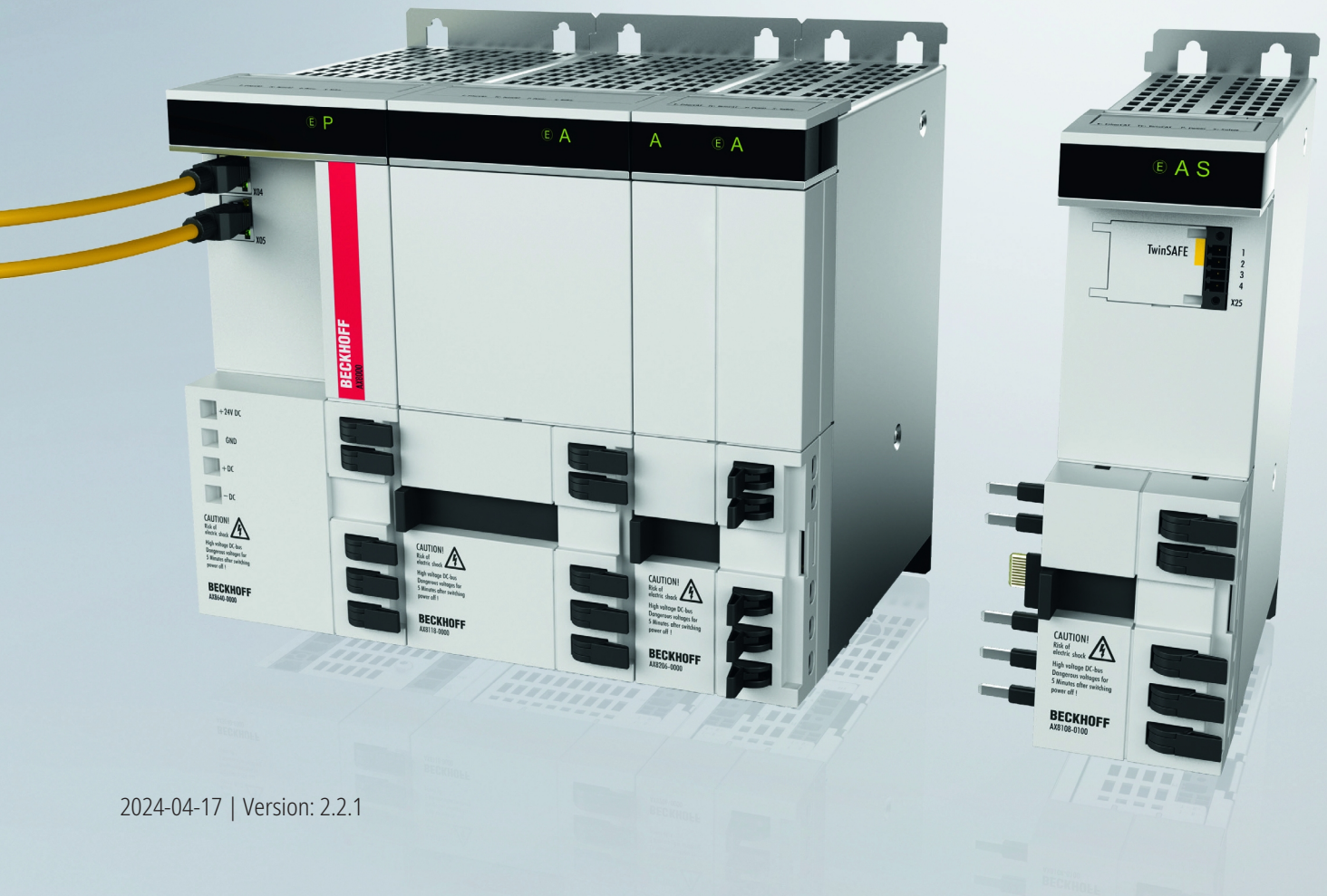


# BECKHOFF New Automation Technology

Operating Instructions | EN

## AX8911

TwinSAFE drive option card for servo drive AX8xxx-x1xx





# Table of contents

<b>1</b>	<b>Notes on the documentation</b> .....	<b>5</b>
1.1	Disclaimer.....	5
1.1.1	Trademarks.....	5
1.1.2	Patents.....	5
1.1.3	Limitation of liability.....	6
1.1.4	Copyright.....	6
1.2	Version numbers.....	7
1.3	References.....	8
1.3.1	Document classification in the overall documentation.....	8
1.4	Version history.....	9
1.5	Staff qualification.....	9
1.6	Safety and instruction.....	10
1.7	Beckhoff Support and Service.....	11
1.8	Notes on information security.....	12
<b>2</b>	<b>For your safety</b> .....	<b>13</b>
2.1	Due diligence.....	13
2.2	General safety instructions.....	13
2.2.1	Before operation.....	13
2.2.2	During operation.....	14
2.2.3	After operation.....	15
<b>3</b>	<b>System description</b> .....	<b>16</b>
<b>4</b>	<b>Product overview</b> .....	<b>17</b>
4.1	Product description.....	17
4.2	Type key.....	18
4.3	Intended use.....	18
<b>5</b>	<b>Technical data</b> .....	<b>19</b>
5.1	Product data.....	19
5.2	Target failure measures.....	20
5.2.1	STO + SS1-t.....	20
5.3	Environmental conditions.....	21
5.4	AX8911 project design limits.....	22
5.5	Error reaction.....	23
5.5.1	Global Shutdown.....	23
5.5.2	Global Fault.....	23
5.5.3	Module Shutdown.....	23
5.6	Lifetime.....	24
5.6.1	Name plate.....	25
<b>6</b>	<b>Mechanical installation</b> .....	<b>26</b>
6.1	Control cabinet / terminal box.....	26
<b>7</b>	<b>Electrical installation</b> .....	<b>27</b>
7.1	Digital inputs.....	27
7.2	Connection technology.....	28
7.3	Address setting.....	29

<b>8</b>	<b>Factory setting project</b>	<b>30</b>
8.1	Description	30
8.2	Error reaction	30
8.3	Factory state process image in the I/O tree	30
8.4	Factory setting STO in the TwinSAFE drive option card	31
8.5	Creating a project with the Safe Motion Wizard	33
<b>9</b>	<b>Configuration in TwinCAT</b>	<b>38</b>
9.1	Safety Device Info	38
9.2	Addition of an axis module	39
9.3	Using the AX8911 with the factory setting project	39
9.4	Use of the AX8911 with a safety-related user program	42
9.5	Manual creation of safety functions	44
9.6	Safety parameters	44
9.6.1	STO	44
<b>10</b>	<b>Local process image</b>	<b>46</b>
10.1	Input	46
10.2	Output	48
<b>11</b>	<b>Application examples</b>	<b>51</b>
11.1	Using the STO inputs with TwinSAFE outputs	51
11.2	Using the STO inputs with a third-party safety controller	52
11.3	Using the STO function via FSoE	53
<b>12</b>	<b>Appendix</b>	<b>54</b>
12.1	Certificate	54
12.2	Volatility	56
12.3	Focus of certificates	57

# 1 Notes on the documentation

## 1.1 Disclaimer

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

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

### 1.1.1 Trademarks

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

### 1.1.2 Patents

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

- EP1590927
- EP1789857
- EP1456722
- EP2137893
- DE102015105702



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



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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

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

## 1.2 Version numbers

Version	Comment
2.2.1	<ul style="list-style-type: none"> <li>• Corrections</li> <li>• Chapter name changed to "Version numbers"</li> </ul>
2.2.0	<ul style="list-style-type: none"> <li>• Documentation name changed to "Operating Instructions"</li> <li>• "Lifetime" and "target failure measures" renamed</li> <li>• Chapter "Notes on information security" added</li> <li>• Safety instructions for engineering tools revised</li> <li>• Chapters "Target failure measures" and "Environmental conditions" adapted</li> </ul>
2.1.0	<ul style="list-style-type: none"> <li>• Safety parameters removed from chapter "Type key"</li> </ul>
2.0.0	<ul style="list-style-type: none"> <li>• Title page updated</li> <li>• Editorially revised</li> <li>• Chapter "Signal words" revised</li> <li>• Warning added: Certification for third-party motors invalid</li> <li>• Division of the AX8911 documentation into               <ul style="list-style-type: none"> <li>◦ AX8911 for AX8xxx-x1xx</li> <li>◦ AX8911 for AX8xxx-x2xx</li> <li>◦ TwinSAFE Safe Motion functions</li> </ul> </li> </ul>
1.2.0	<ul style="list-style-type: none"> <li>• General revision</li> </ul>
1.1.0	<ul style="list-style-type: none"> <li>• Description of the Safe Motion functions added</li> <li>• Safety instructions adapted to IEC 82079-1</li> <li>• Illustration of the safety parameters updated</li> </ul>
1.0.0	<ul style="list-style-type: none"> <li>• Certificate added</li> <li>• Description of the safe inputs and outputs added</li> </ul>
0.4.0	<ul style="list-style-type: none"> <li>• Safety parameters for the STO and SS1 functions added</li> </ul>
0.3.0	<ul style="list-style-type: none"> <li>• Description of the Safe Motion functions updated</li> </ul>
0.2.0	<ul style="list-style-type: none"> <li>• Preliminary (internal only)</li> </ul>
0.1.0	<ul style="list-style-type: none"> <li>• Preliminary (internal only)</li> </ul>

### 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	<b>Functional description AX8000 – multi-axis servo system</b> The function description contains information about the configuration in the TC3 Drive Manager 2 and the functions included.
[2]	1.0 or newer	<b>Original operating instructions AX8000 – Multi-axis servo system</b> 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	<b>Operating instructions for EL6910 TwinSAFE Logic module</b> 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	<b>Documentation TwinSAFE Logic FB</b> 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	<b>TwinSAFE Application Guide</b> 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	<b>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</b> 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	<b>TwinSAFE Safe Motion functions</b> 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 firmware version numbers. You will also find an overview of the available ModuleIdents and which firmware supports which ModuleIdents. See the following table.

