

# ctrlX SAFETY

Compact safety controller

Devices SAFEX-C.12 / SAFEX-C.15



The provided data is intended for programming description purposes. If any information on use is given, such information may only be viewed as application examples and suggestions. Catalog information does not constitute guaranteed properties. The information does not release users from the responsibility to perform their own assessments and tests. Our products are subject to a natural wear and aging process

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An example configuration is depicted on the title page. The delivered product may therefore differ from the depicted image.

The original programming manual was created in German.

# Content

<b>1</b>	<b>About this documentation</b>	<b>8</b>
1.1	Editions	8
1.2	Validity of the documentation	8
1.2.1	Technical Status	8
1.3	Required and supplementary documentation	9
1.4	Presentation of information	9
1.4.1	Safety instructions	9
1.4.2	Symbols	10
1.4.3	Terms	10
1.4.4	Abbreviations	11
<b>2</b>	<b>Safety instructions</b>	<b>12</b>
2.1	About this section	12
2.2	Intended use	13
2.3	Improper use	13
2.4	Qualification of personnel	14
2.5	General safety instructions	14
2.6	Product- and technology-dependent safety instructions	15
<b>3</b>	<b>General information about property damage and product damage</b>	<b>16</b>
<b>4</b>	<b>Scope of delivery</b>	<b>17</b>
<b>5</b>	<b>Requirements</b>	<b>18</b>
5.1	Compact safety controller ctrlX SAFETY	18
5.2	Network connection	18
5.2.1	EtherCAT	18
5.2.2	EtherCAT data transmission	19
5.2.3	FSoE	19
5.2.4	FSoE und EtherCAT	20
5.2.5	ctrlX SAFETY <sup>link</sup>	20
<b>6</b>	<b>Selection and parameterization of ctrlX SAFETY via ctrlX SAFETY Engineering</b>	<b>21</b>
6.1	About this manual	21
6.2	Terms	21
6.3	Installation	23
6.3.1	System requirements	23
6.3.2	Installation procedure	24
6.3.3	Uninstalling	27
6.3.4	Program start	28
6.4	User interface	29
6.4.1	Main window	29
6.4.2	Customizing the main window	30
6.4.3	Title bar	32
6.4.4	Main menu	33
6.4.5	Menu of the ribbon	35
6.4.6	Status bar	42

6.4.7	Mouse and keyboard commands	42
6.4.8	Configuration (Configuration window)	44
6.4.9	Control via document tabs	45
6.4.10	Plan types	47
6.4.11	Work surface (Canvas)	51
6.4.12	Library	52
6.4.13	Properties window	53
6.4.14	Message window	59
6.4.15	Global search	61
6.4.16	Print	62
6.4.17	Settings	64
6.4.18	Auto Recovery	67
6.4.19	Information about the program	68
6.4.20	Exit	68
6.4.21	Window „User Rights Dialog“ (in preparation)	69
6.5	Process	71
6.5.1	General workflow	71
6.5.2	Network planning	77
6.5.3	Selection of ctrlX SAFETY controller / network components	80
6.5.4	FSoE settings of the ctrlX SAFETY controller / network options	82
6.5.5	Optional Fieldbus interface / Ethernet 2 interface	82
6.5.6	Determining the inputs and outputs of the devices	84
6.5.7	Slave configuration	87
6.5.8	Determining the functions	93
6.5.9	Embedding of existing Slaves	94
6.5.10	Embedding not predefined Slaves	100
6.5.11	Adding input elements	100
6.5.12	Inserting output elements	100
6.5.13	Logic block elements	101
6.5.14	Circuit	101
6.5.15	Using of groups	103
6.5.16	Creating a program	104
6.5.17	Transferring the program to the device	106
6.5.18	Connection settings	107
6.5.19	System and logic diagnostics	108
6.5.20	Scope diagnostics	114
6.6	Validation report	121
6.7	User management (in preparation)	125
6.8	Device interface	126
6.8.1	Symbols in the device interface	126
6.8.2	Status bar of device interface	128
6.9	Networks	129
6.9.1	Master to Master (SMMC)	129
6.9.2	Fieldbus	137
6.9.3	Reset via network	145
6.9.4	Fast-Channel	146
6.10	Content of library	150
6.10.1	Devices	151
6.10.2	Input blocks	152

