-frequency systems.

The overall system with integrated TwinSAFE drive option card complies with the requirements of the applicable standards for electromagnetic compatibility with regard to interference emission and immunity. If you exceed the limits for interference emissions specified in the standards, the function of the TwinSAFE drive option card may be impaired.

2.2.3 After operation

De-energize and switch off the overall system before working on it

Check all safety-relevant equipment for functionality before working on the overall system. Secure the working environment. Secure the machine or plant against being inadvertently started up.

3 System description

The AX8000 multi-axis servo system allows you to set up multi-channel drive solutions. The AX8911 TwinSAFE drive option card is permanently installed in the servo system and enables you to define the safety functions by application. The servo drive forms the overall system. The of the servo drive determines whether it is a servo drive with STO or Safe Motion. In the delivery state, a factory setting project with the safety function STO according to EN 61800-5-2 is integrated as an example. For further information, please refer to the chapter Factory setting project [▶ 34].

eXtreme Fast Control in the drive

The EtherCAT-based AX8000 multi-axis servo system combines powerful FPGA technology with multi-core ARM processors. The new multi-channel current control technology makes extremely short sampling and reaction times possible. The fully hardware-implemented current controller combines the advantages of analog and digital control technology: setpoint deviations of the current can be reacted to within 1 µs, the speed controller cycle time is 16 µs at a switching frequency of 32 kHz. The processing of the EtherCAT process data (actual and setpoint values) can take place without a processor almost without delay in the hardware, so that the minimum EtherCAT cycle time is only 62.5 µs.

One Cable Technology (OCT)

The AX8000 multi-axis servo system supports OCT, the one-cable solution for power and feedback. In connection with the servomotors from the AM8000 (standard), AM8500 (increased inertia) and AM8800 (stainless steel) series, the wiring is reduced to the obligatory motor cable, via which the feedback signals are then also directly transmitted. As in sensorless control, the user no longer has to use an additional feedback line. All the information required for control purposes is transferred reliably and interference-free via a digital interface.

4 Product overview

4.1 Product description

AX8911 – TwinSAFE card for servo drives of the AX8xxx series

The AX8911 TwinSAFE drive option card is an optional extension of the Beckhoff AX8xxx servo drive series, in which it is permanently installed. The card enables you to define the safety functions by application. The type key of the servo drive determines whether it is a servo drive with STO or Safe Motion. In the delivery state, a factory setting project with the safety function STO according to EN 61800-5-2 is integrated as an example. For further information, please refer to the chapter Factory setting project [▶ 34].

The variant in the AX8xxx-x2xx axis modules provides additional parameters and functionalities to implement more complex Safe Motion functions, such as SLS (Safe Limited Speed).

You have the option to implement Safe Motion functions with higher requirements regarding the safety level, for example by using another encoder system or an encoder with a higher safety level.

⚠ CAUTION

Higher Performance Level for Safe Motion functions

The machine manufacturer or user is solely responsible for the execution and evaluation of the measures to attain a higher Performance Level, for example with the aid of an integrated encoder.

⚠ WARNING

Digital inputs and FailSafe over EtherCAT

If you use the FSoE connection for accessing the TwinSAFE drive option card and additionally the digital inputs of the AX8000 on X15 or X25 during the commissioning of the axis, make sure that the wiring to the digital inputs is removed after the commissioning of the axis.

If you do not remove the commissioning bypass, the safety application will not take effect.

If the STO function integrated in the factory state does not suit your use case, you have the option of creating application-specific projects and loading them onto the TwinSAFE drive option card. Further information can be found in chapter Creating a project with the Safe Motion Wizard [▶ 37].

The entire parameterization of the TwinSAFE drive option card is carried out in the same way as the programming and configuration of a safety application in the TE9000 - TwinCAT 3 Safety Editor. For the exchange of the TwinSAFE drive option card you have the possibility to use the Backup&Restore function known from the EL69x0. Further information on this can be found in the EL6910 user documentation. See document [3] at References [▶ 8].

4.2 Type key

AX8 x yz – a b c d – e f g h	Explanation
AX	Product area Servo drive
8	Series AX8000
x	Axis module 1 = 1-channel axis module 2 = 2-channel axis module Supply and axis module 5
yz, a	Variant coding
b	Safety function 0 = No safety function 1 = Safety functions STO, SS1 2 = TwinSAFE Safe Motion functions
c-h	Variant coding

Depending on the order identifier in the type key, the following safety functions according to EN 61800-5-2 can be implemented with the corresponding AX8000 variant.

Order identifier	Safety functions			
AX8xxx-x**2**xx	**Stop functions**			
	STO	Safe torque off		
	SOS	Safe operating stop		
	SS1	Safe stop 1	- t	Time controlled
			- r	Ramp monitored
	SS2	Safe stop 2		
	Speed functions			
	SLS	Safely limited speed		
	SSM	Safe speed monitor		
	SSR	Safe speed range		
	SMS	Safe maximum speed		
	Position functions			
	SLP	Safely limited position		
	SCA	Safe cam		
	SLI	Safely limited increment		
	Acceleration functions			
	SAR	Safe acceleration range		
	SMA	Safe maximum acceleration		
	Direction of rotation functions			
	SDIp	Safe direction positive		
	SDIn	Safe direction negative		
	Brake functions			
	SBC	Safe brake control		
	SBT	Safe brake test		

4.3 Intended use

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

The TwinSAFE drive option card is designed for machine safety functions and directly associated industrial automation tasks. The TwinSAFE drive option cards are used to switch the overall system torque-free in hazardous situations.

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

Observe the intended use of the overall system according to document [2] at References [▶ 8].

⚠ WARNING

Improper use

Any use which exceeds the permissible written values from the chapter Technical data [▶ 20] or which does not observe other specifications from these operating instructions or other documents of the overall documentation is considered to be not in accordance with the intended use and is therefore prohibited.

This applies in particular to the use cases defined by Beckhoff Automation, which have been fully tested and certified and whose properties and operating conditions can be guaranteed. Use cases beyond this are regarded as inappropriate and require the approval of Beckhoff Automation.

Improper use will result in loss of safety and invalidation of certifications and approval.

5 Technical data

5.1 Product data

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

Software data		Explanation
Response times		
• Internal fault reaction time in the factory setting	approx. 1 ms	Via hardware inputs or FSoE
• Cycle time	1 ms according to project size maximum: see fault reaction time	The internal cycle time is the runtime of the logic task plus the time difference until it is called again.
• Fault reaction time	Adjustable ≤ watchdog time	
• Watchdog time	2 ms to 60000 ms	
Process image		
• Input	6 to 51 bytes (1 to 24 bytes Safe Data)	For more information, see the chapter Local process image [▶ 54].
• Output	6 to 59 bytes (1 to 28 bytes Safe Data)	

Other product data		Explanation
• Supply voltage	24 V_{DC} (+ 20 % / - 15 %)	
• Number of inputs	2 digital inputs per axis	
• Number of switch-off channels	4 channels per axis	
• Status display	"S" display on the AX8000	See document [2] at References [▶ 8].
• Safety-related accuracy for OCT Safety (SICK)	0.439°	Safety-related accuracy is specified in the SICK encoder documentation. Deviating from this, 4 increments are configured in the TwinSAFE drive option card.

5.2 Target failure measures

Calculation of the $MTTF_D$ value from the PFH_D value

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

- TwinSAFE Application Guide
- EN ISO 13849-1:2015; table K.1.

5.2.1 STO + SS1-t

FSoE communication with 1 % of SIL 3 in accordance with the protocol specification and the use of the 2 safe local inputs are taken into account in the target failure measures.

Safety parameters		Explanation
Lifetime	20 a	
Proof test interval	/	Special proof tests are not required during the entire service life of the TwinSAFE drive option card.
PFH_D	4.7E-9	
PFD_{avg}	2.2E-4	
$MTTF_D$	high	
DC	high, 99.4%	
SFF	>99%	
SIL	3	According to IEC 61508:2010.
Performance Level	e	According to EN ISO 13849-1:2015.
CAT	4	According to EN ISO 13849-1:2015.
HFT	1	
Element classification	Type B	According to EN 61508-2:2010.

For further information, please refer to the chapter Lifetime.

5.2.2 Safe Motion functions with integrated encoder

The following target failure measures apply to the encoders listed in chapter Encoder application [▶ 33].

FSoE communication with 1 % of SIL 3 in accordance with the protocol specification and the use of the 2 safe local inputs are taken into account in the target failure measures.

Target failure measures		Explanation
Lifetime	20 a	
Proof test interval	/	Special proof tests are not required during the entire service life of the TwinSAFE drive option card.
PFH_D	3.70E-07 (SIL 2) [1] [3]	
$MTTF_D$	Medium, 17.5y	
DC	Medium, 94.32%	
SIL	2 [2]	According to IEC 61508:2010.
Performance Level	d	According to EN ISO 13849-1:2015.
CAT	3	According to EN ISO 13849-1:2015.
Basis for safety functions	Safe single-turn absolute position	
Safety-related resolution	13-bit	
Safety-related accuracy [3]	0.045°	
HFT	1	
Element classification	Type B	According to EN 61508-2:2010.

[1] *These data are related to a max. ambient temperature of 115 °C.*
The PFH_D value is determined in accordance with the approximation formula from the manufacturer's data for MTTFD and DC (see Application Guide).

[2] *With additional measures, SIL 3 / PL e category 4 is possible with an EnDat 3 encoder. See chapter "*AdvPosMon with integrated EnDat 3 encoder*" of document [5] at* References [▶ 8].

[3] *The safety-related accuracy indicates the maximum position error limit with which the safety functions can be supported.*

For further information, please refer to the chapter Lifetime [▶ 27].

5.2.3 SBC

⚠ WARNING

Target failure measures limited

The PL e, Cat 4 / SIL 3 classification for SBC is limited to the TwinSAFE drive option card and ends at the connection points of the brake.

For further information, please refer to the chapter Brake control [▶ 24].

FSoE communication with 1 % of SIL 3 in accordance with the protocol specification and the use of the 2 safe local inputs and 4 STO switch-off channels are taken into account in the target failure measures.

Target failure measures		Explanation
Lifetime	20	
Proof test interval	/	Special proof tests are not required during the entire service life of the TwinSAFE drive option card.
PFH_D	5.6E-9	
PFD_{avg}	2.7E-4	
$MTTF_D$	high	
DC	high, 99.5%	
SFF	>99%	
SIL	3	According to IEC 61508:2010.
Performance Level	e	According to EN ISO 13849-1:2015.
CAT	4	According to EN ISO 13849-1:2015.
HFT	1	
Element classification	Type B	According to EN 61508-2:2010.

For further information, please refer to the chapter Lifetime [▶ 27].

5.2.4 TwinSAFE Safe Motion functions with external encoder

FSoE communication with 1 % of SIL 3 in accordance with the protocol specification and the use of the 2 safe local inputs are taken into account in the target failure measures.

Target failure measures		Explanation
Lifetime	20 a	
Proof test interval	Not necessary in High Demand mode. Proof tests within the service life are necessary in Low Demand mode.[1]	
PFH_D	4.8E-9	
PFD_{avg}	2.2E-4	
$MTTF_D$	high	
DC	high, 99.4%	
SFF	>99%	
SIL	3	According to IEC 61508:2010.
Performance Level	e	According to EN ISO 13849-1:2015.
CAT	4	According to EN ISO 13849-1:2015.
HFT	1	
Element classification	Type B	According to EN 61508-2:2010.

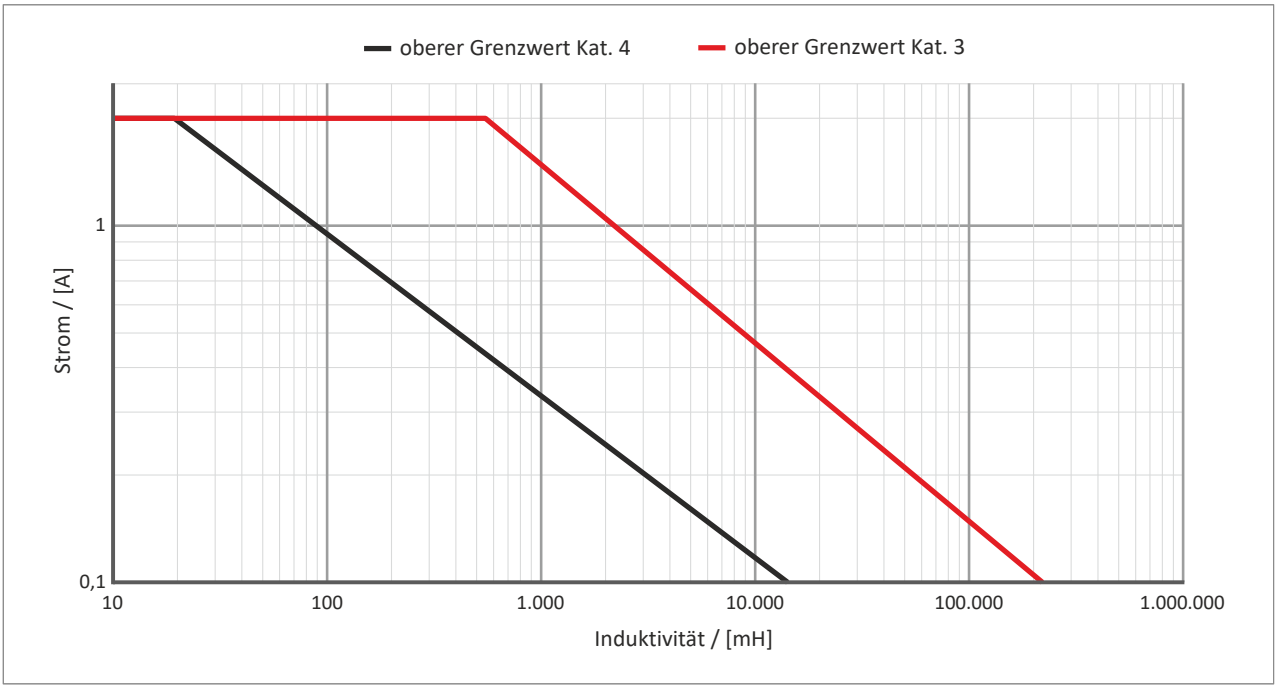
[1] *The proof tests in Low Demand mode must be executed according to the key figure (results in approx. 1 year).*

For further information, please refer to the chapter Lifetime [▶ 27].

5.2.5 Brake control

The inductive energy stored in the connected released brake has an influence on the category achievable for the safety function SBC according to DIN EN ISO 13849.

The following diagram shows the limit values of the permissible braking parameters current and inductance for AX8000. Using these parameters, you can draw the brake used in the diagram and see whether the SBC safety function meets the requirements of Cat. 3 or Cat. 4.



5.3 Environmental conditions

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

⚠ WARNING

Do not use TwinSAFE drive option cards under the following operating conditions:

- under the influence of ionizing radiation (exceeding the natural background radiation)
- in corrosive environments[1]
- in an environment that would lead to impermissible contamination of the TwinSAFE drive option card

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

The environmental conditions of this TwinSAFE drive option card are defined by its installation in the overall system. For the conditions, refer to the "Data for operation and environment" in document [2] at References [▶ 8].

5.4 AX8911 project design limits

Project design limits

The maximum project design size of the AX8911 is limited by the available memory. This is managed dynamically. The values specified in the following table are therefore only guide values and may differ from the actual values, depending on the safety project.

TwinSAFE connections	max. 8 (up to 12 CRCs in total; 1 CRC is required for a TwinSAFE connection with 1 or 2 byte safe data.)
Safe data per TwinSAFE connection	maximum 24 byte (telegram length 51 byte)
TwinSAFE blocks	maximum 512 (ESTOP with complete input and output mapping)
TwinSAFE groups	max. 128
TwinSAFE user	40 max.
Standard PLC inputs	dynamic (memory-dependent), max. 54 byte
Standard PLC outputs	dynamic (memory-dependent), max. 62 byte

5.5 Error reaction

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

Depending on the severity of the cause of the error, the TwinSAFE drive option card changes to one of the following error states:

- Global Shutdown
- Global Fault
- Module Shutdown

5.5.1 Global Shutdown

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

This operating state is a safe state and temporarily shuts down the TwinSAFE drive option card.

Reset the operating state by disconnecting and reconnecting the 24 V supply to the overall system.

5.5.2 Global Fault

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

This operating state permanently shuts down the TwinSAFE component.

Replace the overall system.

5.5.3 Module Shutdown

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

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

An Error Acknowledge resets the operating state.

5.6 Lifetime

The TwinSAFE drive option card has a lifetime of 20 years, during which the target failure measures are guaranteed. For more information, see the chapter Target failure measures [▶ 21].

The lifetime starts from the date of manufacture according to the name plate of the overall system. For more information, see document [2] at References [▶ 8].

⚠ WARNING

Replace overall system after 20 years

After a lifetime of 20 years, the target failure measures are no longer guaranteed.

Use beyond the lifetime may result in loss of safety.