Date	ModuleIdent	AX8911 firmware version	AX8000 firmware version
2020-05-12	#x00670070	01 (V0109)	<b>AX8xxx FW 0103</b> , AX8xxx FW 0104, AX8xxx FW 0105, AX8xxx FW 0106
2021-05-18	#x00680070	03 (V0113)	<b>AX8xxxFW 0104</b> , AX8xxx FW 0105, AX8xxx FW 0106
	#x00690070		<b>AX8xxx FW 0105</b> , AX8xxx FW 0106
2023-06-11	#x006a0070	04 (V0116)	<b>AX8xxx FW 0106</b>

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.

### Explanation of symbols

Various symbols are used for a clear arrangement:

1. The numbering indicates an action that should be taken.
  - The bullet point indicates an enumeration.
- [...] The square brackets indicate cross-references to other text passages in the document.
- [1] The number in square brackets indicates the numbering of a referenced document.

The signal words used in the documentation are classified below.

### Signal words

#### Warning of personal injuries

##### **DANGER**

Hazard with high risk of death or serious injury.

##### **WARNING**

Hazard with medium risk of death or serious injury.

##### **CAUTION**

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

#### Warning of damage to property or environment

##### **NOTICE**

##### **Notes**

The environment, equipment, or data may be damaged.

#### Information on handling the product



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

## 1.7 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](mailto:support@beckhoff.com)  
Web: [www.beckhoff.com/support](http://www.beckhoff.com/support)

### Training

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

Hotline: +49 5246/963-5000  
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### Service

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Hotline: +49 5246/963-460  
E-mail: [service@beckhoff.com](mailto:service@beckhoff.com)  
Web: [www.beckhoff.com/service](http://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](http://www.beckhoff.com/download)

### Headquarters

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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

**i** 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<sub>DC</sub>, 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](#) [► 30].

#### **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  $\mu\text{s}$ , the speed controller cycle time is 16  $\mu\text{s}$  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  $\mu\text{s}$ .

#### **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](#) [► 30].

The variant in the AX8xxx-x1xx axis modules provides the STO (Safe Torque Off) safety function.

#### 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 is not suitable for your application, 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](#) [► 33].

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-x1xx	<b>Stop functions</b>			
	<b>STO</b>	Safe torque off		
	<b>SS1</b>	Safe stop 1	- t	Time controlled

## 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](#) [▶ 19] or which does not observe other specifications from these operating instructions or other documents of the overall documentation is considered to be not in accordance with the intended use and is therefore prohibited.

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

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

## 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
<b>Response times</b>		
• 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	
<b>Process image</b>		
• Input	6 to 51 bytes (1 to 24 bytes Safe Data)	For more information, see the chapter <a href="#">Local process image</a> [▶ 46].
• Output	6 to 59 bytes (1 to 28 bytes Safe Data)	

Other product data		Explanation
• Supply voltage	24 V <sub>DC</sub> (+ 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 in document [2] at <a href="#">References</a> [▶ 8].

## 5.2 Target failure measures

### **i** Calculation of the $MTTF_D$ value from the $PFH_D$ value

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

- TwinSAFE Application Guide
- EN ISO 13849-1:2015; 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](#) [► 24].

## 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<sup>1</sup>
- in an environment that would lead to impermissible contamination of the TwinSAFE drive option card

<sup>1</sup> *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.

<b>TwinSAFE connections</b>	max. 8 (up to 12 CRCs in total; 1 CRC is required for a TwinSAFE connection with 1 or 2 byte safe data.)
<b>Safe data per TwinSAFE connection</b>	maximum 24 byte (telegram length 51 byte)
<b>TwinSAFE blocks</b>	maximum 512 (ESTOP with complete input and output mapping)
<b>TwinSAFE groups</b>	max. 128
<b>TwinSAFE user</b>	40 max.
<b>Standard PLC inputs</b>	dynamic (memory-dependent), max. 54 byte
<b>Standard PLC outputs</b>	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](#) [► 20].

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.*

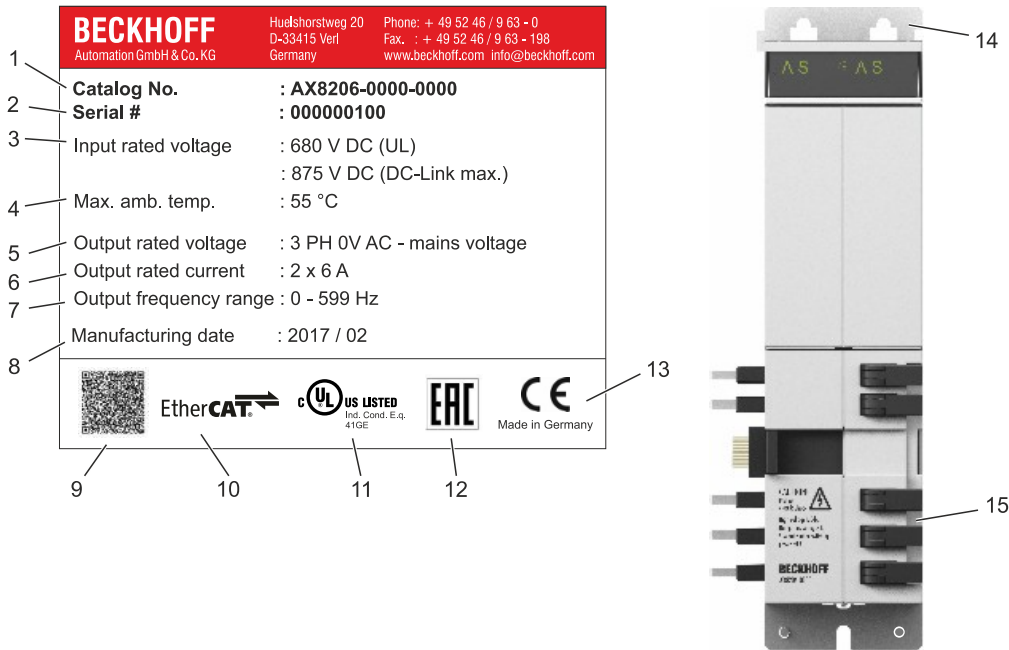
Due to the high diagnostic coverage within the lifecycle no special proof tests are required.

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](#) [► 25] 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<sub>DC</sub>), 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<sub>DC</sub>), 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.

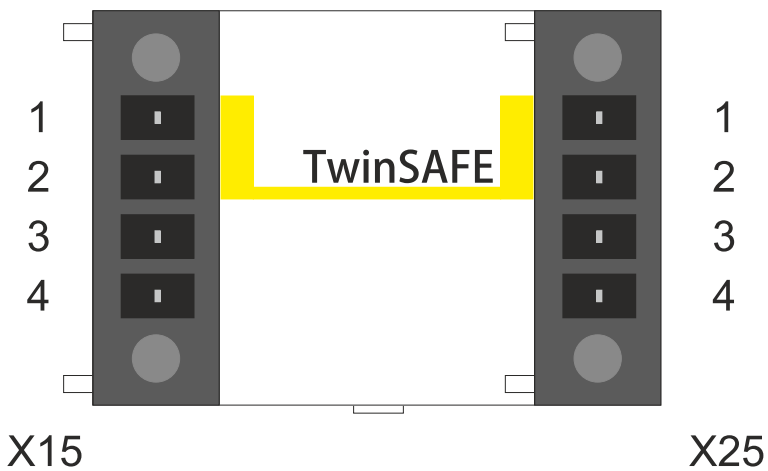



Fig. 1: AX8911: Connection to X15 and X25

## 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 <b>with</b> plastic collar)	0.25 mm <sup>2</sup> - 1 mm <sup>2</sup>

For further information on wiring, please refer to the chapter [Using the STO inputs with a third-party safety controller](#) [► 52].

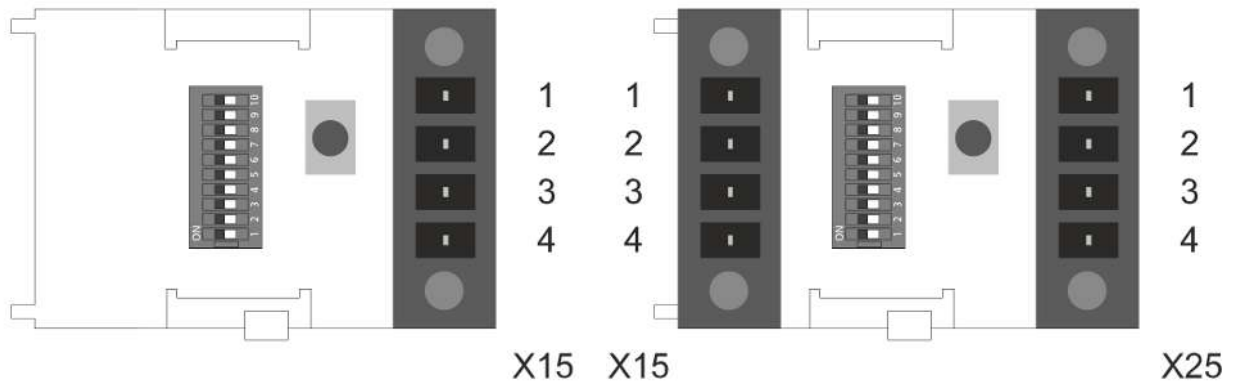
### 7.3 Address setting

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 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.