6.10.3	Output blocks	163
6.10.4	Function blocks	171
6.10.5	Safety functions	180
6.10.6	Muting functions	219
6.10.7	Global network elements	226
6.10.8	Fieldbus network elements	228
6.10.9	Connections	229
6.10.10	Groups	230
<b>7</b>	<b>Commissioning</b>	<b>244</b>
7.1	ctrlX SAFETY Engineering	244
7.2	µSD memory card	245
7.3	Switch-on sequence an device status	245
7.4	LED display/device diagnostics	246
7.4.1	ctrlX SAFETY SAFEX-C.12	246
7.4.2	ctrlX SAFETY SAFEX-C.15	251
7.5	Configuration	255
7.6	Firmware update	255
7.6.1	Update CPU A/B only	256
7.6.2	Update FPGA	256
7.6.3	Error messages update process	257
7.7	µSD - memory card	257
7.7.1	Uses	258
7.8	Security	260
7.8.1	Activation	260
7.8.2	Change Password	261
7.8.3	Reset Password	261
7.9	Validation	263
7.9.1	Procedure	263
7.9.2	Configuration report	265
7.9.3	Validation: IL [AWL]- Program	267
7.9.4	Input elements	268
7.9.5	Monitoring functions	268
7.10	Safety-related verification	271
7.11	Maintenance	272
7.11.1	Regular maintenance activities	272
<b>8</b>	<b>Causes and correction of errors</b>	<b>273</b>
8.1	Reset behavior	273
8.1.1	Reset types and triggering events	273
8.1.1	Reset timing	273
8.1.2	Reset function	274
<b>9</b>	<b>Appendix</b>	<b>276</b>
9.1	CoE Object list	276
9.2	Functional Output	278
9.2.1	Functional Output PROFINET	278
9.2.2	Functional Output EtherCAT	279
9.3	Diagnostics Logbook [Log Book]	280
9.4	IL (AWL) processing	281
9.4.1	IL – commands	281
9.4.2	Resource assignment	282

9.4.3	IL-Operand	284
9.5	Accessories and spare parts	286
<b>10</b>	<b>List of abbreviations</b>	<b>289</b>
<b>11</b>	<b>List of images</b>	<b>292</b>
<b>12</b>	<b>Keyword Index</b>	<b>297</b>



# 1 About this documentation

## 1.1 Editions

**Table 1: Index of editions**

Edition No.	Edition date	Changes
01	2022-02	First edition
02	2022-05	Additions to SMMC, group creation and versioning
03	2023-08	Additions of technical status, networks and $\mu$ SD memory card

## 1.2 Validity of the documentation

This documentation applies to the following products:

- R911175242 SAFEX-C.12
- R911175243 SAFEX-C.15

This documentation is intended for engineers, installers, commissioning engineers and service technicians

This documentation contains important information for the safe and proper commissioning, operation and use.


- ▶ Read this documentation in its entirety and pay particular attention to Section 2 "Safety instructions" before working with the product.

### 1.2.1 Technical Status





The document is valid for the above mentioned devices as of the following status:

Firmware Version <b>1.0.1.45</b> Hardware Version <b>5</b>
---

### 1.3 Required and supplementary documentation

- ▶ Only commission the product after making sure that the documentation marked with the book symbol () is available and you have understood and observed it.

**Table 2: Required and supplementary documentation**

	<b>Title</b>	<b>Document number</b>	<b>Document type</b>
	Operating instructions for ctrlX SAFETY SAFEX-C.1* devices with ctrlX SAFETY Engineering DOK-XSAFE*-SAFEX-C.1XC-ITxx-EN-P <sup>1)</sup>	R911405651	Operating instructions
	Installation manual for ctrlX SAFETY devices SAFEX-C.1* with ctrlX SAFETY Engineering DOK-XSAFE*-SAFEX-C.1XC-COxx-EN-P <sup>2)</sup>	R911405649	Installation manual
	Error list / Diagnostic messages for ctrlX SAFETY SAFEX-C.1* devices DOK-XSAFE*-SAFEX-C.1XC-RExx-EN-P <sup>3)</sup>	R911406843	Error and diagnostic reference
	Application description for the integration of the ctrlX SAFETY SAFEX-C.1* devices in ctrlX AUTOMATION DOK-XSAFE*-SAFEX-C.1XC-APxx-EN-P <sup>4)</sup>	R911407750	Application description

- 1) ITxx: latest edition of operating instructions
- 2) COxx: latest edition of installation manual
- 3) RExx: latest edition of error list / diagnostic messages
- 4) APxx: latest edition of application description in ctrlX AUTOMATION

### 1.4 Presentation of information

Uniform safety instructions, symbols, terms and abbreviations are used in this documentation to make working with your product quick and safe. For better understanding these are explained in the following sections.