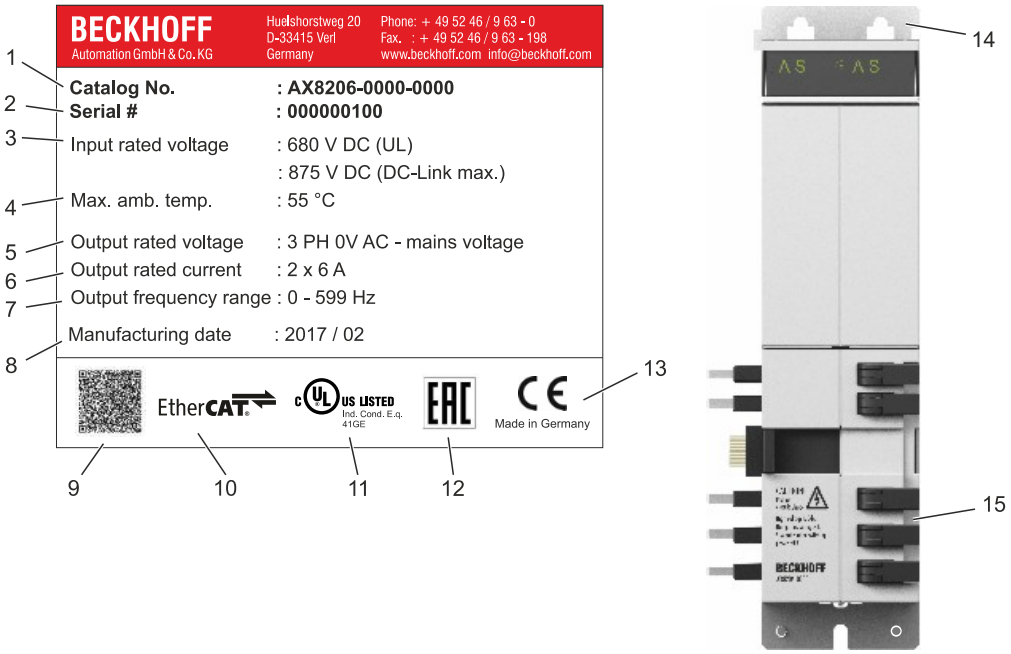
In High Demand mode, special proof tests are not necessary due to the high diagnostic coverage within the life cycle. For information on Low Demand mode, refer to the chapter TwinSAFE Safe Motion functions with external encoder [▶ 23].

The internal TwinSAFE drive option card has a unique serial number that you can read out via CoE.

The date of manufacture and the serial number of the complete device can be found on the name plate of the axis module. See the chapter Name plate [▶ 28] and document [2] at References [▶ 8].

5.6.1 Name plate

The following figure shows an example of the structure and positioning of the name plate using the AX variant AX8206 as an example. For further name plates and positioning, refer to document [2] at References [▶ 8].



No.	Position	No.	Position	No.	Position
1	Order number	6	Nominal output current	11	cULus certification
2	Serial number	7	Output frequency range	12	EAC approval
3	Nominal input voltage	8	Date of manufacture	13	CE conformity
4	Max. ambient temperature	9	QR code	14	Serial number sticker
5	Nominal output voltage	10	EtherCAT conformity	15	Attachment of the name plate

6 Mechanical installation

The TwinSAFE drive option card is permanently installed in the overall system. Subsequent installation or exchange of the card by the user is not possible.

For information on the mechanical installation of the overall system, refer to document [2] at References [▶ 8].

6.1 Control cabinet / terminal box

The TwinSAFE components must be installed for operation in a control cabinet or terminal box with at least protection rating IP54 according to IEC 60529.

7 Electrical installation

For information on the electrical installation of the overall system, refer to document [2] at References [▶ 8].

7.1 Digital inputs

The TwinSAFE drive option card has 2 digital inputs:

- X15 of axis A for 1-channel and 2-channel axis modules
- X25 of axis B for 2-channel axis modules

These are used in the factory setting project.

X15

Contacts 1 and 2 of port X15 are the STO inputs in the factory setting project.
The following applies:

- If both signals are logic 1 (wired with 24 V_{DC}), you can move the axis A.
- If one of the signals is logic 0, STO for axis A is triggered. Axis A is switched torque-free.

X25

Contacts 1 and 2 of the connection X25 are the STO inputs for axis B.
The following applies:

- If both signals are logic 1 (wired with 24 V_{DC}), you can move axis B.
- If one of the signals is logic 0, STO for axis B is triggered. Axis B is switched torque-free.

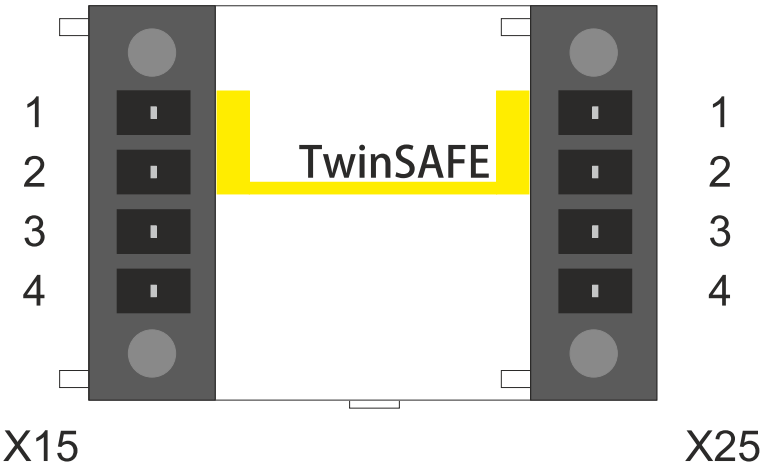


Fig. 1: AX8911: Connection to X15 and X25

7.2 Connection technology

A connector is required in each case to connect signals to X15 and, in the case of 2-channel axis modules, to X25 also.

View	Terminal point	Connection	Strip length	Clamping method
	1	Safe input 1	9 mm	push in
	2	Safe input 2		
	3	Digital input 3 (filter time 8 µs)		
	4	Digital input 4 (filter time 8 µs)		

NOTICE

Wiring

When using the STO safety function via the safe inputs on X15 and X25, use wires with ferrules with plastic collars.

Wire type	Wire cross-section
Wire cross-section – stranded wire (with ferrule **with** plastic collar)	0.25 mm² - 1 mm²

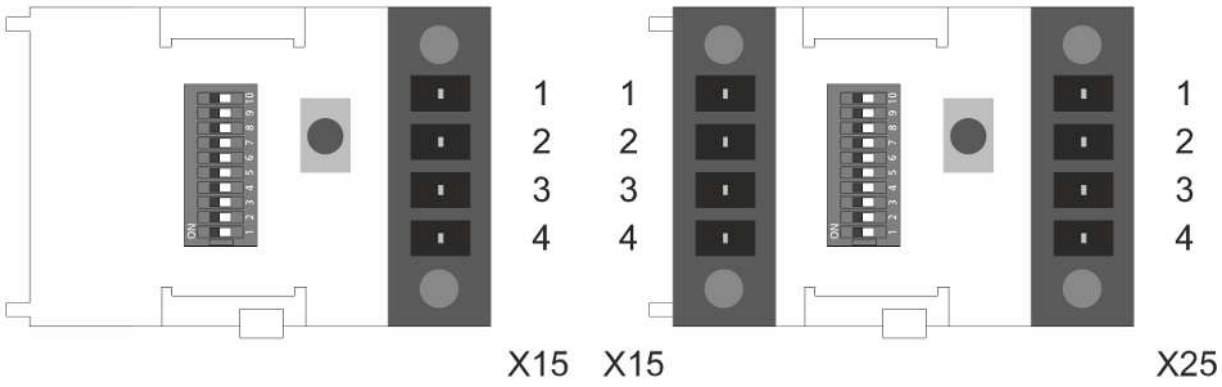
For further information on wiring, please refer to the chapter Using the STO inputs with a third-party safety controller [▶ 65].

7.3 Address setting

If you use a TwinSAFE connection instead of the digital inputs to implement the safety functions, you must set a safety address on the axis module.

This setting is made with the integrated DIP switch on the AX8000 axis module, which is located under the cover between inputs X15 and X25 or to the left of input X15 on single-axis modules.

AX81xx-xxxx single-axis module **AX82xx-xxxx two-axis module**



⚠ WARNING

Use TwinSAFE address only once

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

The address 0 is not a valid TwinSAFE address.

Failure to observe this may result in malfunctions.

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

8 TwinSAFE Safe Motion functionality

8.1 Encoder application

Encoder type	Manufacturer	Protocol	Resolution	Reduced CRC
Beckhoff OCT SingleTurn (EDS35)	Sick	OCT (Hiperface DSL)	24-bit	0xD3E0
Beckhoff OCT MultiTurn (EDM35)	Sick	OCT (Hiperface DSL)	24-bit	0xDF54
AMO LMKA 3010	AMO	EnDat 2.2		Not available
Heidenhain LC415	Heidenhain	EnDat 2.2		

The following table shows the possible combinations when using multiple encoders.

Combination option (applies to both axes)	OCT	EnDat 2.2	EnDat 3
A	Connection A Axis A/B	Connection B Axis A/B	/
B1	Connection A Axis A	/	Connection A Axis B
B2	Connection A Axis B	/	Connection A Axis A
C	/	Connection B Axis A/B	Connection A Axis A/B

9 Factory setting project

⚠ WARNING

Setup of a restart lock

Set up a restart lock in the higher-level safety controller.
Alternatively, you have the option of setting up a restart lock by changing the safety-related program on the TwinSAFE drive option card.

An uncontrolled restart of the servo system can lead to serious injuries.

Adaptation of OSSD signals to X15 and X25

Adjust the length of the test pulses by changing the safety-related program on the TwinSAFE drive option card. The test pulses must not exceed a length of 3.5 ms.

Longer test pulses can lead to triggering of the STO. The malfunction may compromise safety.

Prevention of cross-circuits and external power supply

The higher-level safety controller is responsible for checking the wiring between the safety controller and the safe inputs X15 and X25 of the TwinSAFE drive option card. The necessary tests and checks arise from the risk and hazard analysis carried out by the machine manufacturer. Perform the necessary checks.

Failure to observe this may result in a malfunction of the TwinSAFE drive option card.

NOTICE

Testing the X15 and X25 inputs

The TwinSAFE drive option card internally checks the safe inputs 1 and 2 of ports X15 and X25 for their function. The external test pulses for detecting cross-circuits or an external power supply serve only to check the correct wiring between the safety controller and the TwinSAFE drive option card.

9.1 Description

The overall system with integrated safety technology cannot be operated without safety. The overall system with integrated safety technology is supplied with a factory setting project as an example, which enables simple commissioning.

By using the factory setting project, you have the option of triggering the STO safety function via FSoE.

9.2 Error reaction

- Errors in the FSoE slave connection are automatically acknowledged on the slave side (AX8911), since acknowledgment by the user takes place on the FSoE master side (TwinSAFE logic).
- The following applies to all other errors:
  Error messages and associated acknowledgements are implemented on the AX8911 TwinSAFE drive option card via the status and control word of the AX8000.
  The ErrAck for errors on the AX8911 is realized via the DS402 control word (bit 7) together with the reset of the axis via TwinCAT 3. If an error occurs on the AX8911, a diag message is generated and the error bit in the DS402 status word (bit 3) is set.

9.3 Factory state process image in the I/O tree

Process image valid for the factory setting project

Note that the process image depends on the active project and the implemented safety functions. The process image listed in this document applies exclusively to the factory setting project. For customer-specific projects, the process image may differ from the process image shown here. For further information on customer-specific projects, please refer to the chapter Configuration in TwinCAT [▶ 42].

Input

The process image of the input signals consists of 7 bytes of data, 2 bytes of which are usage data.

Offset	Name	Data type	Group	Description
0.0	ChA_STO	BOOL	Safety	**True:** No STO, STO outputs are enabled **False:** STO, safe state

Output

The process image of the output signals consists of 7 bytes of data, 2 bytes of which are usage data.

Offset	Name	Data type	Group	Description
0.0	STO_active_ChA	BOOL	Safety	State of the signal reported to the Drive Application (standard firmware) **True:** No STO, STO outputs are enabled **False:** STO, safe state

9.4 Factory setting STO in the TwinSAFE drive option card

⚠ WARNING

STO switch-off paths

There are 4 STO switch-off paths per axis within the logic. These are the STO outputs "STO_1" to "STO_4". If you replace the safety logic on the TwinSAFE drive option card with a user-specific project, you must set all 4 switch-off paths per axis.

In addition, the signal must be reported back to the servo system via the "no_STO_to_Drive" output.

A safety-oriented logic program is stored on the TwinSAFE drive option card in the delivery state.

You have 2 different possibilities to activate the STO function:

Possibility 1	Activation via the hardware inputs on X15 and X25
The input signals are filtered and checked for discrepancy. External test pulses up to a length of 3.5 ms are supported. A logic TRUE of both signals allows movement of the axis. The discrepancy time for the two input signals is set to 1000 ms. If the two signals are different for a lengthy time, an error is signaled and a diagnostic message output.	

Possibility 2	Activation via a Safety over EtherCAT connection
This connection contains the STO signals for axis A and axis B. For the STO signal a logic TRUE signal is required so that movement of the axis is possible. The safety address for this connection is set with the DIP switch of the servo system axis module.	

The outputs of the two TwinSAFE groups are logically ORed and then placed on the 4 STO channels. The TwinSAFE groups are implemented equivalently in the factory setting project. So if a group provides an information that the axis may be moved, then this is sufficient.

NOTICE

Hardware inputs and FSoE signals

Hardware inputs and signals via the FSoE connection are equivalent. If one of the two supplies the enable signal to move the axis, the axis can be moved.
If this does not match your desired functionality, you have the option of replacing the safety-oriented program on the TwinSAFE drive option card with a program suitable for the use case.

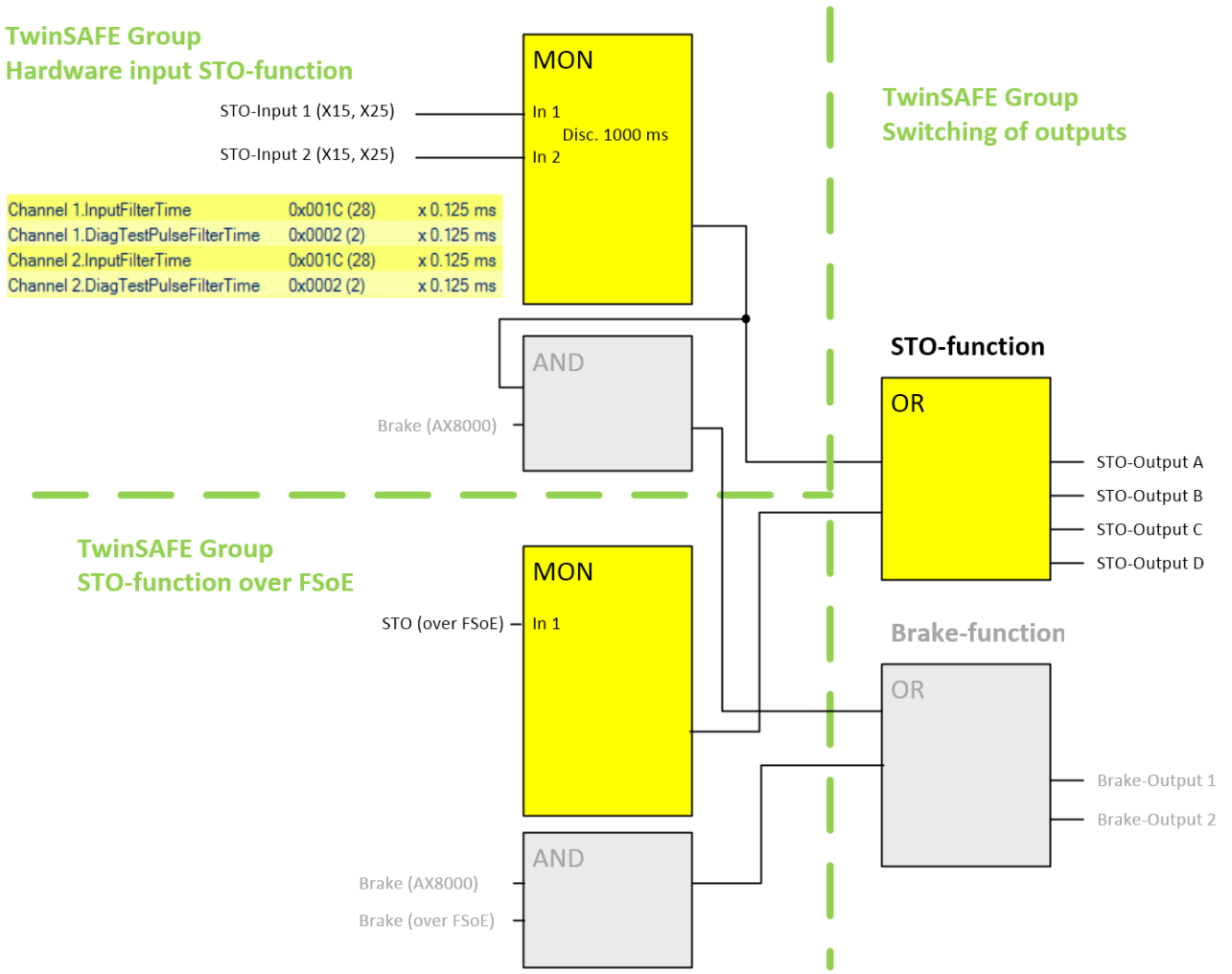


Fig. 2: AX8911 TwinSAFE logic program in factory setting

NOTICE

Brake control

In the delivery state, the brake is only controlled via the servo system according to the parameterization in the TwinCAT 3 Drive Manager 2. The brake output is generally enabled in the firmware of the TwinSAFE drive option card. The TwinSAFE logic program shown above in factory setting is implemented accordingly on the TwinSAFE drive option card, but the outputs Brake output 1 and 2 currently have no effect. The Brake (over FSoE) signal does not exist in the TwinSAFE connection.