### 8.1 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.

### 8.2 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.

### 8.3 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](#) [▶ 38].

**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	<b>True:</b> No STO, STO outputs are enabled <b>False:</b> 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) <b>True:</b> No STO, STO outputs are enabled <b>False:</b> STO, safe state

## 8.4 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.

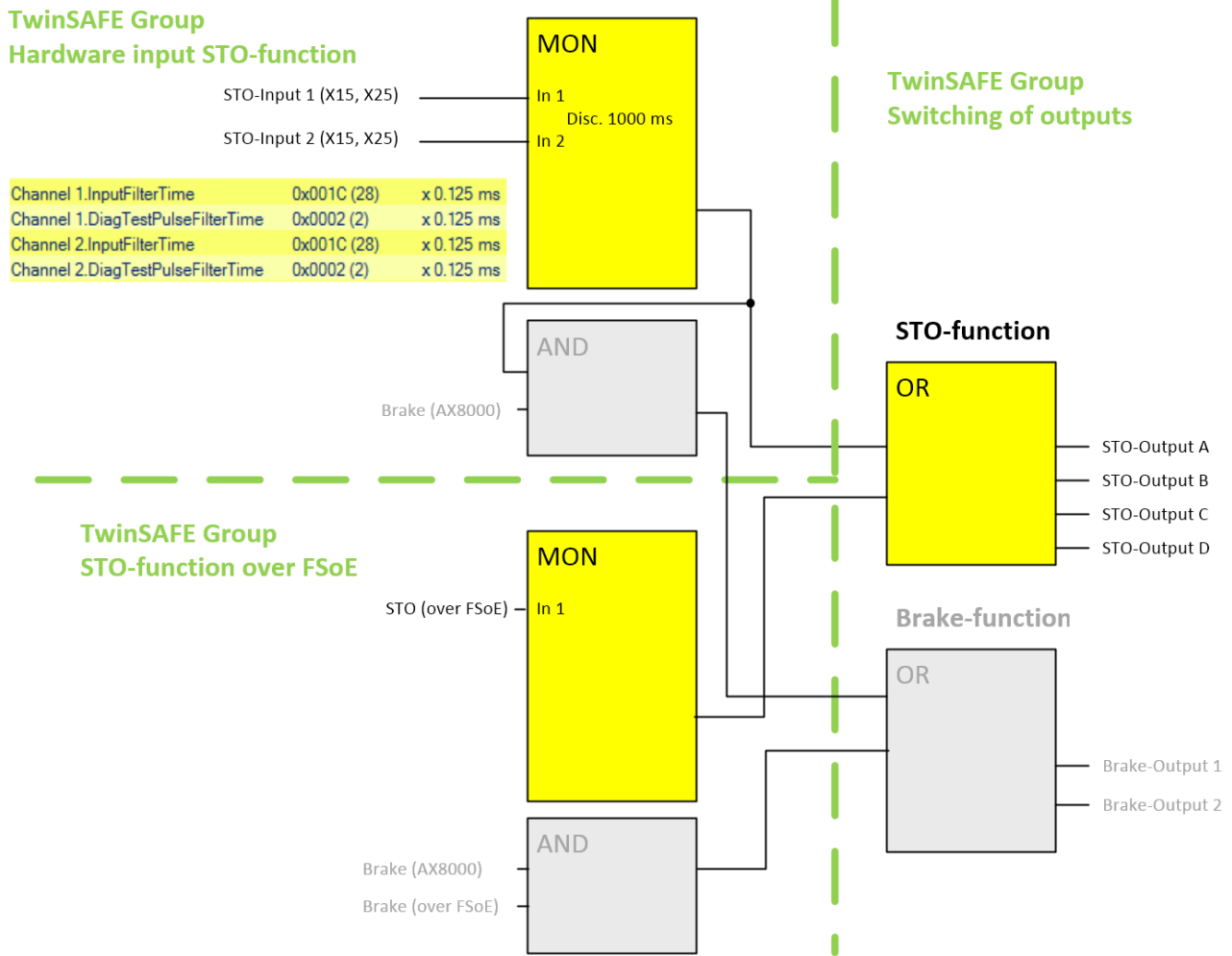


Fig. 2: AX8911 TwinSAFE logic program in factory setting

**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.

## 8.5 Creating a project with the Safe Motion Wizard

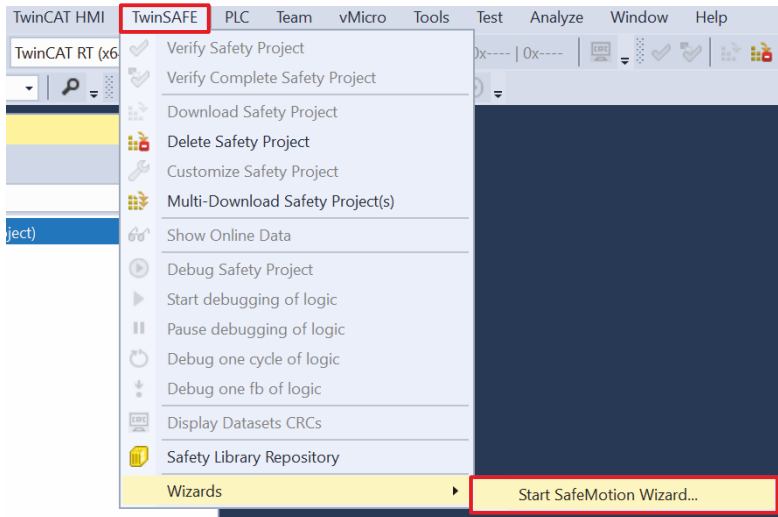
The Safe Motion Wizard is used to simplify the creation of safety projects for TwinSAFE Safe Motion functions, such as SLS or SS2.

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.

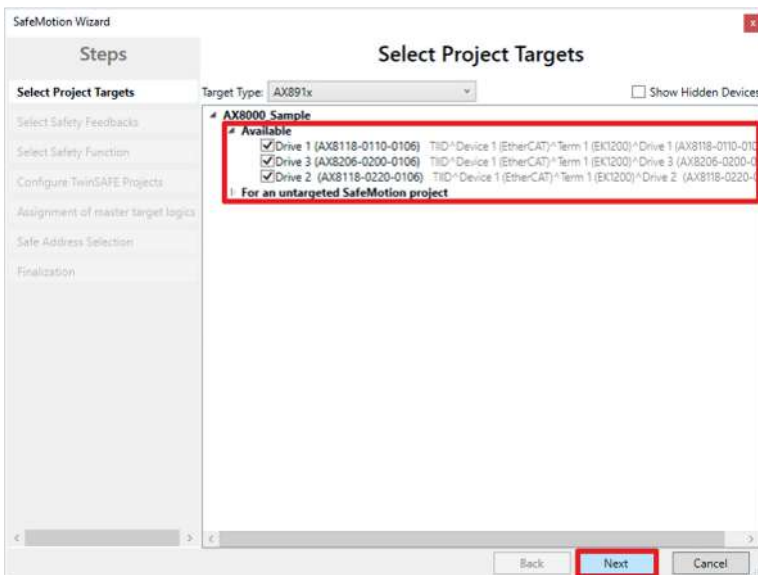
### ● Example connection to a master project

**i** 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:

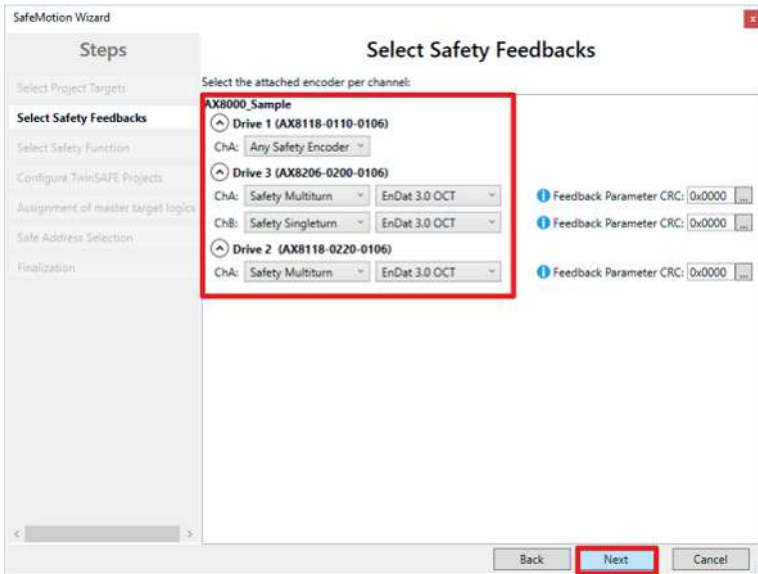


1. Select "TwinSAFE" in the menu bar
2. Select "Start SafeMotion Wizard" via the menu item "Wizards"



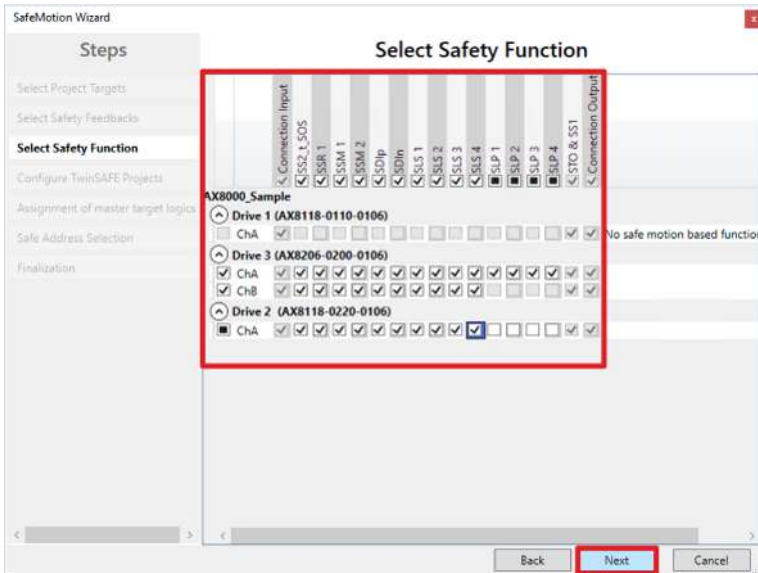
The "Select Project Targets" window shows the existing components and the virtual axes for single-axis and two-axis modules.