#### 1.4.1 Safety instructions

In this documentation, safety instructions precede action sequences in which there is a risk of personal injury or property damage. The described safety measures must be adhered to. Safety instructions are structured as follows:




 **SIGNAL WORD**

**Type and source of the danger**  
 Consequences of non-compliance

- ▶ Safety measure
- ▶ <List>

- **Warning sign:** draws attention to the danger
- **Signal word:** indicates the severity of the danger
- **Type and source of danger:** identifies the type and source of the danger
- **Consequences:** describes the consequences of non-compliance
- **Protection:** indicates how to avert the danger




**Table 3: Hazard classes according to ANSI Z535.6-2006**

Warning sign, signal word	Meaning
	indicates a hazardous situation which, if not avoided, will result in death or serious injury
	indicates a hazardous situation which, if not avoided, could result in death or serious injury
	indicates a hazardous situation which, if not avoided, could result in minor to moderate injury
<b>NOTE</b>	indicates property damage: Damage to the product or the environment could occur.

### 1.4.2 Symbols

The following symbols indicate information that is not related to safety, but instead improves your understanding of the documentation.

**Table 4: Meaning of the symbols**

Symbol	Meaning
	If this information is not observed, the product cannot be used or operated optimally.
	This is a note.
	individual, independent action step
1. 2. 3.	numbered instructions for action: The digits indicate that the action steps are sequential.

### 1.4.3 Terms

The following terms are used in this documentation:



The term “**safe**” is used in accordance with/within the meaning of the following standards: DIN EN ISO 13849-1, DIN EN 61508-1:2011-02 (cf. chapter 18 „Standards“ in Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>).

The term “**safe function for application up to PL e/SIL 3**” specifies functions with appropriate integrity (reliability) within the meaning of the standards mentioned above.

The ctrlX SAFETY controllers are devices for the implementation of safety-related functions with safe communication via FSoE and non-safety-related data communication via EtherCAT. These are internally structured as two channels: System A and System B.

The “ctrlX SAFETY Engineering” system software is used for the programming and configuration of ctrlX SAFETY controllers, ctrlX DRIVE<sup>plus</sup> and 3rd party FSoE devices. It implements safety-oriented functions.

**Table 5: Terms**

Term	Meaning
ctrlX DRIVE <sup>plus</sup>	Safety-Slave
ctrlX SAFETY	refers to the compact safety controllers SAFEX-C.12 / SAFEX-C.15 in the document
ctrlX SAFETY <sup>link</sup> master-interface	is a safe communication interface between a ctrlX SAFETY (SAFEX-C.1*) controller and a ctrlX DRIVE <sup>plus</sup> drive
	EtherCAT® is a registered trademark and patented technology, licensed via Beckhoff Automation GmbH, Germany.
	Safety over EtherCAT® is a registered trademark and patented technology, licensed via Beckhoff Automation GmbH, Germany.
Device group	Device groups are displayed in the library. If several groups have been created, they can be preselected in "Settings".
Peripheral devices	These represent external devices that are connected to the inputs/outputs of the ctrlX SAFETY-C.1* and provide input and output signals.  They are inserted into connection or wiring scheme, where they are automatically connected to the corresponding terminals of the ctrlX SAFETY-C.1*.
SAFEX-C.1*	Compact safety controller ctrlX SAFETY, safety master and slave
SMMC	Safe-Master-to-Master-Communication
User rights	There are 3 types of user rights Administrator, Programmer and User. The user administration can be used to view which permissions the respective user has. It can be reached via the "User rights" button in the "Start" tab of the ribbon. More detailed information in chapter 6.4.21.  User management is in preparation and not included in the first edition.