9.5 Creating a project with the Safe Motion Wizard

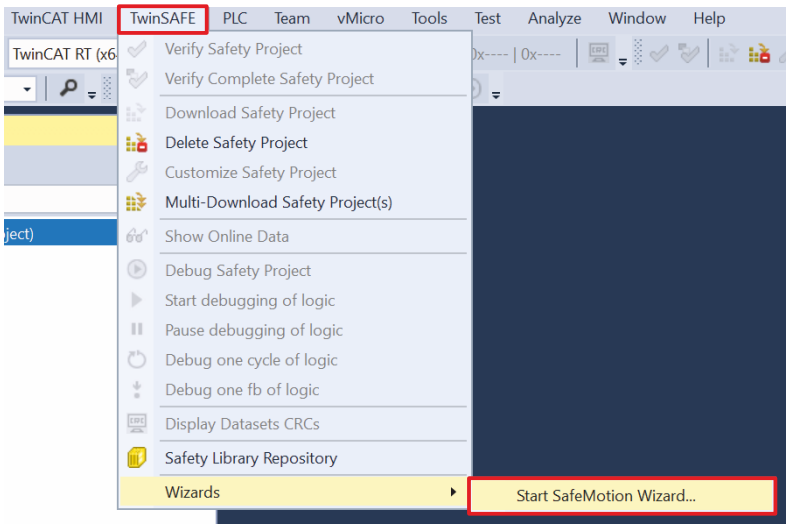
The Safe Motion Wizard is used to simplify the creation of safety projects for TwinSAFE Safe Motion functions, such as SLS or SS2.

You can use the wizard for existing axes in the I/O configuration or virtual axes. You can also use the wizard to create a connection to a master project.

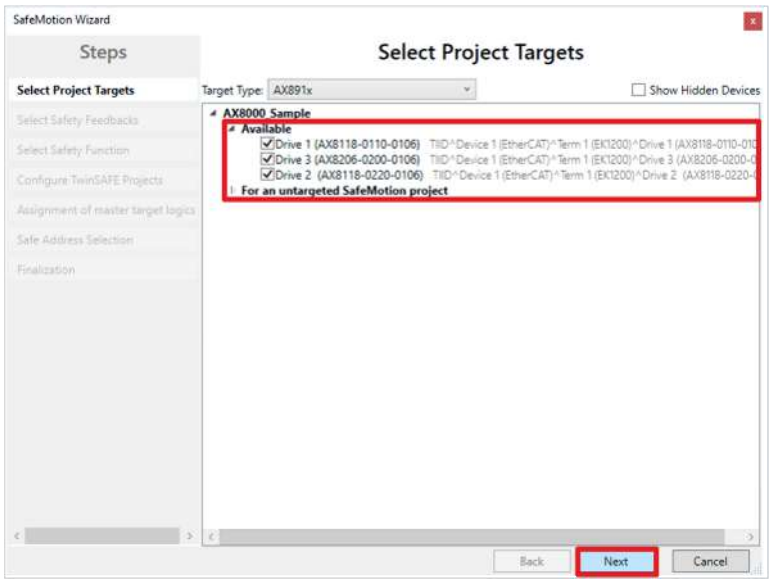
Example connection to a master project

For example, you can select the master project of an EL6910 terminal as the master project. This requires a solution with an I/O configuration and an EL6910 master safety project.

Proceed as follows:

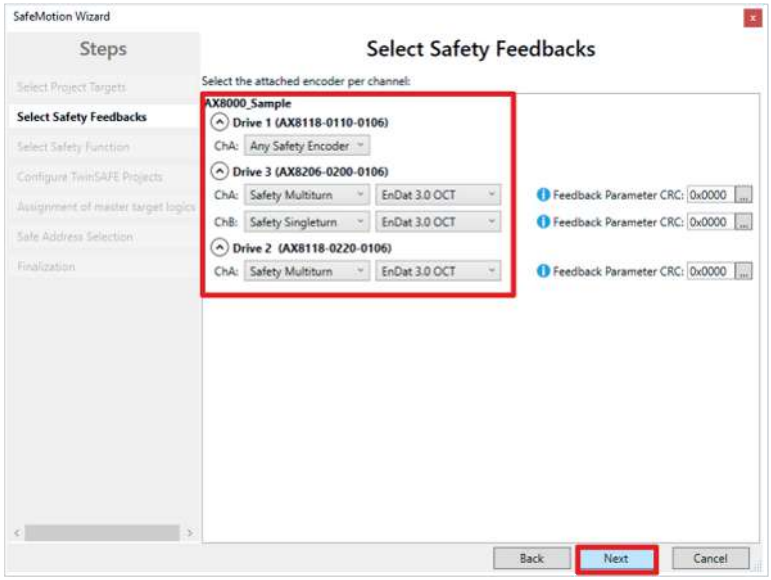


1. Select "TwinSAFE" in the menu bar
2. Select "Start SafeMotion Wizard" via the menu item "Wizards"

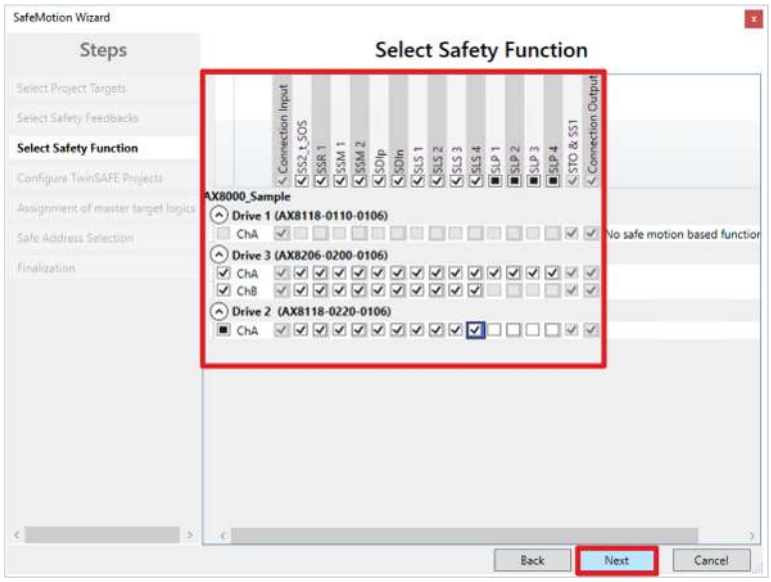


The "Select Project Targets" window shows the existing components and the virtual axes for single-axis and two-axis modules.

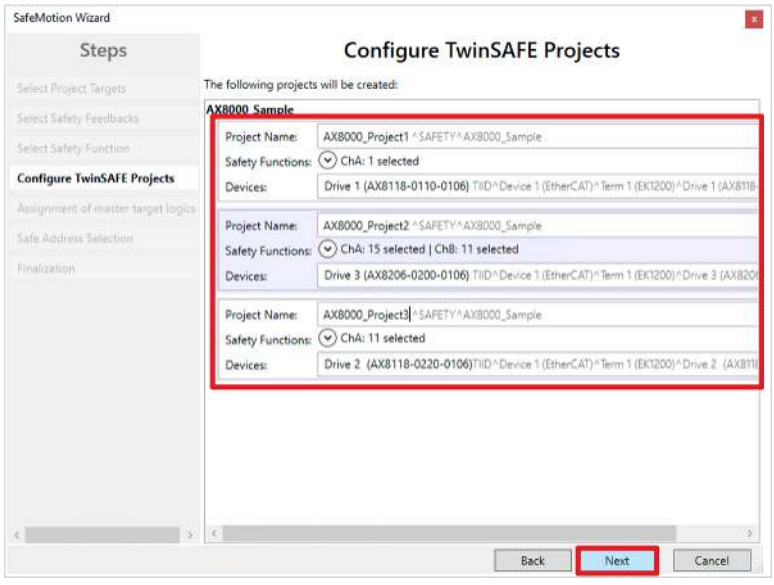
3. Select the desired components and axes
4. Confirm the selection with "Next"



5. Configure the feedback in the "Select Motors" window
6. Confirm configuration with "Next"

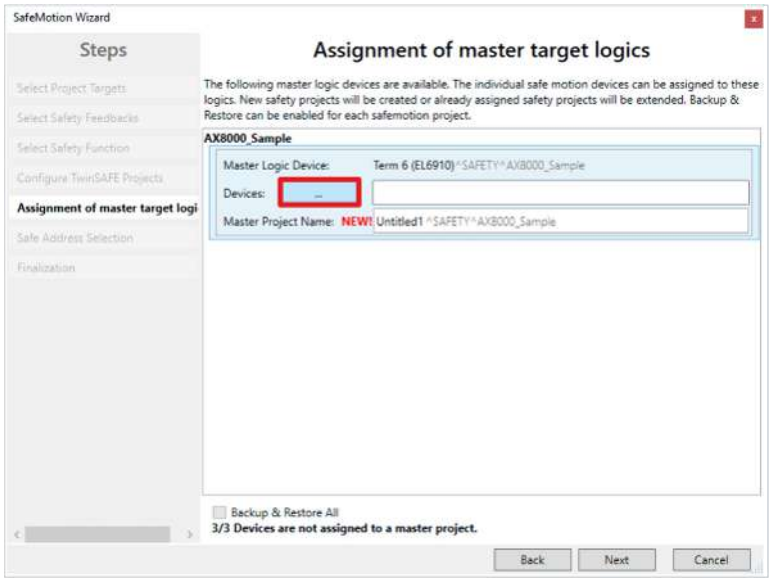


7. In the "Select Safety Function" window, select the safety functions of the axes
8. Confirm the selection with "Next"



The "Configure TwinSAFE Projects" window appears. The "Configure TwinSAFE Projects" window shows the safety projects that are generated. You can rename the safety projects here.

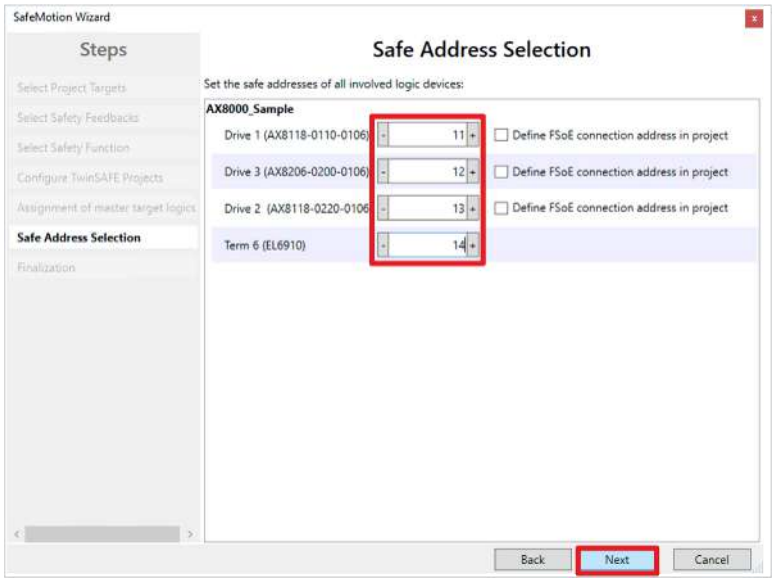
9. If desired, rename safety projects
10. Confirm the selection with "Next"



11. Set the master project in the "Assignment of master target logics" window

Either use an existing master project or generate a new one.

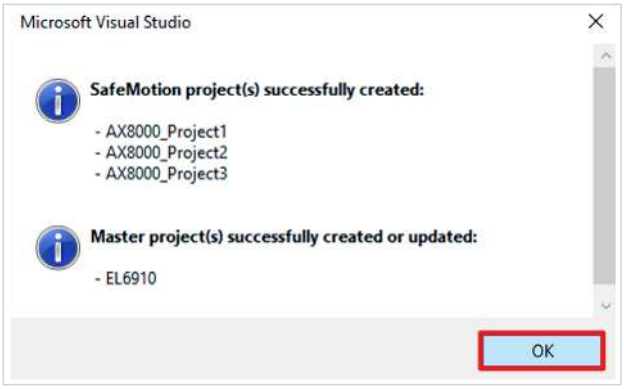
12. Confirm with "Next"



13. In the "Safe Address Selection" window, configure safe addresses of all participants

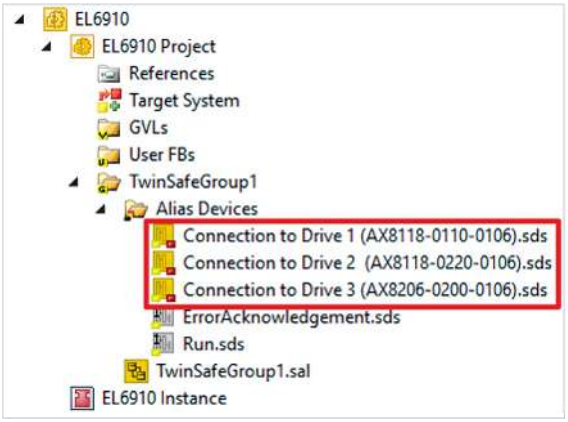
Alternatively, you can also configure the safe addresses within the safety project.

14. Confirm the settings with "Finish"



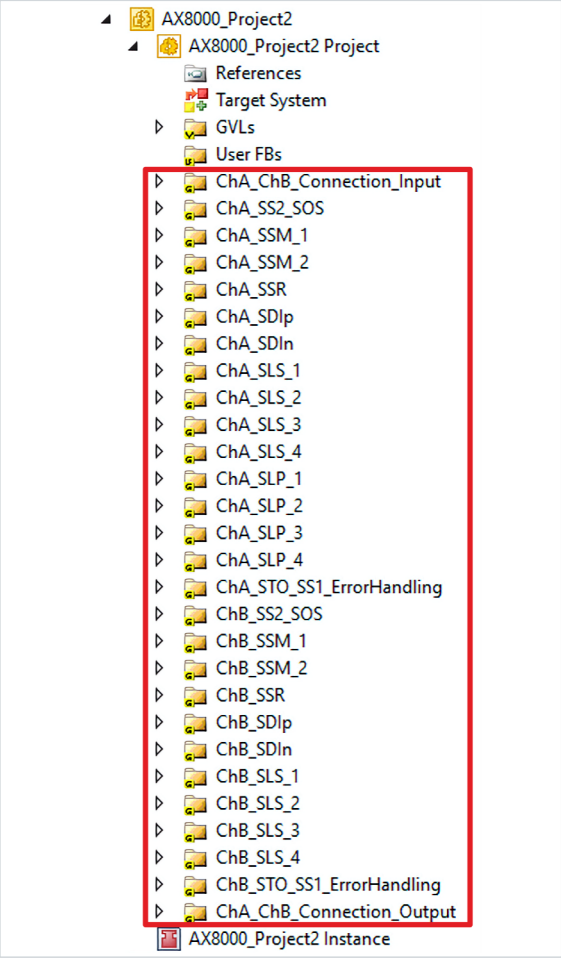
15. Confirm the window with "OK"

You have successfully generated the safety projects.

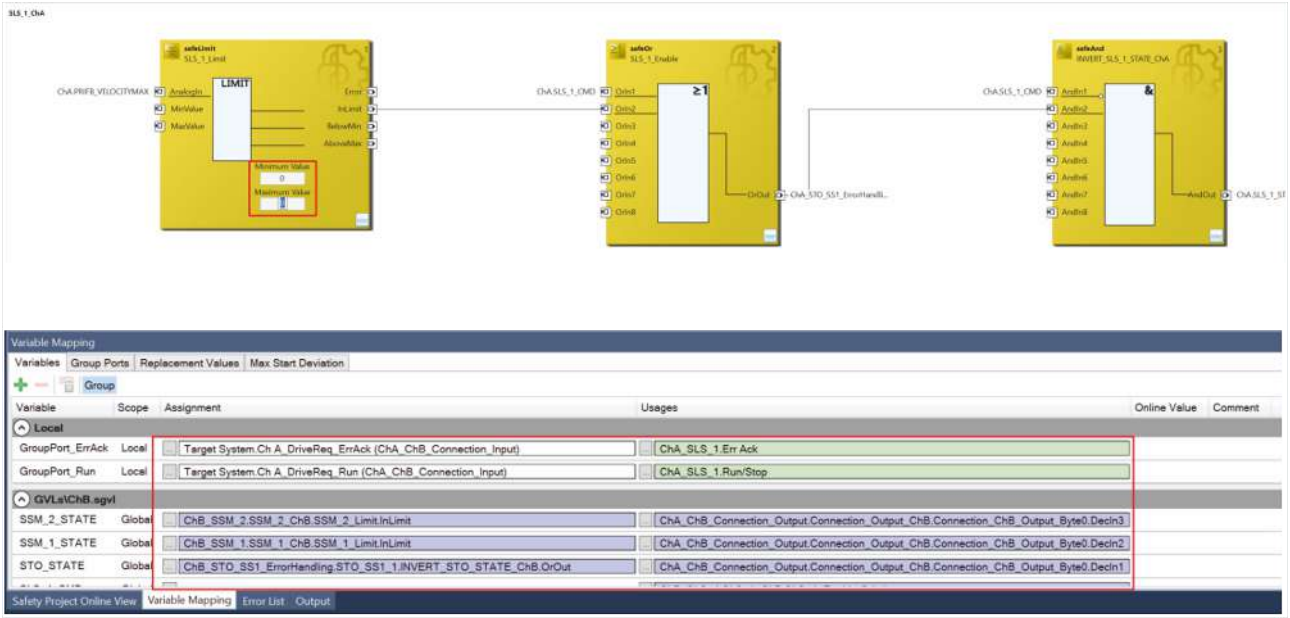


After this procedure you will receive a TC3-Solution with the corresponding safety projects for AX8000 and for example EL6910.