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



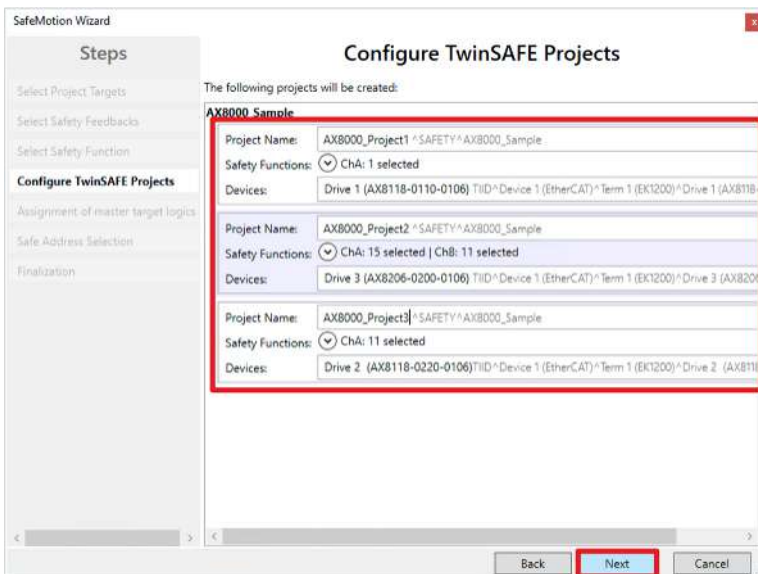
5. Configure the feedback in the "Select Motors" window

6. Confirm configuration with "Next"



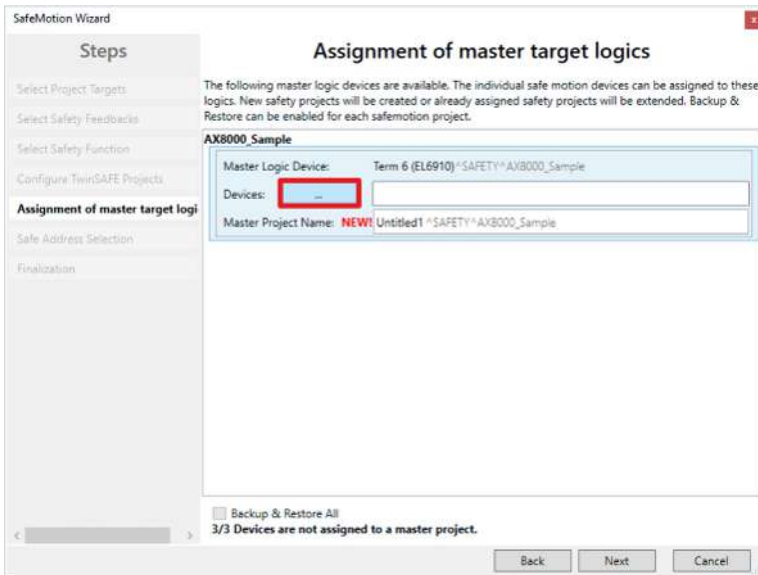
7. In the "Select Safety Function" window, select the safety functions of the axes

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.

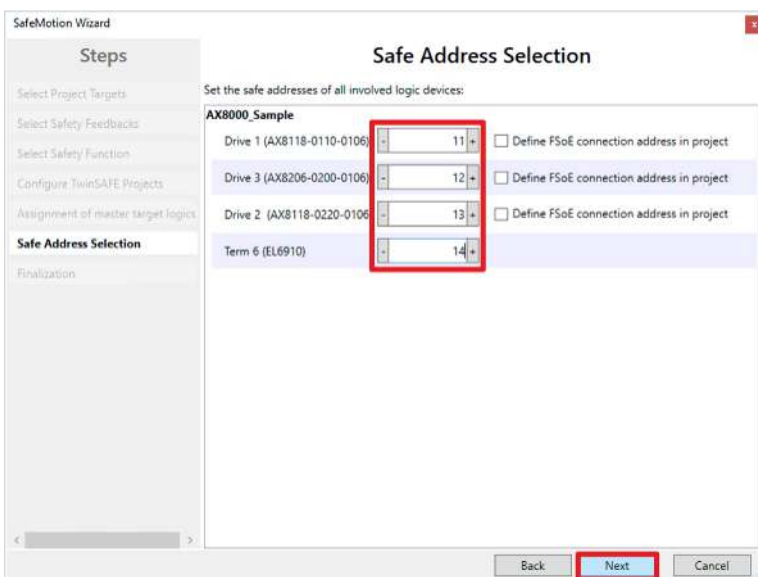
- 9. If desired, rename safety projects
- 10. Confirm the selection with "Next"



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

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

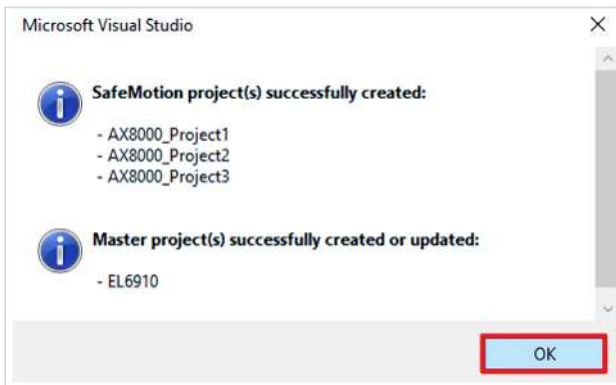
- 12. Confirm with "Next"



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

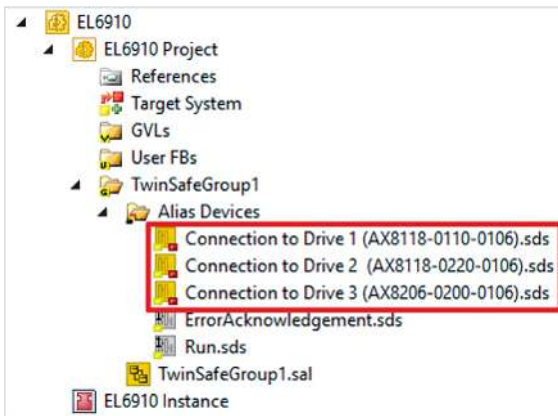
Alternatively, you can also configure the safe addresses within the safety project.

- 14. Confirm the settings with "Finish"



15. Confirm the window with "OK"

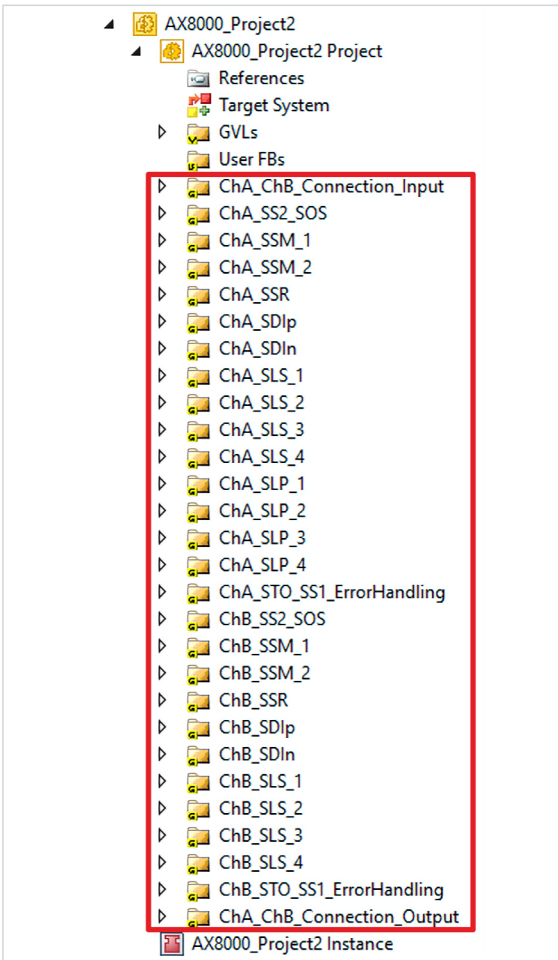
You have successfully generated the safety projects.



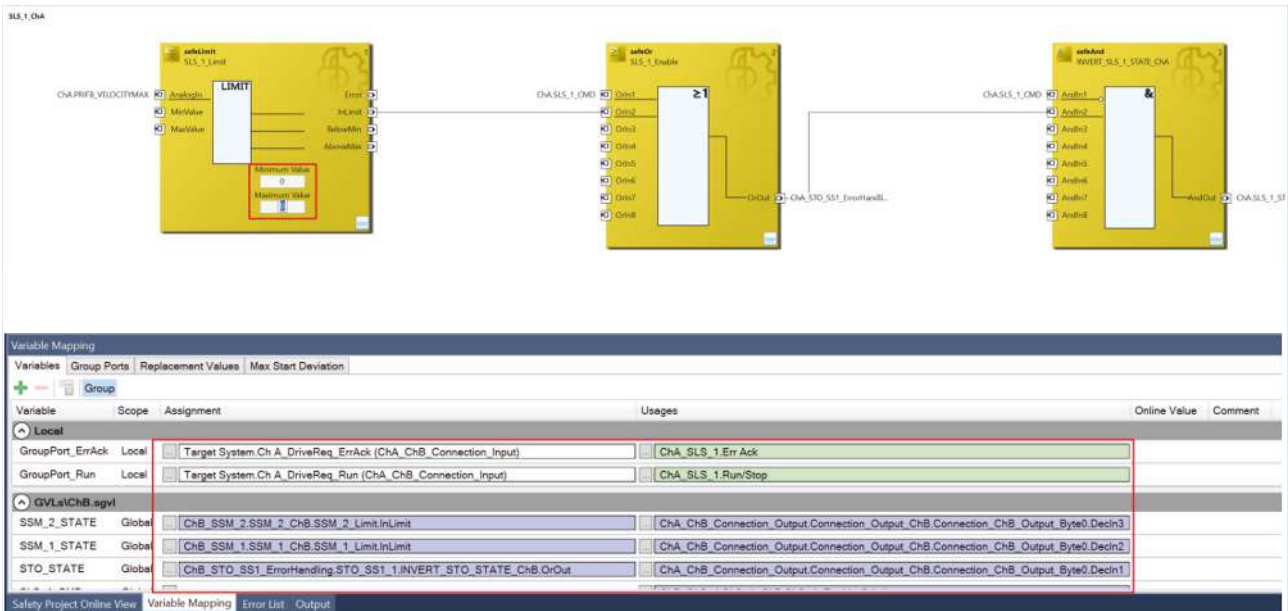
After this procedure you will receive a TC3-Solution with the corresponding safety projects for AX8000 and for example EL6910.