The master project contains the connections to the configured axes.



The AX8000 projects contain the safety functions selected in the wizard. Each safety function is implemented by a separate TwinSAFE group.



16. Set parameters according to the present requirements of the safety applications. Shown here using SLS as an example.

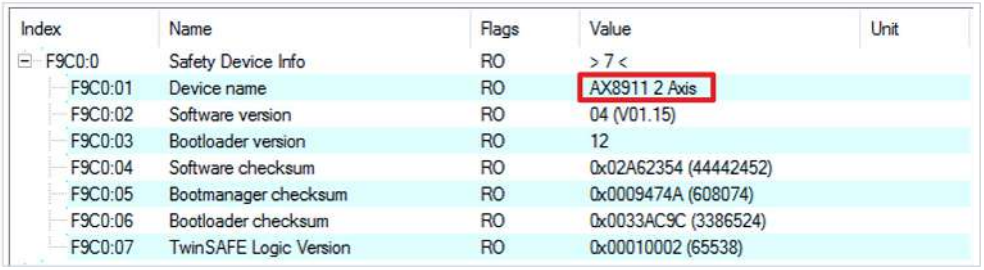
A detailed explanation of the TwinSAFE Safe Motion functions from the basic project can be found in document [7] at References [▶ 8].

10 Configuration in TwinCAT

10.1 Safety Device Info

Display of the number of axes

From firmware 03, inconsistencies may occur when displaying an AX8000 with one axis. A further explanation can be found in the following table under "1 Axis Drive".



Index	Name	Flags	Value	Unit
F9C0:0	Safety Device Info	RO	> 7 <	
F9C0:01	Device name	RO	AX8911 2 Axis	
F9C0:02	Software version	RO	04 (V01.15)	
F9C0:03	Bootloader version	RO	12	
F9C0:04	Software checksum	RO	0x02A62354 (44442452)	
F9C0:05	Bootmanager checksum	RO	0x0009474A (608074)	
F9C0:06	Bootloader checksum	RO	0x0033AC9C (3386524)	
F9C0:07	TwinSAFE Logic Version	RO	0x00010002 (65538)	

Fig. 3: AX8911 - Safety Device Info

Read out the safety device info via CoE of your safety device.

Index	Name	Explanation
0xF9C00:01	Device name	May include the following as of FW03 depending on the device: • **1 Axis Drive:** AX8911 a Axis (00b1-81xx) ◦ **a**: 1 or 2 ◦ **b**: SAFEMOTION (1), STO (0) ◦ **xx**: Size • **2 Axis Drive:** AX8911 2 Axis (00b2-82xx) ◦ **b**: SAFEMOTION (1), STO (0) ◦ **xx**: Size

10.2 Addition of an axis module

Adding an axis module is done in the same way as adding any other TwinSAFE component.

To add a TwinSAFE component, refer to the chapter Adding an EL6910 of document [3] at References [▶ 8].

10.3 Using the AX8911 with the factory setting project

For more information about this project, see the chapter Factory setting STO in the TwinSAFE drive option card [▶ 35].

To use the AX8911 in a safety project, proceed as follows:

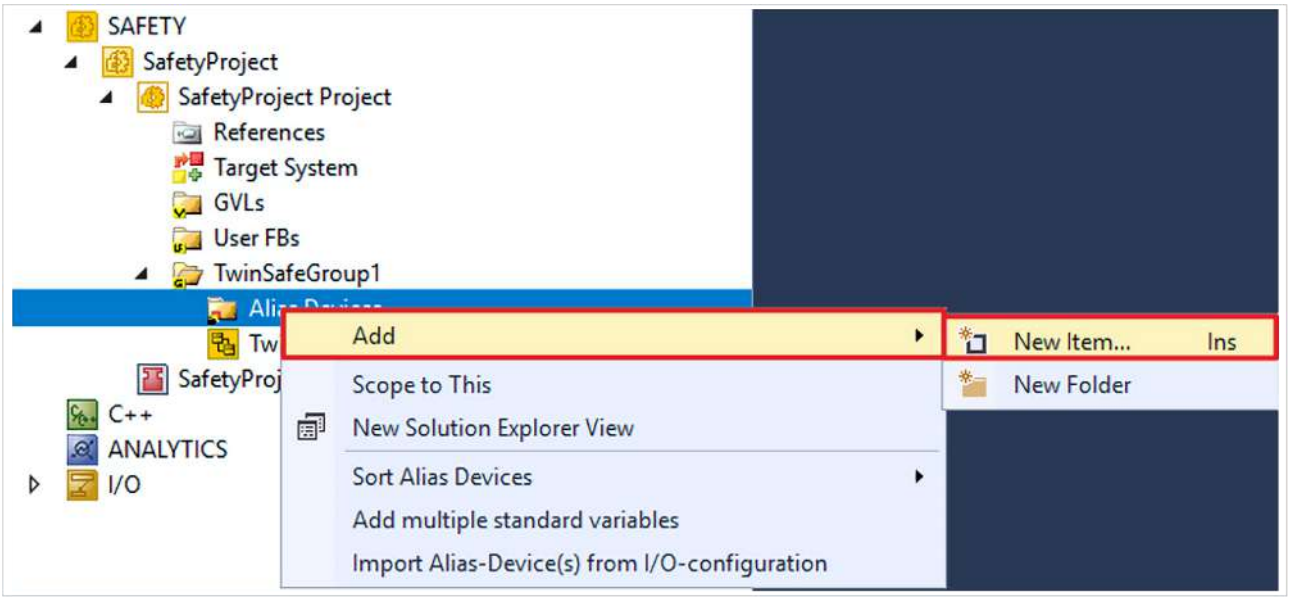


Fig. 4: Insertion of an *alias device*

1. Right-click on the Alias Device folder of your safety project
2. Select "New Item..." via the "Add" field

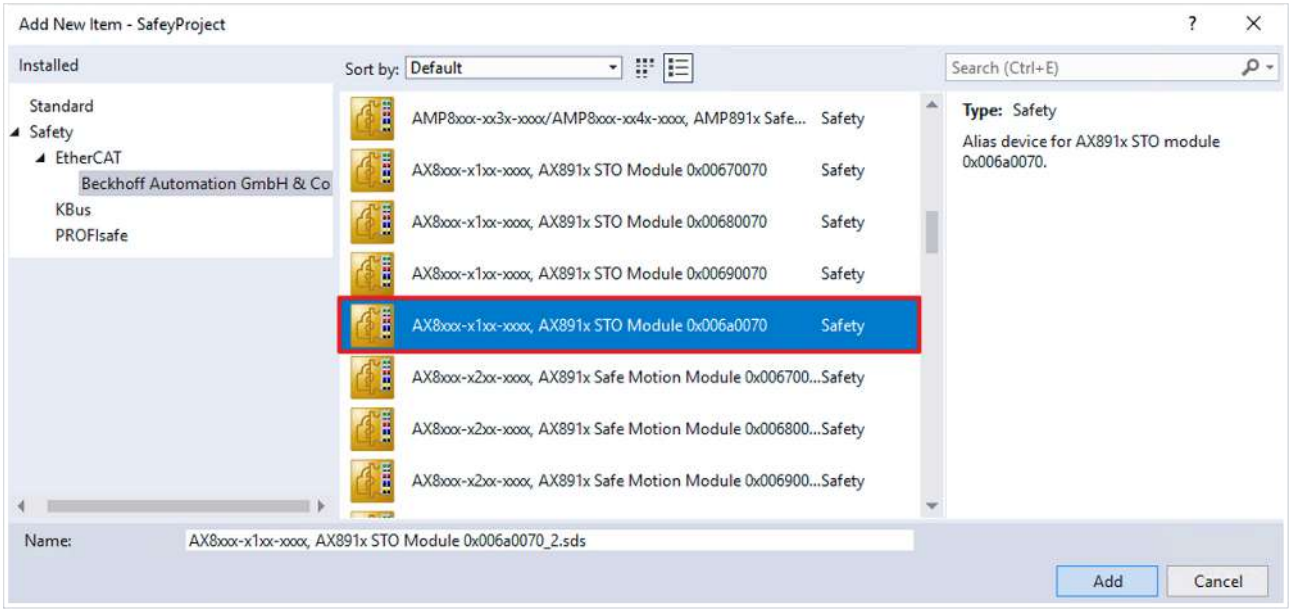


Fig. 5: Dialog *Add New Item* AX891x (Safe Drive Module)

The "Add New Item" window opens and you can select the desired Alias Device. In the name you will find the information about which AX8911 variant with the associated ModuleIdent it is.

You can use the STO signals as safe outputs in the safety-related user program.

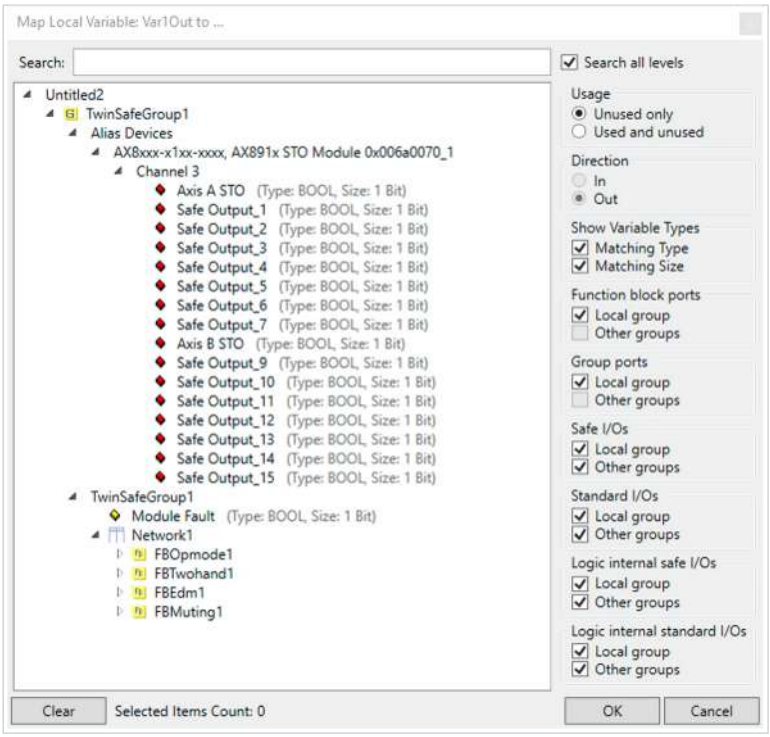


Fig. 6: Dialog for linking the variables of the AX8911

The variables are displayed with the corresponding designation in *Variable Mapping*.

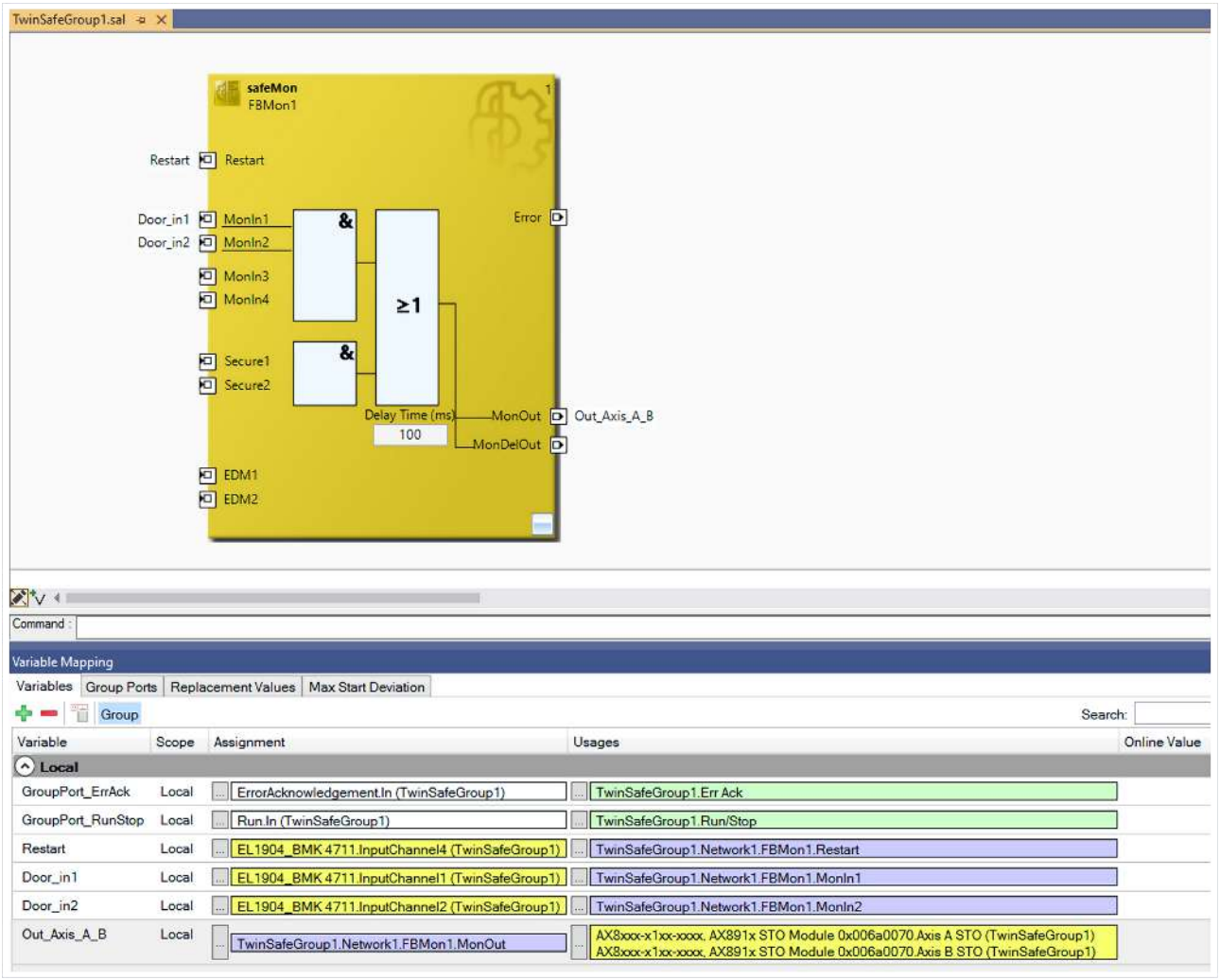


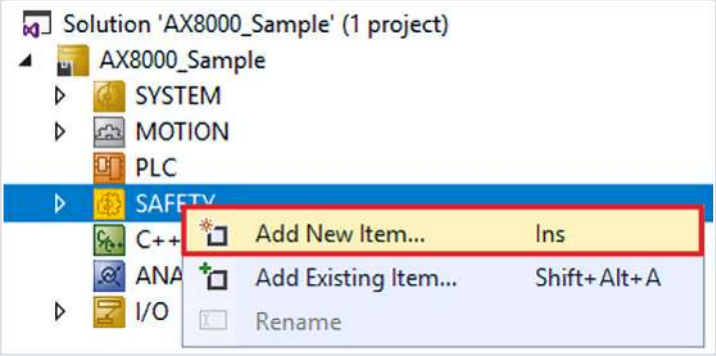
Fig. 7: Projects with outputs to the AX8911

10.4 Use of the AX8911 with a safety-related user program

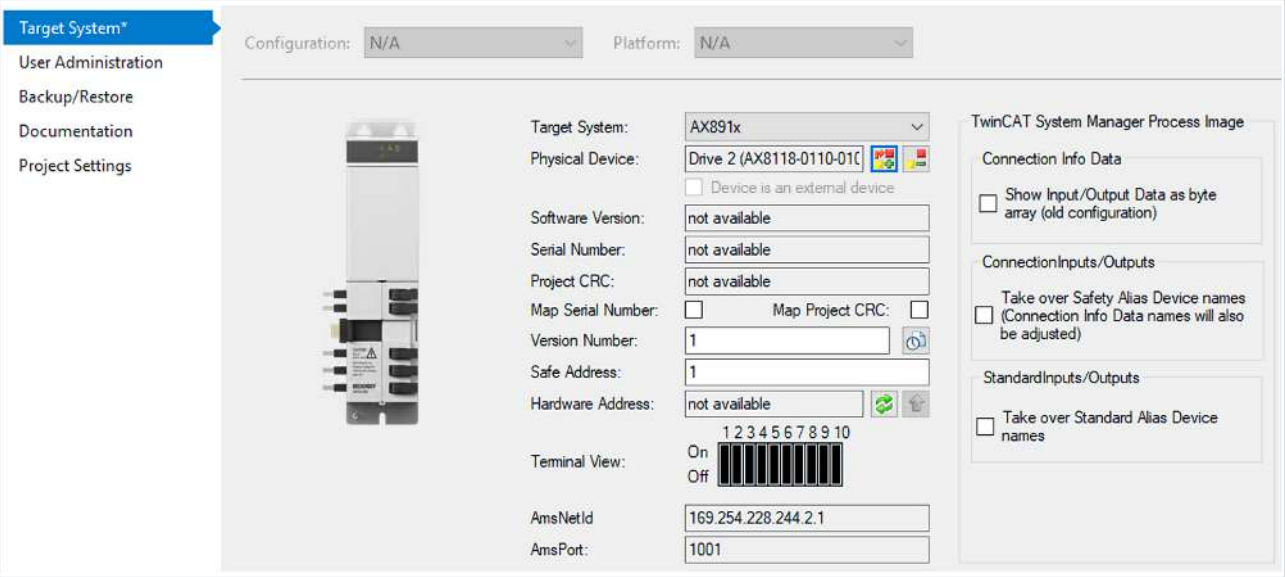
To use your TwinSAFE drive option card with a safety-related user program, you must make certain settings for the target system and the inputs and outputs.

Target system

For the use of the user-specific functions in the AX8911, a safety project is created in TwinCAT 3 and the AX8911 or the axis module is selected as the target system. Proceed as follows:

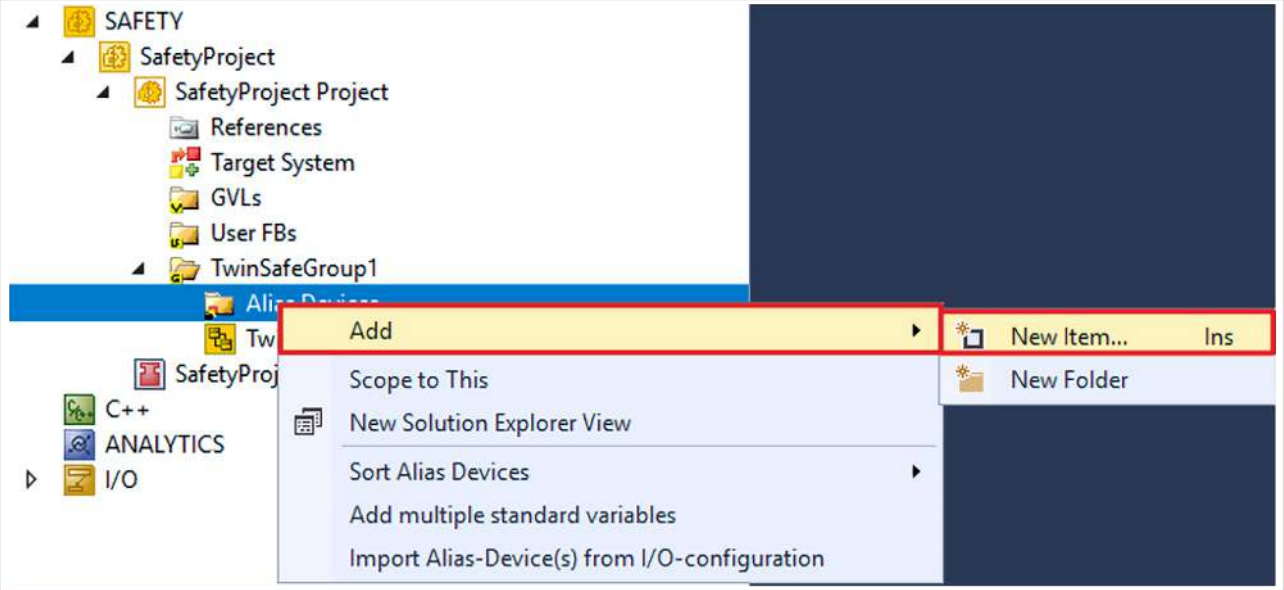


1. Right click on the safety configuration
2. Click on "Add New Item..."



3. Double click on the newly added node
4. Open "Target System" tab to select the target system
5. Select "AX891x" in the drop-down list of the target system
6. Click on  to link the TwinSAFE drive option card to the axis module

Proceed as follows to use the local inputs and outputs of the AX8911:



7. Right-click on the Alias Device folder of the Safety project
8. Select "New Item..." via the "Add" field

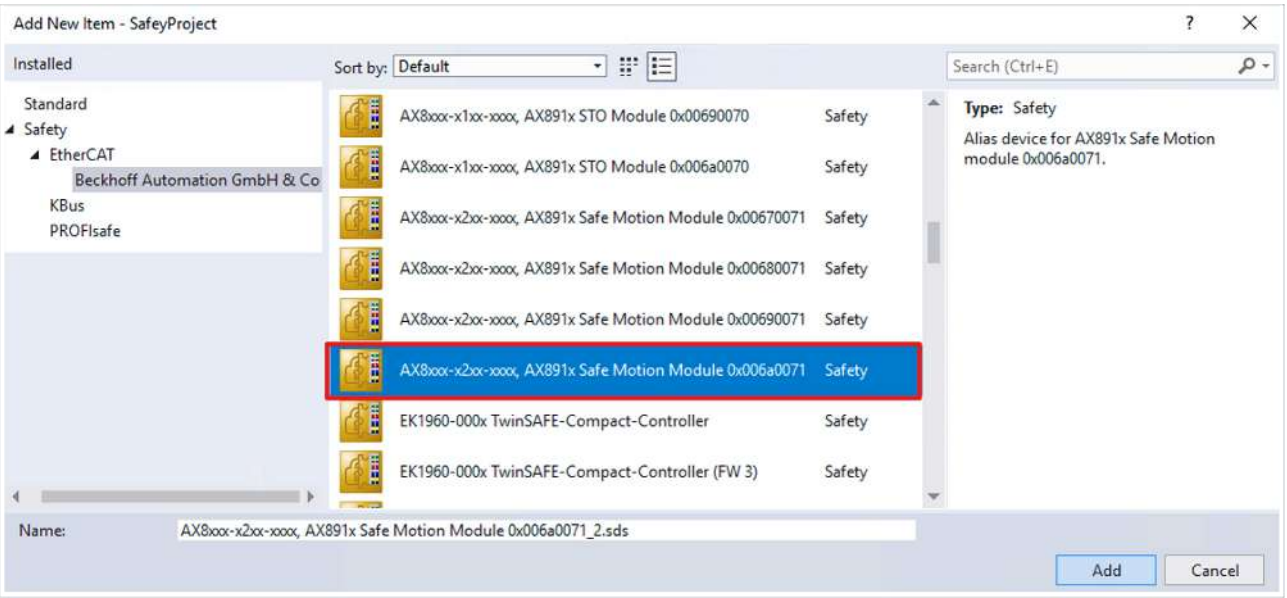
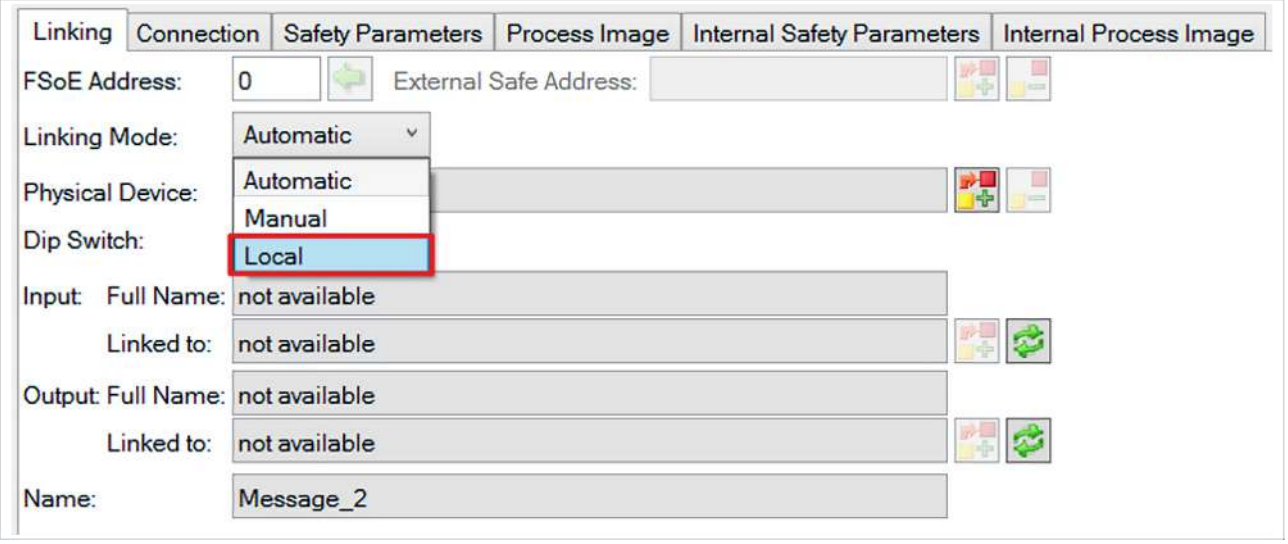


Fig. 8: AX8911 - Add New Item - Alias Device AX891x

The "Add New Item" window opens. Here you can select your desired AX8xxx variant. The name and the ModuleIdent in the alias device description tell you which AX8911 variant it is.

Which ModuleIdent belongs to which firmware version and which AX8000 firmware is supported can be found in the chapter Version history [▶ 9].

9. Select "AX8xxx-x2xx" for the Safe Motion variant
10. Confirm the selection with "Add"



11. Double click on the alias device
12. Open "Linking" tab
13. Select "Local" from the Linking Mode drop-down menu

After changing the linking mode to "Local", all alias device settings that are not relevant are shown as disabled for input. The other safety parameters can be found in chapter Safety parameters [▶ 48].

Safe inputs and outputs within the safety logic

Further information on the process image and the safe and unsafe input and output signals can be found in the chapter Local process image [▶ 54].

10.5 Manual creation of safety functions

The creation of a safety-related user program is explained in the documentation for the EL6910 and the FB description. The corresponding documents are numbers [3] and [4] at References [▶ 8].

NOTICE

Switch back to the factory setting project

By deleting the entire project (Safe Logic, parameters and mapping) on the AX8911 TwinSAFE drive option card, the factory setting project is active again after a power cycle of the complete device.

10.6 Safety parameters

You can access the internal safety parameters via the target system of your safety project.

10.6.1 Safe Motion

The following internal safety parameters are available for the AX8xxx-x2xx ordering option.

In the delivery state, use the TwinSAFE drive option card with the factory setting project STO. If you use the TwinSAFE drive option card with a user-specific application program, you have the option of additionally configuring the TwinSAFE drive option card via the internal safety parameters.

⚠ WARNING

Perform error evaluation

If you activate the parameter for the TwinSAFE Safe Motion functions, perform the corresponding error evaluations and evaluate the feedback *Position Valid* of the encoder(s) used.

If you activate the parameter for brake control, perform the corresponding error evaluations and actively switch the brake from the safety application.

Failure to comply may endanger safety.

NOTICE

Do not change "SAFEDRIVEFEEDBACK Maximum Safe Position Deviation"

In your configuration you can see the parameters "SAFEDRIVEFEEDBACK Maximum Safe Position Deviation".

Do not change these parameters!

Index	Name	Data type	Description
FSOUT settings			
0xC110:01 h	Ch A FSOUT BRAKE ModuloDiagTestPulse	UINT8	Modulo value for the frequency of the generation of a test pulse. 0 -> every time 1 -> every 2nd time … Factory setting: 100
0xC110:02 h	Ch A FSOUT BRAKE MultiplierDiagTestPulse	UINT8	Length of the test pulse in multiples of 625 µs Factory setting: 1 Minimum: 1 Maximum: 255
0xC110:04 h	Ch A FSOUT BRAKE Diag TestPulse active	BOOL	**True: T**est pulses active **False:** Test pulses inactive
0xC390:01 h	Ch B FSOUT BRAKE ModuloDiagTestPulse	UINT8	Modulo value for the frequency of the generation of a test pulse. 0 -> every time 1 -> every 2nd time … Factory setting: 100
0xC390:02 h	Ch B FSOUT BRAKE MultiplierDiagTestPulse	UINT8	Length of the test pulse in multiples of 625 µs Factory setting: 1 Minimum: 1 Maximum: 255
0xC390:04 h	Ch B FSOUT BRAKE Diag TestPulse active	BOOL	**True: T**est pulses active **False:** Test pulses inactive
FSIN settings			
0xC121:01 h	Ch A FSIN Channel 1.InputFilterTime (in 125 µs)	UINT16	Input filter time of the input X15.1 [in µs] Factory setting: 28 Minimum: 1 Maximum: 500
0xC121:04 h	Ch A FSIN Channel 2.InputFilterTime (in 125 µs)	UINT16	Input filter time of the input X15.2 [in µs] Factory setting: 28 Minimum: 1 Maximum: 500
0xC3A1:01 h	Ch B FSIN Channel 1.InputFilterTime (in 125 µs)	UINT16	Input filter time of the input X25.1 [in µs]

Index	Name	Data type	Description
			Factory setting: 28 Minimum: 1 Maximum: 500
0xC3A1:04h	Ch B FSIN Channel 2.InputFilterTime (in 125 µs)	UINT16	Input filter time of the input X25.2 [in µs] Factory setting: 28 Minimum: 1 Maximum: 500
Functional settings			
0xC130:01h	Ch A FSDRIVE Brake Control Enabled	BOOL	**True:** Brake control active **False:** Brake control inactive
0xC130:02h	Ch A FSDRIVE Primary Feedback Enabled	BOOL	**True:** Primary Feedback active **False:** Primary Feedback inactive
0xC130:03h	Ch A FSDRIVE Secondary Feedback Enabled	BOOL	**True:** Secondary Feedback active **False:** Secondary Feedback inactive
0xC3B00:01h	Ch B FSDRIVE Brake Control Enabled	BOOL	**True:** Brake control active **False:** Brake control inactive
0xC3B00:02h	Ch B FSDRIVE Primary Feedback Enabled	BOOL	**True:** Primary Feedback active **False:** Primary Feedback inactive
0xC3B00:03h	Ch B FSDRIVE Secondary Feedback Enabled	BOOL	**True:** Secondary Feedback active **False:** Secondary Feedback inactive
Feedback parameter CRC settings The following parameters are only evaluated if the corresponding feedback is "enabled".			
0xC240:1Bh	Ch A SAFEDRIVEFEEDBACK Primary Feedback Parameter CRC	UINT16	Parameter CRC of the primary feedback of channel A
0xC242:1Bh	Ch A SAFEDRIVEFEEDBACK Secondary Feedback Parameter CRC	UINT16	Parameter CRC of the Secondary Feedback of channel A
0xC4C0:1Bh	Ch B SAFEDRIVEFEEDBACK Primary Feedback Parameter CRC	UINT16	Parameter CRC of the primary feedback of channel B
0xC4C2:1Bh	Ch B SAFEDRIVEFEEDBACK Secondary feedback parameter CRC	UINT16	Parameter CRC of the Secondary Feedback of channel B
Safety settings			
Ch A Primary Feedback			
0xC140:01h	Ch A SAFEDRIVEFEEDBACK Average Calculation Acceleration	BIT4	Average acceleration calculation
0xC140:05h	Ch A SAFEDRIVEFEEDBACK Average Calculation Velocity	BIT4	Average velocity calculation
0xC140:11h	Ch A SAFEDRIVEFEEDBACK Encoder Direction Shift	BIT5	Detection limit for direction of rotation detection
0xC140:17h	Ch A SAFEDRIVEFEEDBACK Enable 64 Bit Division	BOOL	**True:** 64-bit division allowed[1] **False:** 64-bit division not allowed
0xC140:19h	Ch A SAFEDRIVEFEEDBACK Encoder Position Shift	BIT6	Detection limit for position detection
Ch A Secondary Feedback			
0xC141:01h	Ch A SAFEDRIVEFEEDBACK Average Calculation Acceleration	BIT4	Average acceleration calculation
0xC141:05h	Ch A SAFEDRIVEFEEDBACK Average Calculation Velocity	BIT4	Average velocity calculation
0xC141:11h	Ch A SAFEDRIVEFEEDBACK Encoder Direction Shift	BIT5	Detection limit for direction of rotation detection
0xC141:17h	Ch A SAFEDRIVEFEEDBACK Enable 64 Bit Division	BOOL	**True:** 64-bit division allowed[1] **False:** 64-bit division not allowed

Index	Name	Data type	Description
0xC141:19h	Ch A SAFEDRIVEFEEDBACK Encoder Position Shift	BIT6	Detection limit for position detection
Ch B Primary Feedback			
0xC3C00:01h	Ch B SAFEDRIVEFEEDBACK Average Calculation Acceleration	BIT4	Average acceleration calculation
0xC3C00:05h	Ch B SAFEDRIVEFEEDBACK Average Calculation Velocity	BIT4	Average velocity calculation
0xC3C00:11h	Ch B SAFEDRIVEFEEDBACK Encoder Direction Shift	BIT5	Detection limit for direction of rotation detection
0xC3C00:17h	Ch B SAFEDRIVEFEEDBACK Enable 64 Bit Division	BOOL	**True:** 64-bit division allowed[1] **False:** 64-bit division not allowed
0xC3C00:19h	Ch B SAFEDRIVEFEEDBACK Encoder Position Shift	BIT6	Detection limit for position detection
Ch B Secondary Feedback			
0xC3C1:01h	Ch B SAFEDRIVEFEEDBACK Average Calculation Acceleration	BIT4	Average acceleration calculation
0xC3C1:05h	Ch B SAFEDRIVEFEEDBACK Average Calculation Velocity	BIT4	Average velocity calculation
0xC3C1:11h	Ch B SAFEDRIVEFEEDBACK Encoder Direction Shift	BIT5	Detection limit for direction of rotation detection
0xC3C1:17h	Ch B SAFEDRIVEFEEDBACK Enable 64 Bit Division	BOOL	**True:** 64-bit division allowed[1] **False:** 64-bit division not allowed
0xC3C1:19h	Ch B SAFEDRIVEFEEDBACK Encoder Position Shift	BIT6	Detection limit for position detection
Referencing Settings The following parameters are only evaluated if the corresponding feedback is "enabled".			
Ch A Primary Feedback			
0xC142:01h	Ch A SAFEDRIVEFEEDBACK Operation Mode	BIT4	Referencing the operation mode • Automatic referencing, "Set reference position" activated • Automatic referencing, "Set reference position" deactivated • Manual referencing
0xC142:11h	Ch A SAFEDRIVEFEEDBACK Reference SafePostion Singleturn	UINT32	Safe single-turn reference position
0xC142:12h	Ch A SAFEDRIVEFEEDBACK Reference SafePostion Multiturn	INT32	Safe multi-turn reference position
0xC142:13h	Ch A SAFEDRIVEFEEDBACK Speed at Reference Position	UINT32	Maximum permissible velocity at the reference position
0xC142:14h	Ch A SAFEDRIVEFEEDBACK Maximum Singleturn Referenced SafePosition	UINT32	Maximum safe single-turn reference position
0xC142:15h	Ch A SAFEDRIVEFEEDBACK Maximum Multiturn Referenced SafePosition	INT32	Maximum safe multi-turn reference position
0xC142:16h	Ch A SAFEDRIVEFEEDBACK Minimum Singleturn Referenced SafePosition	UINT32	Minimum safe single-turn reference position
0xC142:17h	Ch A SAFEDRIVEFEEDBACK Minimum Multiturn Referenced SafePosition	INT32	Minimum safe multi-turn reference position