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].



## 9 Configuration in TwinCAT

### 9.1 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	<p>May include the following as of FW03 depending on the device:</p> <ul style="list-style-type: none"> <li> <b>1 Axis Drive:</b>                      AX8911 a Axis (00b1-81xx)                     <ul style="list-style-type: none"> <li><b>a:</b> 1 or 2</li> <li><b>b:</b> SAFEMOTION (1), STO (0)</li> <li><b>xx:</b> Size</li> </ul> </li> <li> <b>2 Axis Drive:</b>                      AX8911 2 Axis (00b2-82xx)                     <ul style="list-style-type: none"> <li><b>b:</b> SAFEMOTION (1), STO (0)</li> <li><b>xx:</b> Size</li> </ul> </li> </ul>

## 9.2 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].

## 9.3 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](#) [31].

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

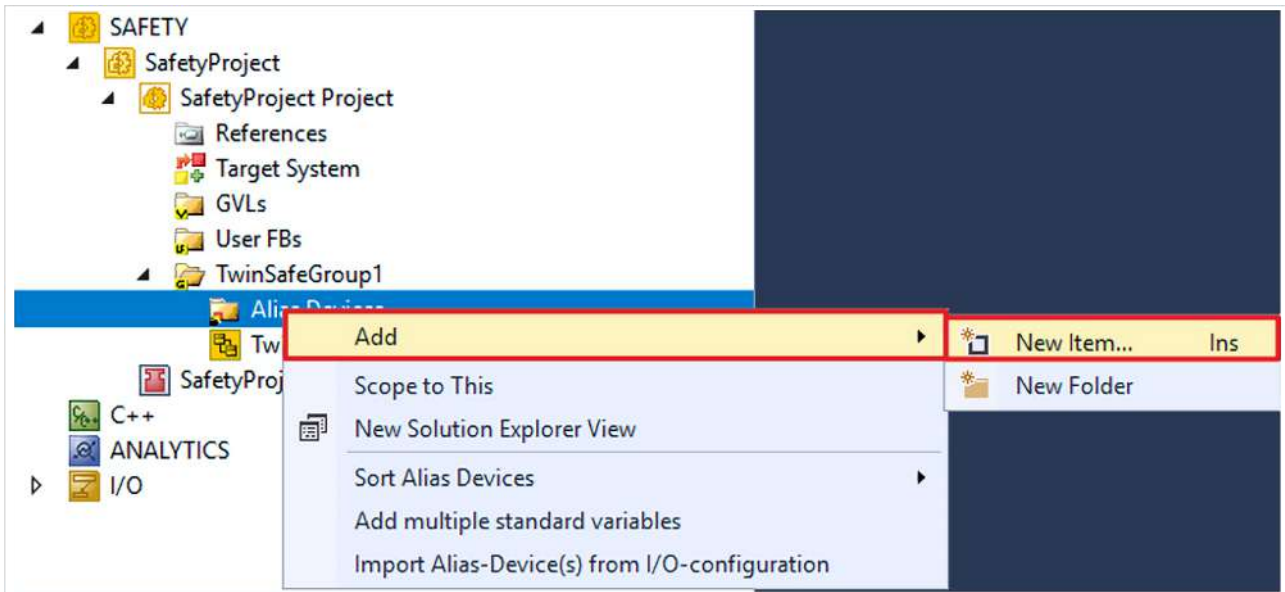


Fig. 4: Insertion of an *alias device*

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

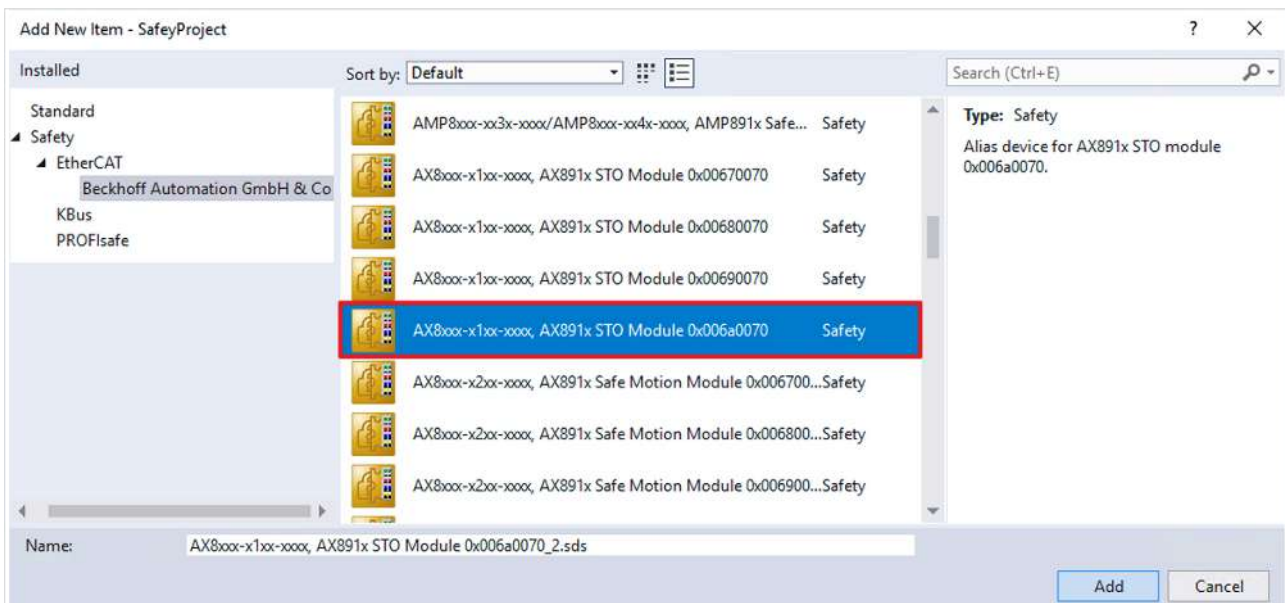


Fig. 5: Dialog *Add New Item* AX891x (Safe Drive Module)

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.

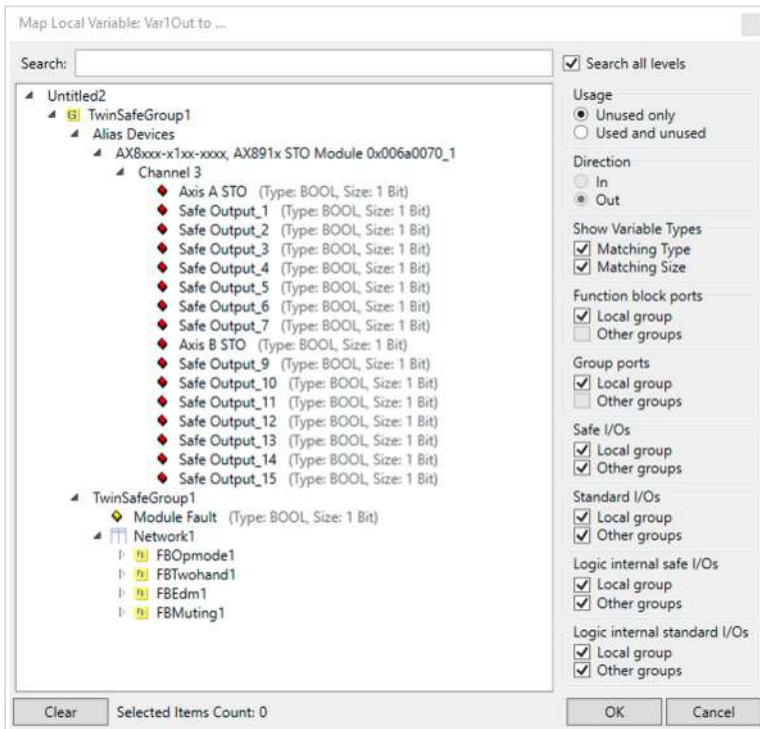


Fig. 6: Dialog for linking the variables of the AX8911

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

The screenshot displays a TwinCAT project window titled 'TwinSafeGroup1.sal'. The main area shows a ladder logic diagram for a function block named 'safeMon' (FBMon1). The diagram includes several input variables: 'Restart', 'Door\_in1' (MonIn1), 'Door\_in2' (MonIn2), 'MonIn3', 'MonIn4', 'Secure1', 'Secure2', 'EDM1', and 'EDM2'. The logic consists of two parallel AND gates. The first AND gate combines 'Restart' and 'Door\_in1'. The second AND gate combines 'Secure1' and 'Secure2'. The outputs of these AND gates are connected to a '≥ 1' (OR) gate. The output of the OR gate is connected to a 'Delay Time (ms)' block set to 100. The output of the delay block is connected to 'MonOut' and 'MonDelOut'. The 'Error' output is also shown. The 'Out\_Axis\_A\_B' output is connected to 'MonOut'.