Index	Name	Data type	Description
0xC142:18 h	Ch A SAFEDRIVEFEEDBACK Deviation Startup Position	UINT32	Permissible deviation when initializing the reference position
Ch A Secondary Feedback			
0xC143:01 h	Ch A SAFEDRIVEFEEDBACK Operation Mode	BIT4	Referencing the operation mode • Automatic referencing, "Set reference position" activated • Automatic referencing, "Set reference position" deactivated • Manual referencing
0xC143:11 h	Ch A SAFEDRIVEFEEDBACK Reference SafePostion Singleturn	UINT32	Safe single-turn reference position
0xC143:12 h	Ch A SAFEDRIVEFEEDBACK Reference SafePostion Multiturn	INT32	Safe multi-turn reference position
0xC143:13 h	Ch A SAFEDRIVEFEEDBACK Speed at Reference Position	UINT32	Maximum permissible velocity at the reference position
0xC143:14 h	Ch A SAFEDRIVEFEEDBACK Maximum Singleturn Referenced SafePosition	UINT32	Maximum safe single-turn reference position
0xC143:15 h	Ch A SAFEDRIVEFEEDBACK Maximum Multiturn Referenced SafePosition	INT32	Maximum safe multi-turn reference position
0xC143:16 h	Ch A SAFEDRIVEFEEDBACK Minimum Singleturn Referenced SafePosition	UINT32	Minimum safe single-turn reference position
0xC143:17 h	Ch A SAFEDRIVEFEEDBACK Minimum Multiturn Referenced SafePosition	INT32	Minimum safe multi-turn reference position
0xC143:18 h	Ch A SAFEDRIVEFEEDBACK Deviation Startup Position	UINT32	Permissible deviation when initializing the reference position
Ch B Primary Feedback			
0xC3C2:01 h	Ch B SAFEDRIVEFEEDBACK Operation Mode	BIT4	Referencing the operation mode • Automatic referencing, "Set reference position" activated • Automatic referencing, "Set reference position" deactivated • Manual referencing
0xC3C2:11 h	Ch B SAFEDRIVEFEEDBACK Reference SafePostion Singleturn	UINT32	Safe single-turn reference position
0xC3C2:12 h	Ch B SAFEDRIVEFEEDBACK Reference SafePostion Multiturn	INT32	Safe multi-turn reference position
0xC3C2:13 h	Ch B SAFEDRIVEFEEDBACK Speed at Reference Position	UINT32	Maximum permissible velocity at the reference position
0xC3C2:14 h	Ch B SAFEDRIVEFEEDBACK Maximum Singleturn Referenced SafePosition	UINT32	Maximum safe single-turn reference position
0xC3C2:15 h	Ch B SAFEDRIVEFEEDBACK Maximum Multiturn Referenced SafePosition	INT32	Maximum safe multi-turn reference position
0xC3C2:16 h	Ch A SAFEDRIVEFEEDBACK Minimum Singleturn Referenced SafePosition	UINT32	Minimum safe single-turn reference position

Index	Name	Data type	Description
0xC3C2:17 h	Ch B SAFEDRIVEFEEDBACK Minimum Multiturn Referenced SafePosition	INT32	Minimum safe multi-turn reference position
0xC3C2:18 h	Ch B SAFEDRIVEFEEDBACK Deviation Startup Position	UINT32	Permissible deviation when initializing the reference position
Ch B Secondary Feedback			
0xC3C3:01 h	Ch B SAFEDRIVEFEEDBACK Operation Mode	BIT4	Referencing the operation mode • Automatic referencing, "Set reference position" activated • Automatic referencing, "Set reference position" deactivated • Manual referencing
0xC3C3:11 h	Ch B SAFEDRIVEFEEDBACK Reference SafePostion Singleturn	UINT32	Safe single-turn reference position
0xC3C3:12 h	Ch B SAFEDRIVEFEEDBACK Reference SafePostion Multiturn	INT32	Safe multi-turn reference position
0xC3C3:13 h	Ch B SAFEDRIVEFEEDBACK Speed at Reference Position	UINT32	Maximum permissible velocity at the reference position
0xC3C3:14 h	Ch B SAFEDRIVEFEEDBACK Maximum Singleturn Referenced SafePosition	UINT32	Maximum safe single-turn reference position
0xC3C3:15 h	Ch B SAFEDRIVEFEEDBACK Maximum Multiturn Referenced SafePosition	INT32	Maximum safe multi-turn reference position
0xC3C3:16 h	Ch A SAFEDRIVEFEEDBACK Minimum Singleturn Referenced SafePosition	UINT32	Minimum safe single-turn reference position
0xC3C3:17 h	Ch B SAFEDRIVEFEEDBACK Minimum Multiturn Referenced SafePosition	INT32	Minimum safe multi-turn reference position
0xC3C3:18 h	Ch B SAFEDRIVEFEEDBACK Deviation Startup Position	UINT32	Permissible deviation when initializing the reference position

[1] *Depending on the configuration of the feedback, a 64-bit division may be necessary for EnDat 2.2 encoders. This cannot be performed by the AX8911 in all cases. If the need for a 64-bit division is detected, this is signaled by a corresponding error message (0xD1B4, 0xD2B4). By the parameters "SAFEDRIVEFEEDBACK Enable 64 Bit Division" the 64 bit division can be allowed. The necessity is subsequently indicated only by a warning (0xD1B4, 0xD2B4). The error state is not assumed until a 64-bit division that cannot be implemented occurs.*

11 Local process image

The process image of the AX8911 is composed of the input process image and the output process image. The following local process image is available for your customer-specific safety application.

⚠ WARNING

Use non-safe signals only functionally

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

11.1 Input

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

Offset	Name	Data type	Group	Description
0.0	ChA_STO _Error	BOOL	Safety	**True**: Error detected in switch-off paths STO of axis 1 **False**: No error (link to output signal 6.1)
0.1	ChB_STO_Error	BOOL	Safety	**True**: Error detected in switch-off paths STO of axis 2 **False**: No error (link to output signal 10.1)
0.2	ChA_Brake_Error	BOOL	Safety	**True**: Error detected in the brake control of axis 1 **False**: No error (link to output signal 6.3)
0.3	ChA_DriveReq_Activate_Brake	BOOL	Standard	**True**: Brake of axis 1 is released according to AX8xxx **False**: Brake is applied according to AX8xxx.
0.4	ChB_Brake_Error	BOOL	Safety	**True**: Error detected in the brake control of axis 2 **False**: No error (link to output signal 10.3)
0.5	ChB_DriveReq_Activate_Brake	BOOL	Standard	**True**: Brake of axis 2 is released according to AX8xxx **False**: Brake is applied according to AX8xxx.
0.6	ChA_SafeInput_1	BOOL	Safety	**True**: 24 V at port X15.1 (axis 1) **False**: 0 V at port X15.1 (axis 1)
0.7	ChA_SafeInput_2	BOOL	Safety	**True**: 24 V at port X15.2 (axis 1) **False**: 0 V at port X15.2 (axis 1)
1.0	ChA_SafeInputs_Error	BOOL	Safety	**True**: Error detected at safe inputs of axis 1 **False**: No error (link to output signal 6.2)
1.1	ChB_SafeInput_1	BOOL	Safety	**True**: 24 V at port X25.1 (axis 2) **False**: 0 V at port X25.1 (axis 2)
1.2	ChB_SafeInput_2	BOOL	Safety	**True**: 24 V at port X25.2 (axis 2) **False**: 0 V at port X25.2 (axis 2)
1.3	ChB_SafeInputs_Error	BOOL	Safety	**True**: Error detected at safe inputs of axis 2 **False**: No error (link to output signal 10.2)
1.4	ChA_STO_State	BOOL	Standard	**True**: Axis 1 enabled **False**: No error
1.5	ChB_STO_State	BOOL	Standard	**True**: Axis 2 enabled **False**: No error

Offset	Name	Data type	Group	Description
2.0	ChA_EncoderVoltage_Underrange	BOOL	Standard	**True**: Undervoltage at encoder (OCT or EnDat axis 1) **False**: No error (link to output signal 6.4)
2.1	ChA_EncoderVoltage_Overrange	BOOL	Standard	**True**: Overvoltage at encoder (OCT or Endat axis 1) **False**: No error (link to output signal 6.5)
2.2	ChA_EncoderVoltage_Error	BOOL	Standard	**True**: Axis 1 encoder voltage error **False**: No error
2.3	ChA_DriveReq_Activate_Encoder	BOOL	Standard	**True**: Encoder of axis 1 is switched on according to AX8xxx. **False**: Encoder of axis 1 is switched off according to AX8xxx. (Link to output signal 6.6)
4.0	ChA_EncoderVoltage	INT16	Standard	Analog value of the encoder voltage (OCT or EnDat axis 1) in mV
10.0	ChA_ElectricalAngle	UINT16	Standard	Electrical angle (2π per pole, axis 1)
12.0	ChA_Current_Iq	INT32	Standard	Analog value of current I_Q (axis 1), torque-forming current
16.0	ChA_Current_Id	INT32	Standard	Analog value of current I_D (axis 1), field-forming current
22.0	ChA_DriveReq_Run	BOOL	Standard	Run signal for axis 1 of the AX8xxx control word
22.1	ChA_DriveReq_ErrAck	BOOL	Standard	Error acknowledge signal for axis A of the AX8xxx control word (link to output signal 0.4, 1.5, 2.2, 4.0, 14.0, 18.0)
24.0	ChB_EncoderVoltage_Underrange	BOOL	Standard	**True:** Undervoltage at encoder (OCT or EnDat axis 2) **False:** No error (link to output signal 6.4)
24.1	ChB_EncoderVoltage_Overrange	BOOL	Standard	**True:** Overvoltage at encoder (OCT or EnDat axis 2) **False:** No error (link to output signal 6.5)
24.2	ChB_EncoderVoltage_Error	BOOL	Standard	**True**: Axis 2 encoder voltage error **False**: No error
24.3	ChB_DriveReq_Activate_Encoder	BOOL	Standard	**True**: Encoder of axis 2 is switched on according to AX8xxx. **False**: Encoder of axis 2 is switched off according to AX8xxx. (Link to output signal 6.6)
26.0	ChB_EncoderVoltage	INT16	Standard	Analog value of the encoder voltage (OCT or EnDat axis 2) in mV
30.0	ChB_ElectricalAngle	UINT16	Standard	Electrical angle (2π per pole, axis 2)
32.0	ChB_Current_Iq	INT32	Standard	Analog value of current I_Q (axis 2), torque-forming current
36.0	ChB_Current_Id	INT32	Standard	Analog value of current I_D (axis 2), field-forming current
42.0	ChB_DriveReq_Run	BOOL	Standard	Run signal for axis 2 of the AX8xxx control word
42.1	ChB_DriveReq_ErrAck	BOOL	Standard	Error acknowledge signal for axis 2 of the AX8xxx control word (link to output signal 0.4, 1.5, 2.2, 4.0, 14.0, 18.0)

Offset	Name	Data type	Group	Description
56.0	ChA_PriFb_Error	BOOL	Safety	**True**: Error in primary feedback module of axis 1 **False**: No error
56.1	ChA_PriFb_Encoder_Ready	BOOL	Standard	**True**: Primary feedback module of axis 1 ready **False**: No error
56.2	ChA_PriFb_Position_Valid	BOOL	Safety	**True**: Position of the primary feedback module of axis 1 valid **False**: No error
56.3	ChA_PriFb_SDI_p	BOOL	Safety	**True**: Drive rotates in positive direction (axis 1) **False**: No error
56.4	ChA_PriFb_SDI_n	BOOL	Safety	**True**: Drive rotates in negative direction (axis 1) **False**: No error
56.5	ChA_PriFb_RefRequired	BOOL	Safety	**True**: Reference position of primary feedback module of axis 1 required **False**: No error
56.6	ChA_PriFb_RefPosition_Valid	BOOL	Safety	**True**: Reference position of the primary feedback module of axis 1 valid **False**: No error
58.0	ChA_PriFb_Safe_RefMultiturnPosition	INT32	Safety	Multi-turn position value of the primary feedback module of axis 1
62.0	ChA_PriFb_Standard_MultiturnPosition	UINT32	Standard	Multi-turn position value of the primary feedback module of axis 1
66.0	ChA_PriFb_Safe_SingleturnPosition	UINT32	Safety	Single-turn position value of the primary feedback module of axis 1
70.0	ChA_PriFb_Safe_RefSingleturnPosition	UINT32	Safety	Single-turn position value of the primary feedback module of axis 1
74.0	ChA_PriFb_Acceleration_Maximum	INT32	Safety	Analog value of the maximum acceleration in the last logic cycle (axis 1, port X13.T+ and T-) (unit: increments/ms²)
78.0	ChA_PriFb_Acceleration_Average	INT32	Safety	Analog value of the average acceleration according to the setting of the safety parameters (axis 1, port X13.T+ and T-) (unit: increments/ms²)
82.0	ChA_PriFb_Velocity_Maximum	INT32	Safety	Analog value of the maximum velocity in the last logic cycle (axis 1, port X13.T+ and T-) (unit: increments/ms)
86.0	ChA_PriFb_Velocity_Average	INT32	Safety	Analog value of the average velocity according to the setting of the safety parameters (axis 1, port X13.T+ and T-) (unit: increments/ms)
98.0	ChA_SecFb_Error	BOOL	Safety	**True**: Error in secondary feedback module of axis 1 **False**: No error
98.1	ChA_SecFb_Encoder_Ready	BOOL	Standard	**True**: Secondary feedback module of axis 1 ready **False**: No error
98.2	ChA_SecFb_Position_Valid	BOOL	Safety	**True**: Position of the secondary feedback module of axis 1 valid **False**: No error
98.3	ChA_SecFb_SDI_p	BOOL	Safety	**True**: Drive rotates in positive direction (axis 1) **False**: No error
98.4	ChA_SecFb_SDI_n	BOOL	Safety	**True**: Drive rotates in negative direction (axis 1) **False**: No error
98.5	ChA_SecFb_RefRequired	BOOL	Safety	**True**: Reference position of secondary feedback module of axis 1 required **False**: No error
98.6	ChA_SecFb_RefPosition_Valid	BOOL	Safety	**True**: Reference position of the secondary feedback module of axis 1 valid **False**: No error

Offset	Name	Data type	Group	Description
100.0	ChA_SecFb_Safe_RefMultiturnPosition	INT32	Safety	Multi-turn position value of the secondary feedback module of axis 1
104.0	ChA_SecFb_Standard_MultiturnPosition	UINT32	Standard	Multi-turn position value of the secondary feedback module of axis 1
108.0	ChA_SecFb_Safe_SingleturnPosition	UINT32	Safety	Single-turn position value of the secondary feedback module of axis 1
112.0	ChA_SecFb_Safe_RefSingleturnPosition	UINT32	Safety	Single-turn position value of the secondary feedback module of axis 1
116.0	ChA_SecFb_Acceleration_Maximum	INT32	Safety	Analog value of the maximum acceleration in the last logic cycle (axis 1, port X13.T+ and T-) (unit: increments/ms²)
120.0	ChA_SecFb_Acceleration_Average	INT32	Safety	Analog value of the average acceleration according to the setting of the safety parameters (axis 1, port X13.T+ and T-) (unit: increments/ms²)
124.0	ChA_SecFb_Velocity_Maximum	INT32	Safety	Analog value of the maximum velocity in the last logic cycle (axis 1, port X13.T+ and T-) (unit: increments/ms)
128.0	ChA_SecFb_Velocity_Average	INT32	Safety	Analog value of the average velocity according to the setting of the safety parameters (axis 1, port X13.T+ and T-) (unit: increments/ms)
140.0	ChB_PriFb_Error	BOOL	Safety	**True**: Error in primary feedback module of axis 2 **False**: No error
140.1	ChB_PriFb_Encoder_Ready	BOOL	Standard	**True**: Primary feedback module of axis 2 ready **False**: No error
140.2	ChB_PriFb_Position_Valid	BOOL	Safety	**True**: Position of the primary feedback module of axis 2 valid **False**: No error
140.3	ChB_PriFb_SDI_p	BOOL	Safety	**True**: Drive rotates in positive direction (axis 2) **False**: No error
140.4	ChB_PriFb_SDI_n	BOOL	Safety	**True**: Drive rotates in negative direction (axis 2) **False**: No error
140.5	ChB_PriFb_RefRequired	BOOL	Safety	**True**: Reference position of primary feedback module of axis 2 required **False**: No error
140.6	ChB_PriFb_RefPosition_Valid	BOOL	Safety	**True**: Reference position of the primary feedback module of axis 2 valid **False**: No error
142.0	ChB_PriFb_Safe_RefMultiturnPosition	INT32	Safety	Multi-turn position value of the primary feedback module of axis 2
146.0	ChB_PriFb_Standard_MultiturnPosition	UINT32	Standard	Multi-turn position value of the primary feedback module of axis 2
150.0	ChB_PriFb_Safe_SingleturnPosition	UINT32	Safety	Single-turn position value of the primary feedback module of axis 2
154.0	ChB_PriFb_Safe_RefSingleturnPosition	UINT32	Safety	Single-turn position value of the primary feedback module of axis 2
158.0	ChB_PriFb_Acceleration_Maximum	INT32	Safety	Analog value of the maximum acceleration in the last logic cycle (axis 2, port X23.T+ and T-) (unit: increments/ms²)
162.0	ChB_PriFb_Acceleration_Average	INT32	Safety	Analog value of the average acceleration according to the setting of the safety parameters (axis 2, port X23.T+ and T-) (unit: increments/ms²)
166.0	ChB_PriFb_Velocity_Maximum	INT32	Safety	Analog value of the maximum velocity in the last logic cycle (axis 2, port X23.T+ and T-) (unit: increments/ms)