Below the diagram is the 'Variable Mapping' section, which includes a table with the following data:

Variable	Scope	Assignment	Usages	Online Value
GroupPort_ErrAck	Local	ErrorAcknowledgement.In (TwinSafeGroup1)	TwinSafeGroup1.Err Ack	
GroupPort_RunStop	Local	Run.In (TwinSafeGroup1)	TwinSafeGroup1.Run/Stop	
Restart	Local	EL1904_BMK 4711.InputChannel4 (TwinSafeGroup1)	TwinSafeGroup1.Network1.FBMon1.Restart	
Door_in1	Local	EL1904_BMK 4711.InputChannel1 (TwinSafeGroup1)	TwinSafeGroup1.Network1.FBMon1.MonIn1	
Door_in2	Local	EL1904_BMK 4711.InputChannel2 (TwinSafeGroup1)	TwinSafeGroup1.Network1.FBMon1.MonIn2	
Out_Axis_A_B	Local	TwinSafeGroup1.Network1.FBMon1.MonOut	AX8xxx-x1xx-xxxx, AX891x STO Module 0x006a0070.Axis A STO (TwinSafeGroup1) AX8xxx-x1xx-xxxx, AX891x STO Module 0x006a0070.Axis B STO (TwinSafeGroup1)	

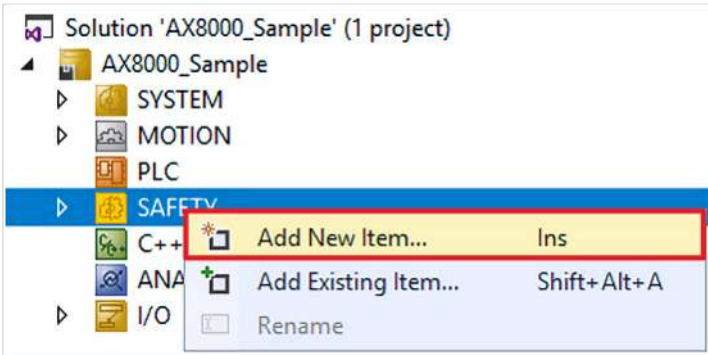
Fig. 7: Projects with outputs to the AX8911

## 9.4 Use of the AX8911 with a safety-related user program

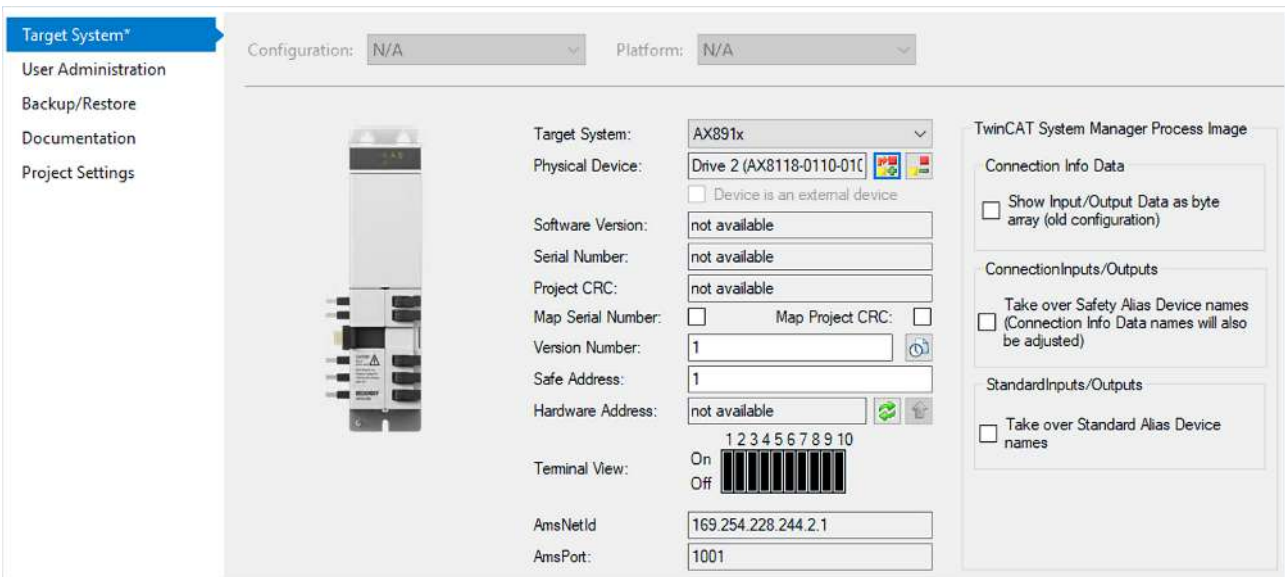
To use your TwinSAFE drive option card with a safety-related user program, you must make certain settings for the target system and the inputs and outputs.


### 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:

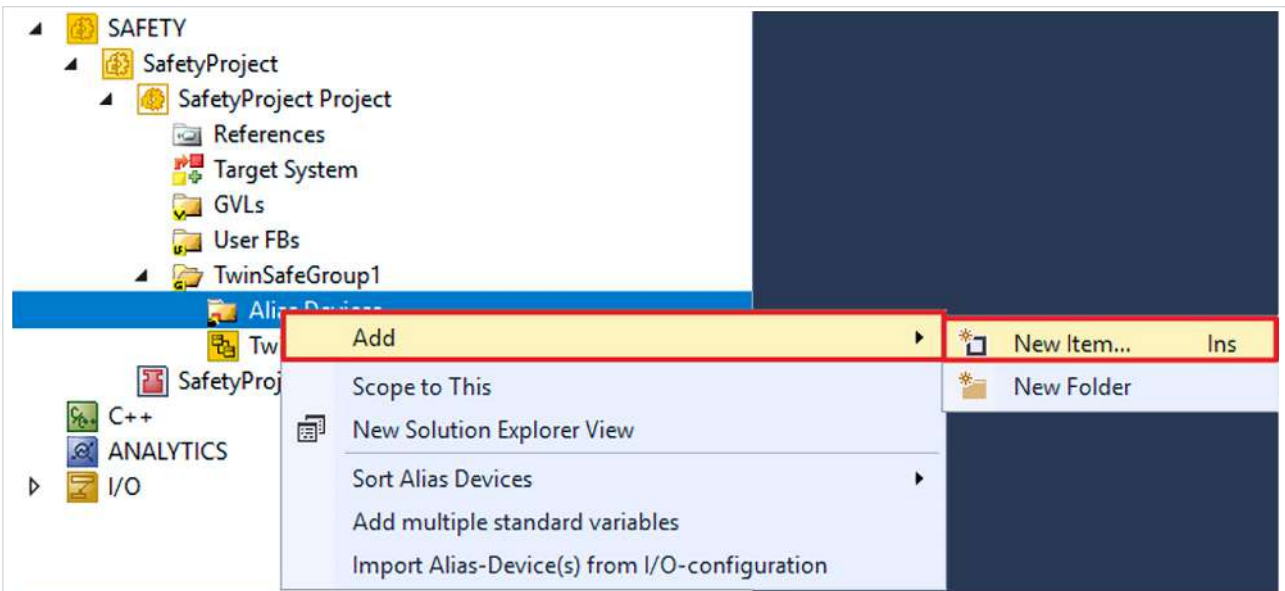


1. Right click on the safety configuration
2. Click on "Add New Item..."



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

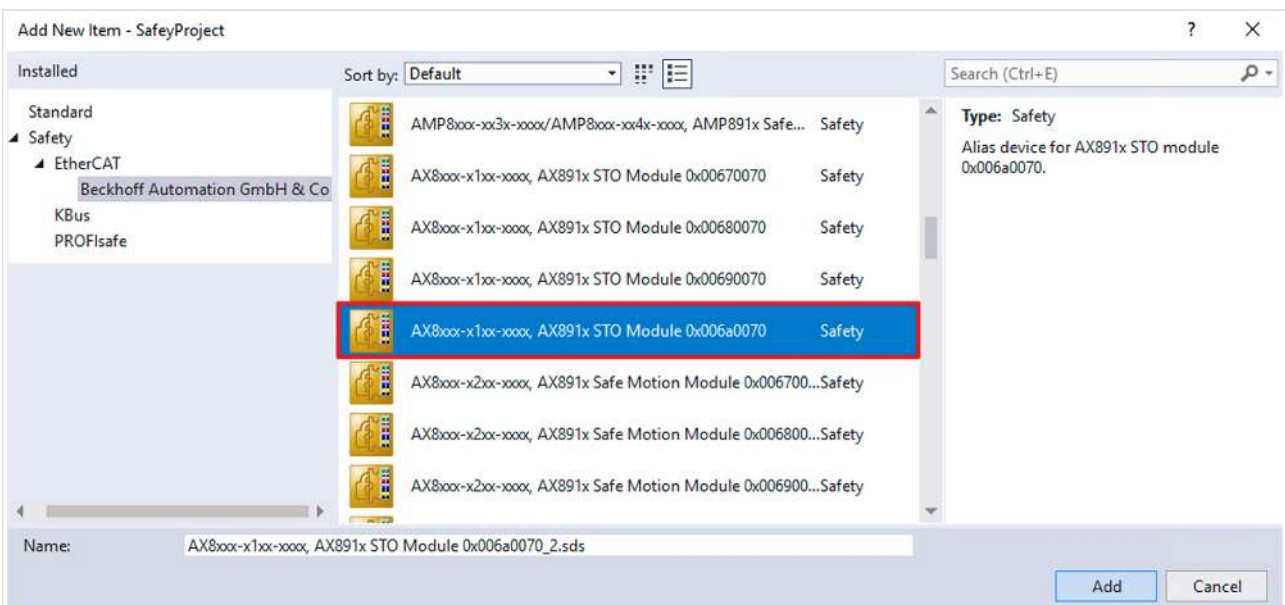


Fig. 8: AX8911 - Add new item - Alias Device AX891x

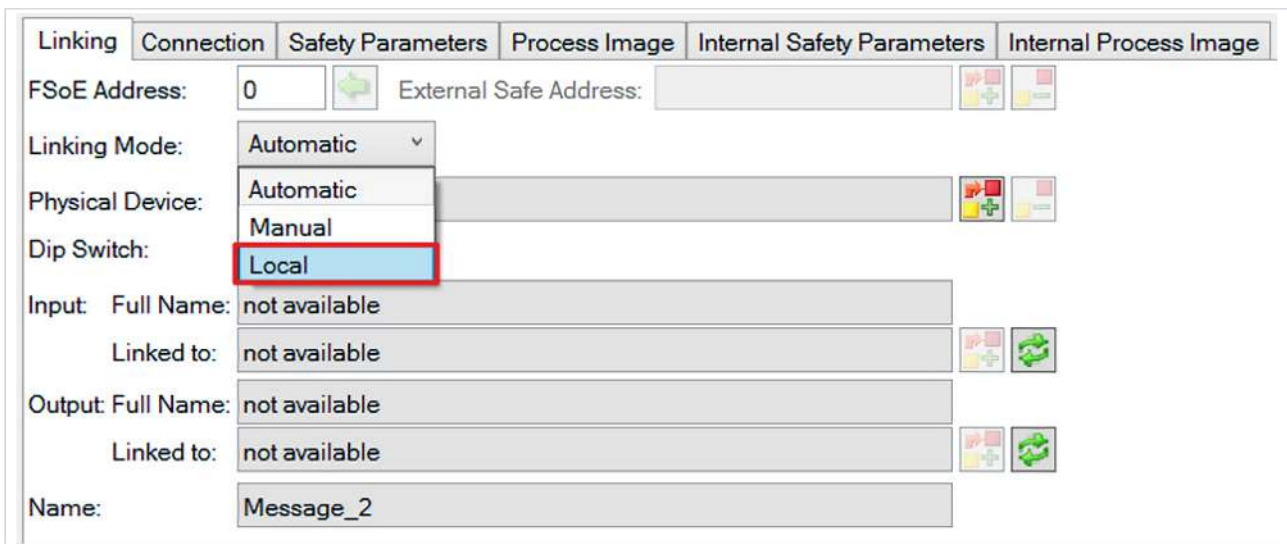
The "Add New Item" window opens. Here you can select your desired AX8xxx variant. The name and the ModuleIdent in the alias device description tell you which AX8911 variant it is.

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-x1xx" for the STO 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](#) [▶ 44].

**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](#).

## 9.5 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.

## 9.6 Safety parameters

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

### 9.6.1 STO

The following internal safety parameters are available for the AX8xxx-x1xx order option.

Index	Name	Data type	Description
<b>FSOUT settings</b>			
0xC110:01h	Ch A FSOUT BRAKE ModuloDiagTestPulse	UINT8	Modulo value for the frequency of the generation of a test pulse. 0 -> every time 1 -> every second time and so on Factory setting: 100

Index	Name	Data type	Description
0xC110:02h	Ch A FSOUT BRAKE MultiplierDiagTestPulse	UINT8	Length of the test pulse in multiples of 625 µs Factory setting: 1 Minimum: 1 Maximum: 255
0xC110:04h	Ch A FSOUT BRAKE Diag TestPulse active	BOOL	<b>True:</b> Test pulses active <b>False:</b> Test pulses inactive
0xC390:01h	Ch B FSOUT BRAKE ModuloDiagTestPulse	UINT8	Modulo value for the frequency of the generation of a test pulse. 0 -> every time 1 -> every second time and so on Factory setting: 100
0xC390:02h	Ch B FSOUT BRAKE MultiplierDiagTestPulse	UINT8	Length of the test pulse in multiples of 625 µs Factory setting: 1 Minimum: 1 Maximum: 255
0xC390:04h	Ch B FSOUT BRAKE Diag TestPulse active	BOOL	<b>True:</b> Test pulses active <b>False:</b> Test pulses inactive
<b>FSIN settings</b>			
0xC121:01h	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
0xC121:04h	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
0xC3A1:01h	Ch B FSIN Channel 1.InputFilterTime (in 125 µs)	UINT16	Input filter time of the input X25.1 [in µs] 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
<b>Functional settings</b>			
0xC130:01h	Ch A FSDRIVE Brake Control Enabled	BOOL	<b>True:</b> Brake control active <b>False:</b> Brake control inactive
0xC130:02h	Ch A FSDRIVE Primary Feedback Enabled	BOOL	<b>True:</b> Primary Feedback active <b>False:</b> Primary Feedback inactive
0xC130:03h	Ch A FSDRIVE Secondary Feedback Enabled	BOOL	<b>True:</b> Secondary Feedback active <b>False:</b> Secondary Feedback inactive
0xC3B00:01h	Ch B FSDRIVE Brake Control Enabled	BOOL	<b>True:</b> Brake control active <b>False:</b> Brake control inactive
0xC3B00:02h	Ch B FSDRIVE Primary Feedback Enabled	BOOL	<b>True:</b> Primary Feedback active <b>False:</b> Primary Feedback inactive
0xC3B00:03h	Ch B FSDRIVE Secondary Feedback Enabled	BOOL	<b>True:</b> Secondary Feedback active <b>False:</b> Secondary Feedback inactive



## 10 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.

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

Offset	Name	Data type	Group	Description
2.0	ChA_EncoderVoltage_Underange	BOOL	Standard	<b>True:</b> Undervoltage at encoder (OCT or EnDat axis 1) <b>False:</b> No error (link to output signal 6.4)
2.1	ChA_EncoderVoltage_Overrange	BOOL	Standard	<b>True:</b> Overvoltage at encoder (OCT or Endat axis 1) <b>False:</b> No error (link to output signal 6.5)
2.2	ChA_EncoderVoltage_Error	BOOL	Standard	<b>True:</b> Axis 1 encoder voltage error <b>False:</b> No error
2.3	ChA_DriveReq_Activate_Encoder	BOOL	Standard	<b>True:</b> Encoder of axis 1 is switched on according to AX8xxx. <b>False:</b> 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 ( $2\pi$ 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_Underange	BOOL	Standard	<b>True:</b> Undervoltage at encoder (OCT or EnDat axis 2) <b>False:</b> No error (link to output signal 6.4)
24.1	ChB_EncoderVoltage_Overrange	BOOL	Standard	<b>True:</b> Overvoltage at encoder (OCT or EnDat axis 2) <b>False:</b> No error (link to output signal 6.5)
24.2	ChB_EncoderVoltage_Error	BOOL	Standard	<b>True:</b> Axis 2 encoder voltage error <b>False:</b> No error
24.3	ChB_DriveReq_Activate_Encoder	BOOL	Standard	<b>True:</b> Encoder of axis 2 is switched on according to AX8xxx. <b>False:</b> 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 ( $2\pi$ 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)

## 10.2 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	<b>True:</b> Enable switch-off path A (STO axis 1, port X13) <b>False:</b> Disable switch-off path A (STO axis 1, port X13)
0.1	ChA_STO_2	BOOL	Safety	<b>True:</b> Enable switch-off path B (STO axis 1, port X13) <b>False:</b> Disable switch-off path B (STO axis 1, port X13)
0.2	ChA_STO_3	BOOL	Safety	<b>True:</b> Enable switch-off path C (STO axis 1, port X13) <b>False:</b> Disable switch-off path C (STO axis 1, port X13)
0.3	ChA_STO_4	BOOL	Safety	<b>True:</b> Enable switch-off path D (STO axis 1, port X13) <b>False:</b> 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	<b>True:</b> Enable to AX8xxx: Output stage is enabled for AX8xxx (axis 1) <b>False:</b> Output stage is disabled for AX8000.
0.6	ChB_STO_1	BOOL	Safety	<b>True:</b> Enable switch-off path A (STO axis 2, port X23) <b>False:</b> Disable switch-off path A (STO A axis 2, port X23)
0.7	ChB_STO_2	BOOL	Safety	<b>True:</b> Enable switch-off path B (STO axis 2, port X23) <b>False:</b> Disable switch-off path B (STO axis 2, port X23)
1.0	ChB_STO_3	BOOL	Safety	<b>True:</b> Enable switch-off path C (STO axis 2, port X23) <b>False:</b> Disable switch-off path C (STO axis 2, port X23)
1.1	ChB_STO_4	BOOL	Safety	<b>True:</b> Enable switch-off path D (STO axis 2, port X23) <b>False:</b> 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	<b>True:</b> Enable to AX8xxx: Output stage is enabled for AX8xxx (axis 2) <b>False:</b> Output stage is disabled for AX8xxx. (1=Port to Drive Application is 0 (no STO))
1.4	ChA_Brake_Release	BOOL	Safety	<b>True:</b> Release brake (axis 1, port X13.B+ and B-) <b>False:</b> 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	<b>True:</b> Release brake (axis 2, port X23.B+ and B-) <b>False:</b> 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)

Offset	Name	Data type	Group	Description
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 AX8000: Group error at axis 2
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
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.
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.

Offset	Name	Data type	Group	Description
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.
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.

# 11 Application examples

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 \[▶ 8\]](#).