Offset	Name	Data type	Group	Description
170.0	ChB_PriFb_Velocity_Average	INT32	Safety	Analog value of the average velocity according to the setting of the safety parameters (axis 2, port X23.T+ and T-) (unit: increments/ms)
182.0	ChB_SecFb_Error	BOOL	Safety	**True**: Error in secondary feedback module of axis 2 **False**: No error
182.1	ChB_SecFb_Encoder_Ready	BOOL	Standard	**True**: Secondary feedback module of axis 2 ready **False**: No error
182.2	ChB_SecFb_Position_Valid	BOOL	Safety	**True**: Position of the secondary feedback module of axis 2 valid **False**: No error
182.3	ChB_SecFb_SDI_p	BOOL	Safety	**True**: Drive rotates in positive direction (axis 2) **False**: No error
182.4	ChB_SecFb_SDI_n	BOOL	Safety	**True**: Drive rotates in negative direction (axis 2) **False**: No error
182.5	ChB_SecFb_RefRequired	BOOL	Safety	**True**: Reference position of secondary feedback module of axis 2 required **False**: No error
182.6	ChB_SecFb_RefPosition_Valid	BOOL	Safety	**True**: Reference position of the secondary feedback module of axis 2 valid **False**: No error
184.0	ChB_SecFb_Safe_RefMultiturnPosition	INT32	Safety	Multi-turn position value of the secondary feedback module of axis 2
188.0	ChB_SecFb_Standard_MultiturnPosition	UINT32	Standard	Multi-turn position value of the secondary feedback module of axis 2
192.0	ChB_SecFb_Safe_SingleturnPosition	UINT32	Safety	Single-turn position value of the secondary feedback module of axis 2
196.0	ChB_SecFb_Safe_RefSingleturnPosition	UINT32	Safety	Single-turn position value of the secondary feedback module of axis 2
200.0	ChB_SecFb_Acceleration_Maximum	INT32	Safety	Analog value of the maximum acceleration in the last logic cycle (axis 2, port X23.T+ and T-) (unit: increments/ms²)
204.0	ChB_SecFb_Acceleration_Average	INT32	Safety	Analog value of the average acceleration according to the setting of the safety parameters (axis 2, port X23.T+ and T-) (unit: increments/ms²)
208.0	ChB_SecFb_Velocity_Maximum	INT32	Safety	Analog value of the maximum velocity in the last logic cycle (axis 2, port X23.T+ and T-) (unit: increments/ms)
212.0	ChB_SecFb_Velocity_Average	INT32	Safety	Analog value of the average velocity according to the setting of the safety parameters (axis 2, port X23.T+ and T-) (unit: increments/ms)

11.2 Output

The local process image of the output signals consists of a maximum of 32 bytes of data.

Offset	Name	Data type	Group	Description
0.0	ChA_STO_1	BOOL	Safety	**True**: Enable switch-off path A (STO axis 1, port X13) **False**: Disable switch-off path A (STO axis 1, port X13)

Offset	Name	Data type	Group	Description
0.1	ChA_STO_2	BOOL	Safety	**True**: Enable switch-off path B (STO axis 1, port X13) **False**: Disable switch-off path B (STO axis 1, port X13)
0.2	ChA_STO_3	BOOL	Safety	**True**: Enable switch-off path C (STO axis 1, port X13) **False**: Disable switch-off path C (STO axis 1, port X13)
0.3	ChA_STO_4	BOOL	Safety	**True**: Enable switch-off path D (STO axis 1, port X13) **False**: Disable switch-off path D (STO axis 1, port X13)
0.4	ChA_STO_ErrAck	BOOL	Standard	Acknowledgement of an error in the switch-off paths of axis 1
0.5	ChA_no_STO_to_Drive	BOOL	Standard	**True**: Enable to AX8xxx: Output stage is enabled for AX8xxx (axis 1) **False**: Output stage is disabled for AX8xxx.
0.6	ChB_STO_1	BOOL	Safety	**True**: Enable switch-off path A (STO axis 2, port X23) **False**: Disable switch-off path A (STO A axis 2, port X23)
0.7	ChB_STO_2	BOOL	Safety	**True**: Enable switch-off path B (STO axis 2, port X23) **False**: Disable switch-off path B (STO axis 2, port X23)
1.0	ChB_STO_3	BOOL	Safety	**True**: Enable switch-off path C (STO axis 2, port X23) **False**: Disable switch-off path C (STO axis 2, port X23)
1.1	ChB_STO_4	BOOL	Safety	**True**: Enable switch-off path D (STO axis 2, port X23) **False**: Disable switch-off path D (STO axis 2, port X23)
1.2	ChB_STO_ErrAck	BOOL	Standard	Acknowledgement of an error in the switch-off paths of axis 2
1.3	ChB_no_STO_to_Drive	BOOL	Standard	**True**: Enable to AX8xxx: Output stage is enabled for AX8xxx (axis 2) **False**: Output stage is disabled for AX8xxx. (1=Port to Drive Application is 0 (no STO))
1.4	ChA_Brake_Release	BOOL	Safety	**True**: Release brake (axis 1, port X13.B+ and B-) **False**: Lock brake (axis 1, port X13.B+ and B-)
1.5	ChA_Brake_ErrAck	BOOL	Standard	Acknowledgement of a brake control error of axis 1
1.6	ChB_Brake_Release	BOOL	Safety	**True**: Release brake (axis 2, port X23.B+ and B-) **False**: Lock brake (axis 2, port X23.B+ and B-)
1.7	ChB_Brake_ErrAck	BOOL	Standard	Acknowledgement of a brake control error of axis 2
2.2	ChA_SafeInputs_ErrAck	BOOL	Standard	Acknowledgement of an error in the safe inputs (Axis 1, Port X15.1 & X15.2)
2.3	ChB_SafeInputs_ErrAck	BOOL	Standard	Acknowledgement of an error in the safe inputs (Axis 2, Port X25.1 & X25.2)
4.0	ChA_EncoderVoltage_ErrAck	BOOL	Standard	Acknowledgement of an error of the encoder voltage monitoring of axis 1
6.0	ChA_DriveCmd_GroupError	BOOL	Standard	Status to AX8xxx: Group error at axis 1
8.0	ChB_EncoderVoltage_ErrAck	BOOL	Standard	Acknowledgement of an error of the encoder voltage monitoring of axis 2
10.0	ChB_DriveCmd_GroupError	BOOL	Standard	Status to AX8xxx: Group error at axis 2

Offset	Name	Data type	Group	Description
12.0	ChA_PriFb_Enable	BOOL	Standard	**True**: Activate primary feedback module of axis 1 **False**: Disable primary feedback module of axis 1
12.1	ChA_PriFb_ErrAck	BOOL	Standard	Acknowledgement of an error of the primary feedback module of axis 1
12.2	ChA_PriFb_SetRef	BOOL	Safety	Setting the reference position for the primary feedback module of axis 1
14.0	ChA_SecFb_Enable	BOOL	Standard	**True**: Activate secondary feedback module of axis 1 **False**: Disable secondary feedback module of axis 1
14.1	ChA_SecFb_ErrAck	BOOL	Standard	Acknowledgement of an error of the secondary feedback module of axis 1
14.2	ChA_SecFb_SetRef	BOOL	Safety	Setting the reference position for the secondary feedback module of axis 1
16.0	ChA_DriveCmd_Emergency_Stop	BOOL	Standard	reserved
16.1	ChA_DriveCmd_2	BOOL	Standard	reserved
16.2	ChA_DriveCmd_3	BOOL	Standard	reserved
16.3	ChA_DriveCmd_4	BOOL	Standard	reserved
16.4	ChA_DriveCmd_5	BOOL	Standard	reserved
16.5	ChA_DriveCmd_6	BOOL	Standard	reserved
16.6	ChA_DriveCmd_7	BOOL	Standard	reserved
16.7	ChA_DriveCmd_8	BOOL	Standard	reserved
20.0	ChB_PriFb_Enable	BOOL	Standard	**True**: Activate primary feedback module of axis 2 **False**: Disable primary feedback module of axis 2
20.1	ChB_PriFb_ErrAck	BOOL	Standard	Acknowledgement of an error of the primary feedback module of axis 2
20.2	ChB_PriFb_SetRef	BOOL	Safety	Setting the reference position for the primary feedback module of axis 2
22.0	ChB_SecFb_Enable	BOOL	Standard	**True**: Activate secondary feedback module of axis 2 **False**: Disable secondary feedback module of axis 2
22.1	ChB_SecFb_ErrAck	BOOL	Standard	Acknowledgement of an error of the secondary feedback module of axis 2
22.2	ChB_SecFb_SetRef	BOOL	Safety	Setting the reference position for the secondary feedback module of axis 2
24.0	ChB_DriveCmd_Emergency_Stop	BOOL	Standard	reserved
24.1	ChB_DriveCmd_2	BOOL	Standard	reserved
24.2	ChB_DriveCmd_3	BOOL	Standard	reserved
24.3	ChB_DriveCmd_4	BOOL	Standard	reserved
24.4	ChB_DriveCmd_5	BOOL	Standard	reserved
24.5	ChB_DriveCmd_6	BOOL	Standard	reserved
24.6	ChB_DriveCmd_7	BOOL	Standard	reserved
24.7	ChB_DriveCmd_8	BOOL	Standard	reserved
28.0	ChA_DiagMessage_1	BOOL	Safety	On falling edge, Diag message 0xD300 is entered in the Diag history.
28.1	ChA_DiagMessage_2	BOOL	Safety	On falling edge, Diag message 0xD301 is entered in the Diag history.
28.2	ChA_DiagMessage_3	BOOL	Safety	On falling edge, Diag message 0xD302 is entered in the Diag history.

Offset	Name	Data type	Group	Description
28.3	ChA_DiagMessage_4	BOOL	Safety	On falling edge, Diag message 0xD303 is entered in the Diag history.
28.4	ChA_DiagMessage_5	BOOL	Safety	On falling edge, Diag message 0xD304 is entered in the Diag history.
28.5	ChA_DiagMessage_6	BOOL	Safety	On falling edge, Diag message 0xD305 is entered in the Diag history.
28.6	ChA_DiagMessage_7	BOOL	Safety	On falling edge, Diag message 0xD306 is entered in the Diag history.
28.7	ChA_DiagMessage_8	BOOL	Safety	On falling edge, Diag message 0xD307 is entered in the Diag history.
29.0	ChA_DiagMessage_9	BOOL	Safety	On falling edge, Diag message 0xD308 is entered in the Diag history.
29.1	ChA_DiagMessage_10	BOOL	Safety	On falling edge, Diag message 0xD309 is entered in the Diag history.
29.2	ChA_DiagMessage_11	BOOL	Safety	On falling edge, Diag message 0xD30A is entered in the Diag history.
29.3	ChA_DiagMessage_12	BOOL	Safety	On falling edge, Diag message 0xD30B is entered in the Diag history.
29.4	ChA_DiagMessage_13	BOOL	Safety	On falling edge, Diag message 0xD30C is entered in the Diag history.
29.5	ChA_DiagMessage_14	BOOL	Safety	On falling edge, Diag message 0xD30D is entered in the Diag history.
29.6	ChA_DiagMessage_15	BOOL	Safety	On falling edge, Diag message 0xD30E is entered in the Diag history.
29.7	ChA_DiagMessage_16	BOOL	Safety	On falling edge, Diag message 0xD30F is entered in the Diag history.
30.0	ChB_DiagMessage_1	BOOL	Safety	On falling edge, Diag message 0xD310 is entered in the Diag history.
30.1	ChB_DiagMessage_2	BOOL	Safety	On falling edge, Diag message 0xD311 is entered in the Diag history.
30.2	ChB_DiagMessage_3	BOOL	Safety	On falling edge, Diag message 0xD312 is entered in the Diag history.
30.3	ChB_DiagMessage_4	BOOL	Safety	On falling edge, Diag message 0xD313 is entered in the Diag history.
30.4	ChB_DiagMessage_5	BOOL	Safety	On falling edge, Diag message 0xD314 is entered in the Diag history.
30.5	ChB_DiagMessage_6	BOOL	Safety	On falling edge, Diag message 0xD315 is entered in the Diag history.
30.6	ChB_DiagMessage_7	BOOL	Safety	On falling edge, Diag message 0xD316 is entered in the Diag history.
30.7	ChB_DiagMessage_8	BOOL	Safety	On falling edge, Diag message 0xD317 is entered in the Diag history.
31.0	ChB_DiagMessage_9	BOOL	Safety	On falling edge, Diag message 0xD318 is entered in the Diag history.
31.1	ChB_DiagMessage_10	BOOL	Safety	On falling edge, Diag message 0xD319 is entered in the Diag history.
31.2	ChB_DiagMessage_11	BOOL	Safety	On falling edge, Diag message 0xD31A is entered in the Diag history.
31.3	ChB_DiagMessage_12	BOOL	Safety	On falling edge, Diag message 0xD31B is entered in the Diag history.
31.4	ChB_DiagMessage_13	BOOL	Safety	On falling edge, Diag message 0xD31C is entered in the Diag history.

Offset	Name	Data type	Group	Description
31.5	ChB_DiagMessage_14	BOOL	Safety	On falling edge, Diag message 0xD31D is entered in the Diag history.
31.6	ChB_DiagMessage_15	BOOL	Safety	On falling edge, Diag message 0xD31E is entered in the Diag history.
31.7	ChB_DiagMessage_16	BOOL	Safety	On falling edge, Diag message 0xD31F is entered in the Diag history.

12 Motor replacement

NOTICE

Check axes

After a motor replacement, check that the axes are not reversed to ensure clear signal transmission.

It may be necessary to adjust the position offset and the referencing position by means of the application.

Two different CRCs are available to implement the replacement of a motor:

- Full CRC
- Reduced CRC

You can still use the full CRC to prevent motor replacement. This CRC gives you more control on the one hand, and prevents the creation of offline projects on the other.

Motor replacement is not possible if

- the read encoder parameters do not match the stored encoder parameters for any of the two possible encoders. The module reports a module error. Only one motor can be replaced at a time.

Motor replacement is possible if

- the calculated reduced CRC matches the CRC transmitted via the safety parameters.
- in case of two possible encoders the read out encoder parameters of one encoder do not match the stored encoder parameters and the parameters of the other encoder match.
- the module is activated for one encoder only and the read encoder parameters of the encoder do not match the stored encoder parameters. The encoder ID is not evaluated.

The module sends a diagnostic message in the Diag history once when the motor is replaced.

13 Application examples

Create the realizable safety functions with the Safe Motion Wizard in the TwinCAT 3 Safety Editor.

Procedures and application examples can be found in the Safe Motion Wizard tutorials. The tutorials can be found at https://www.beckhoff.com/de-de/support/webinare/index.html.

Further application examples can be found in document [5] at References [▶ 8].

For information on the TwinSAFE Safe Motion functions, refer to document [7] at References [▶ 8].