## 11.1 Using the STO inputs with TwinSAFE outputs

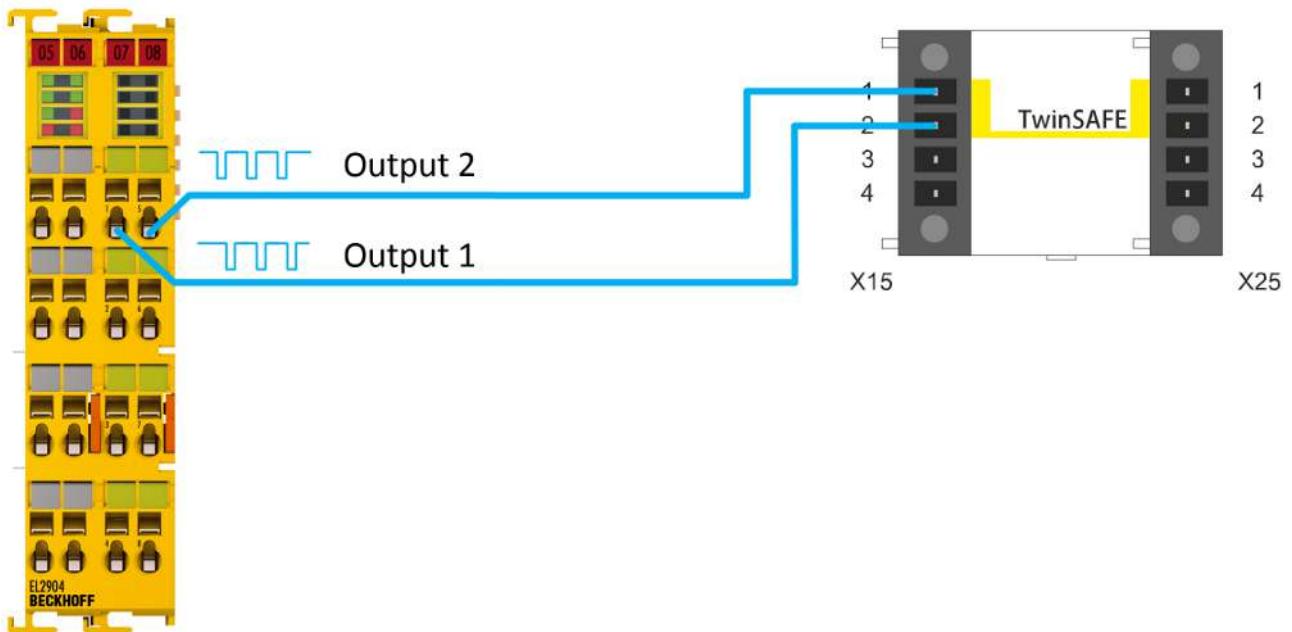


Fig. 9: TwinSAFE outputs connected to STO inputs

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.

## 11.2 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.

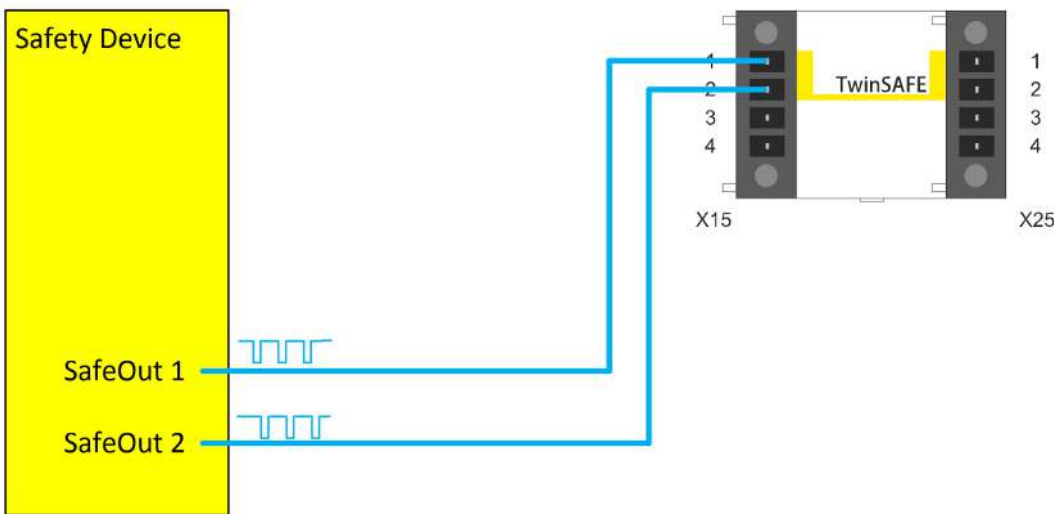


Fig. 10: Safe outputs from a third-party manufacturer connected to STO inputs

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.

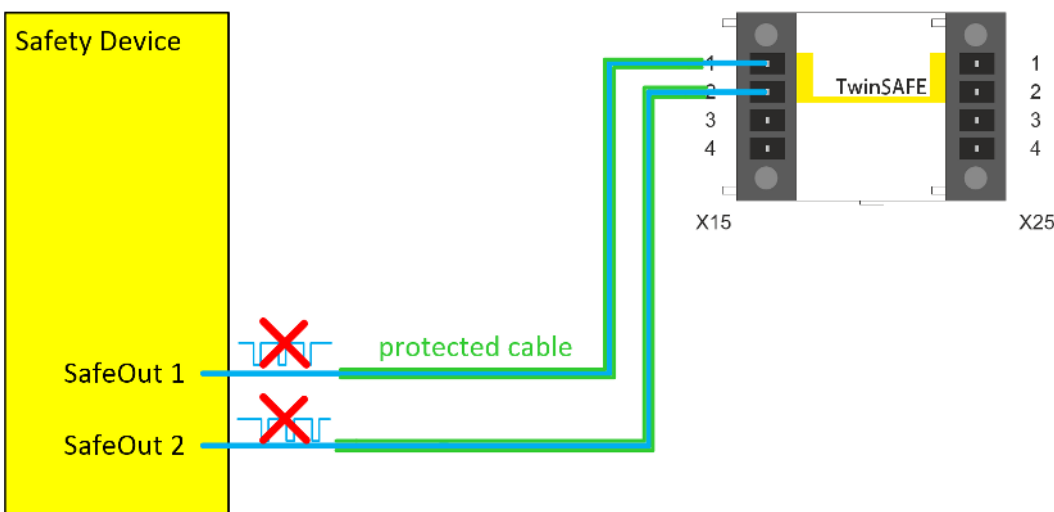


Fig. 11: Safe outputs from a third-party manufacturer connected to STO inputs without the use of test pulses

If the safety controller does not implement test pulses on the outputs, but only supplies static 24 V<sub>DC</sub> 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.



### 11.3 Using the STO function via FSoE

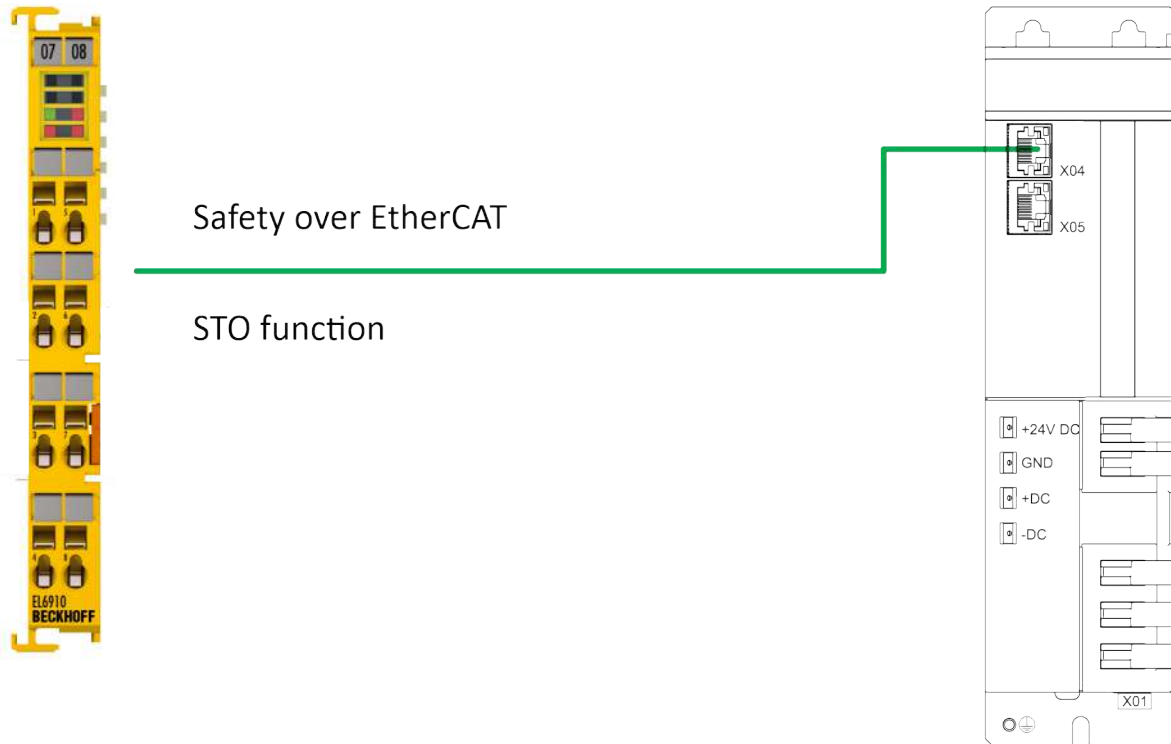


Fig. 12: STO function via TwinSAFE connection

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.



# 12 Appendix

## 12.1 Certificate

**BECKHOFF** New Automation Technology


**EU-Konformitätserklärung, EU Declaration of Conformity**

<b>Hersteller</b> <i>Manufacturer</i>	<b>Beckhoff Automam</b> GmbH & Co.KG
<b>Anschrift</b> <i>Address</i>	Hülshorstweg 20 33415 Verl Bundesrepublik Deutschland
<b>Produktbezeichnung</b> <i>Product description</i>	<b>Servoverstärker (siehe Anhang)</b> <i>Servo drives (see Appendix)</i>

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:*

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

Verl, den / the 17.07.2017

<b>Unterschrift, signature</b> <i>Name, name</i> <b>Funktion, function</b>	 <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <b>Hans Beckhoff</b> Geschäftsführer, <i>Executive Director</i>
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1 / 2

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

**BECKHOFF** New Automation Technology**EU-Konformitätserklärung**  
*EU declaration of conformity***Servoverstärker, Servo drives**

<b>Bestellnummer</b> <i>order number</i>	<b>Bezeichnung</b> <i>designation</i>
AX20xx-xxxx-xxxx	Digital Kompakt Servoverstärker, <i>Digital Compact Servo Drive</i>
AX25xx-xxxx-xxxx	Digital Kompakt Servoverstärker, <i>Digital Compact Servo Drive</i>
AX5xxx-xxxx-xxxx	Digital Kompakt Servoverstärker, <i>Digital Compact Servo Drive</i>
AX8xxx-xxxx-xxxx	Digital Kompakt Servoverstärker, <i>Digital Compact Servo Drive</i>

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

## 12.2 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.

### 12.3 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.



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/AX8911](http://www.beckhoff.com/AX8911)**

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