13.1 Using the STO inputs with TwinSAFE outputs

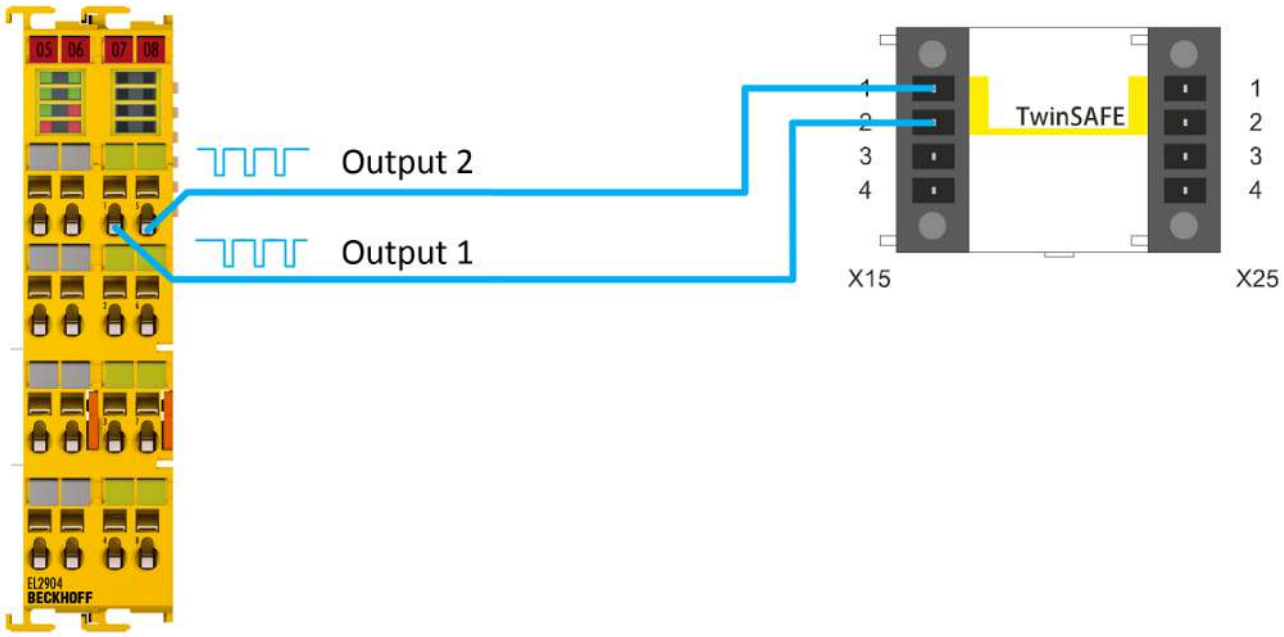


Fig. 9: TwinSAFE outputs connected to STO inputs

In this use case the STO inputs 1 and 2 of the digital inputs X15 and, if applicable, X25 are wired directly to safe outputs of a TwinSAFE component, for example of an EL2904.

The safe outputs are parameterized as follows when using the EL2904:

- The test pulses are active.
- The parameter "Current Measurement active" is deactivated.

If other TwinSAFE outputs are used they must also be parameterized in the same way so that test pulses are active at the output.

A filter is implemented within the logic of the TwinSAFE drive option card so that the test pulses of the TwinSAFE component do not cause the STO channels to be shut down.

The value of the test pulses in the factory setting is 3.5 ms.

13.2 Using the STO inputs with a third-party safety controller

⚠ WARNING

Implement protected cable laying

If no test pulses are used on the signals between the outputs of the safety controller and the STO inputs of the servo system, implement the wiring as cable laying. See the EN ISO 13849-2 standard for more information.

Failure to observe this may result in a malfunction of the TwinSAFE drive option card.

NOTICE

Safety assessment

When using a third-party safety controller, the safety assessment must be carried out by the user or the machine manufacturer.

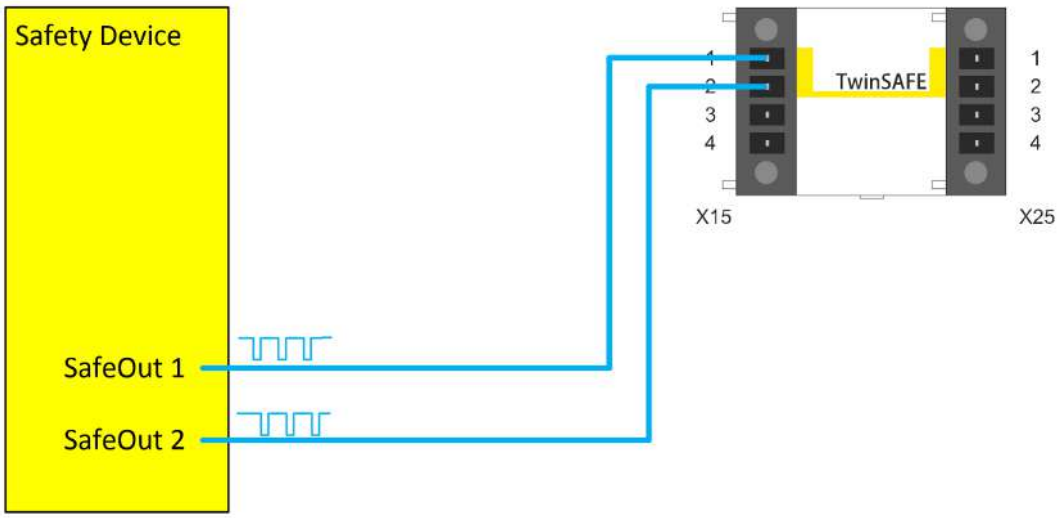


Fig. 10: Safe outputs from a third-party manufacturer connected to STO inputs

It must also be ensured that test pulses are generated when using a third-party safety controller or safe output. Make sure that the test pulse length and test pulse frequency do not cause the STO channels or the TwinSAFE drive option card to shut down. A filter with a filter time of 3.5 ms is implemented within the logic of the TwinSAFE drive option card.

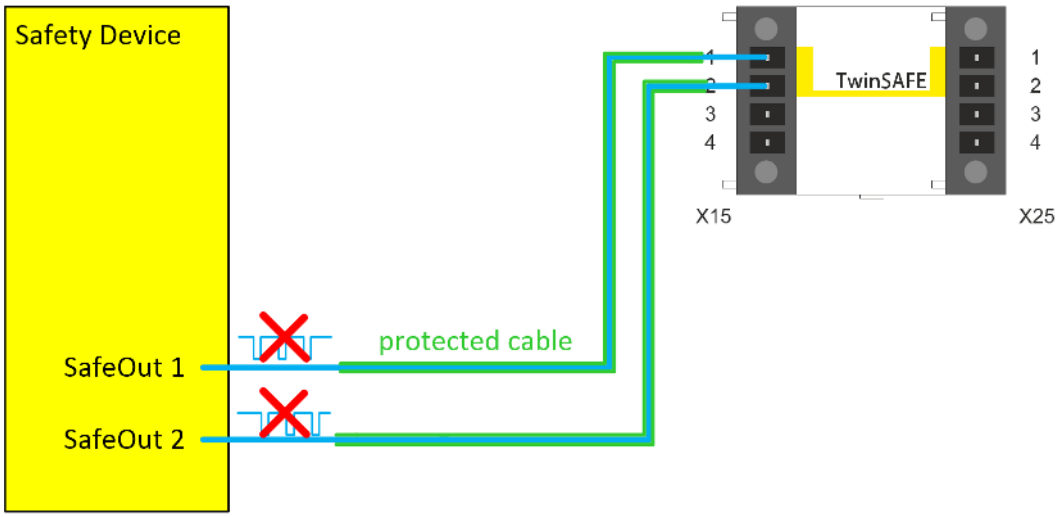


Fig. 11: Safe outputs from a third-party manufacturer connected to STO inputs without the use of test pulses

If the safety controller does not implement test pulses on the outputs, but only supplies static 24 V_{DC} signals, carry out the wiring in such a way that fault exclusion is permissible for the wiring. Further information about fault exclusions can be found in EN ISO 13849-2.

13.3 Using the STO function via FSoE

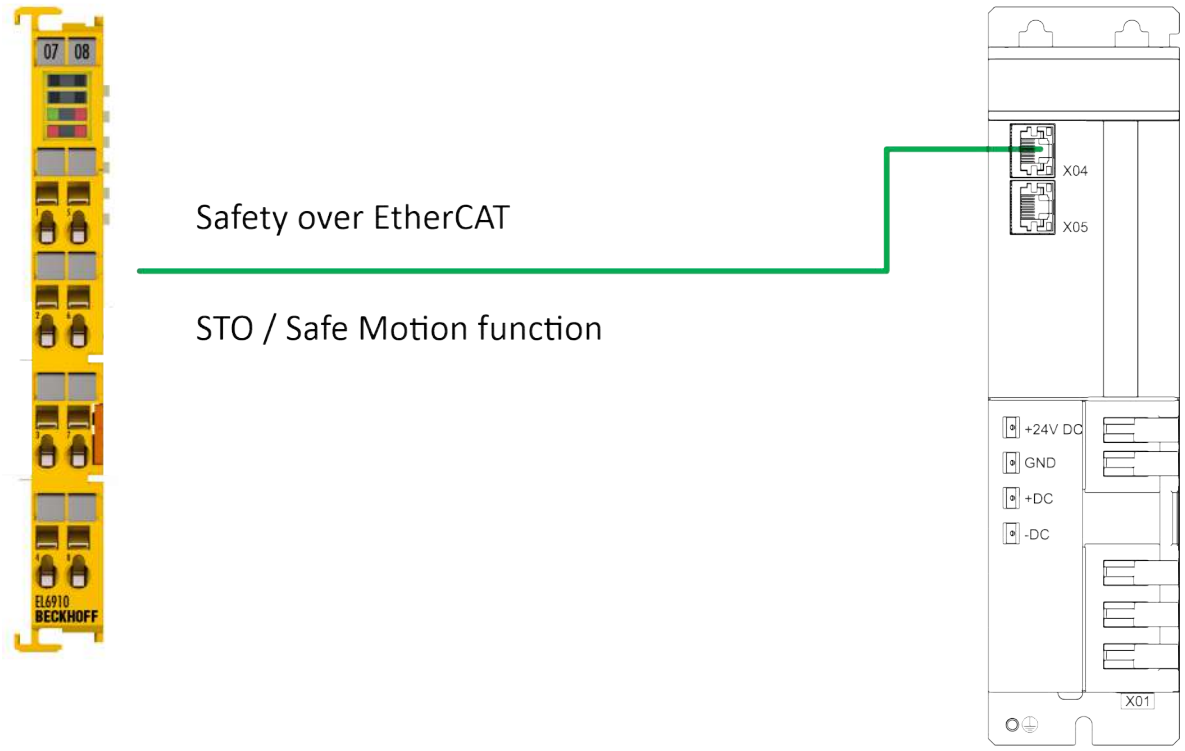


Fig. 12: STO function via TwinSAFE connection

Additional wiring of the STO inputs is unnecessary if the servo system is connected to a TwinSAFE logic via EtherCAT and the Safety-over-EtherCAT protocol (FSoE).

Here the signals of the connection to the TwinSAFE logic, for example EL6910, are used in the logic of the servo system. This allows the STO channels and the brake control of the servo system to be switched off.

14 Appendix

14.1 Certificate

BECKHOFF New Automation Technology

EU-Konformitätserklärung, EU Declaration of Conformity

Hersteller *Manufacturer*	**Beckhoff Automation** GmbH & Co.KG
Anschrift *Address*	Hülshorstweg 20 33415 Verl Bundesrepublik Deutschland
Produktbezeichnung *Product description*	**Servoverstärker (siehe Anhang)** *Servo drives (see Appendix)*

Die hier genannten Baugruppen sind entwickelt, konstruiert und gefertigt in Übereinstimmung mit der Niederspannungsrichtlinie 2014/35/EU sowie der EMV-Richtlinie 2014/30/EU. Sie entsprechen den Anforderungen der RoHS-Richtlinie 2011/65/EU. Folgende Normen wurden angewandt:
The components mentioned herein have been developed, designed and manufactured in accordance with the Low Voltage Directive 2014/35/EU as well as EMC Directive 2014/30/EU. They meet the requirements of RoHS Directive 2011/65/EU. The following standards have been used:

Fachgrundnorm: EN 61000-6-2:2005 *Generic Standard: EN 61000-6-2:2005*	**Störfestigkeit für Industriebereich** *immunity for industrial environments*
Fachgrundnorm: EN 61000-6-4:2007+A1:2011 *Generic Standard: EN 61000-6-4:2007+A1:2011*	**Störaussendung für Industriebereich** *emission standard for industrial environments*
Produktnorm: EN 61800-3:2004+A1:2012 *Product Standard: EN 61800-3:2004+A1:2012*	**Drehzahlveränderbare elektrische Antriebe - EMV-Anforderungen einschließlich spezieller Prüfverfahren** *Adjustable speed electrical power drive systems – EMC requirements and specific test methods*
Produktnorm: EN 61800-5-1:2007 *Product Standard: EN 61800-5-1:2007*	**Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Anforderungen an die Sicherheit** *Adjustable speed electrical power drive systems – Safety requirements – Electrical, thermal and energy*
RoHS: EN 50581:2012 *RoHS: EN 50581:2012*	**Technische Dokumentation zur Regelung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkung gefährlicher Stoffe** *Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances*

Verl, den / *the* **17.07.2017**

Unterschrift, *signature*
Name, *name*
Funktion, *function*

Hans Beckhoff
Geschäftsführer, *Executive Director*

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Fig. 13: AX servo drive EC Declaration of Conformity, page 1

BECKHOFF New Automation Technology

EU-Konformitätserklärung
EU declaration of conformity

Servoverstärker, *Servo drives*

Bestellnummer *order number*	**Bezeichnung** *designation*
AX20xx-xxxx-xxxx	**Digital Kompakt Servoverstärker**, *Digital Compact Servo Drive*
AX25xx-xxxx-xxxx	**Digital Kompakt Servoverstärker**, *Digital Compact Servo Drive*
AX5xxx-xxxx-xxxx	**Digital Kompakt Servoverstärker**, *Digital Compact Servo Drive*
AX8xxx-xxxx-xxxx	**Digital Kompakt Servoverstärker**, *Digital Compact Servo Drive*

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Fig. 14: AX servo drive EC Declaration of Conformity, page 2

14.2 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.

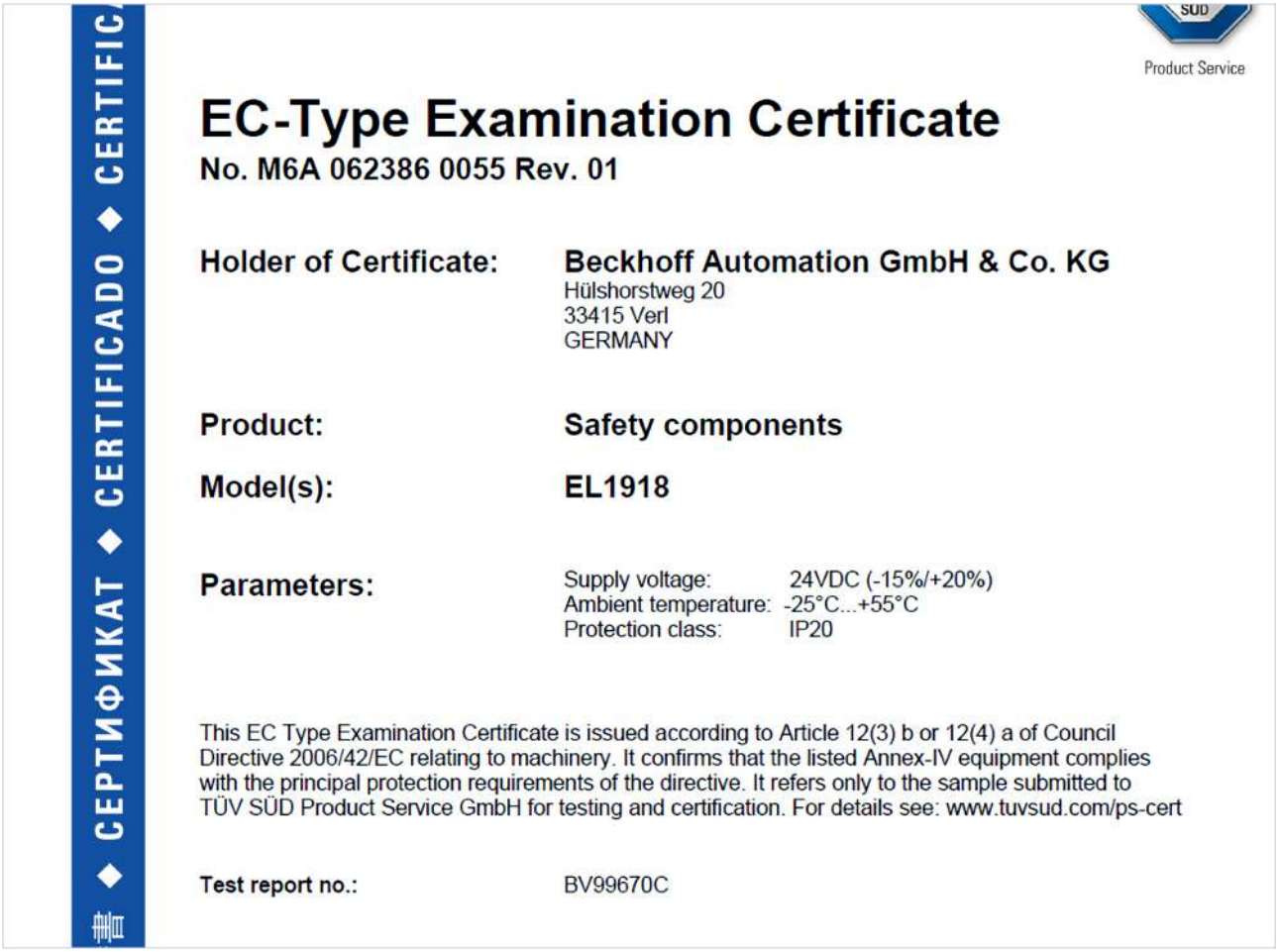
If there is customer specific data saved on the product, it cannot be ensured that this data might not be restored through for example forensic measures, even after the data is deleted through the provided tool chain. If this data is confidential, the scrapping of the product after usage is recommended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

14.3 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.

More Information:
www.beckhoff.com/twinsafe

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com