#### 1.4.4 Abbreviations

The abbreviations used in this documentation can be found in section “List of abbreviations“ at the end of this documentation.

## 2 Safety instructions

### 2.1 About this section

The product has been developed, tested and manufactured in accordance with generally accepted rules of technology. Nevertheless, there is a risk of personal injury and property damage if the safety instructions in this documentation and this section are not observed.

- ▶ Read the documentation listed in Section 1.2 thoroughly and completely before working with the product.
- ▶ Store the documentation in such a way that it is accessible to all users at all times.
- ▶ Always pass the product on to third parties together with the necessary documentation

### **DANGER**

#### **Malfunction of the plant**

Programming or changing the programming can cause malfunctions. Malfunctions can cause unexpected starts of the complete system .

### **WARNING**

#### **Malfunction by data error**

Inputs and outputs for standard functions, or the digital and analogue data transmitted by communication units must not be used for safety-related applications. Data errors can cause malfunctions which can cause unexpected starts of the system.

### **NOTE**

#### **Electrical installation**

All activities for electrical installation are performed according to the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>

<sup>1)</sup> RS = latest edition

## 2.2 Intended use

The product is a programmable safety controller.

You may use the product as follows:

- For provision safety shut-off systems and safety functions
- as a safety component within the meaning of the Machinery Directive 2006/42/EC,
- as an E/PE for risk reduction within the meaning of IEC 61508,
- in safety circuits according to EN 60204-1 and EN 60204-32,
- as an E/PE for functional safety within the meaning of 62061,
- as SRP/CS (see abbr.) within the meaning of EN 13849,
- as a device for the provision of safety functions according to EN 61800-5-2,
- as a logic unit for signal conversion and processing in two-hand controls according to EN 574.

The device is a safety component according to Annex IV of the EU Directive 2006/42/EG (Machinery Directive). It was developed, designed and manufactured in accordance with the above-mentioned directive, as well as EU Directive 2014/30/EU (EMC Directive)

The product is intended for professional use only and not for private use.

Intended use also includes and requires fully reading and understanding this documentation and, in particular, the 2 „Safety instructions“ section.

## 2.3 Improper use

Any use other than the use described in the Intended use section is considered improper use and is therefore not permitted.

If unsuitable products are installed or used in safety-related applications, this could lead to the occurrence of unintended operating conditions in the application, which could cause personal injury and/or property damage. Therefore, only use products in safety-related applications if such use is explicitly specified and permitted in the product documentation. For example, in EX-protected areas or in safety-related parts of a controller (functional safety).

Bosch Rexroth AG disclaims liability for damage caused by improper use. All risks associated with improper use are borne solely by the user.

Improper use of the product includes, for example:

- Applications for which ATEX certification is necessary,
- Applications for which approval by classification societies is required,  
or
- Applications in countries for which a national certificate not yet issued for the product is required.

## 2.4 Qualification of personnel

The activities described in this documentation require basic knowledge of mechanical and electrical systems, as well as knowledge of the associated technical terms. In order to ensure safe use, these activities may therefore only be carried out by an appropriate specialist or a trained person under the direction of a specialist.

Specialists are persons who, based on their professional training, their knowledge and experience, as well as their knowledge of the relevant regulations, can assess the work assigned to them, identify potential risks and take appropriate safety measures. Specialists must always comply with the relevant technical rules.

## 2.5 General safety instructions



### WARNING

#### Non-observance of the general safety instructions

Damage to the product and the environment

- ▶ Observe the applicable regulations for accident prevention and environmental protection.
- ▶ Observe the safety regulations and the regulations of the country in which the product is used/applied.
- ▶ Use Rexroth products only in technically perfect condition.
- ▶ Observe all instructions on the product.
- ▶ Persons who install, operate, dismantle or maintain Rexroth products must not be under the influence of alcohol, other drugs or medications that affect their reaction capacity.
- ▶ Only use accessories and spare parts approved by the manufacturer in order to eliminate risks to personnel due to unsuitable spare parts.
- ▶ Comply with the technical data and ambient conditions specified in the product documentation.
- ▶ If unsuitable products are installed or used in safety-related applications, unintended operating conditions can occur in the application, which can cause personal injury and/or property damage. Therefore, only use products in safety-related applications if such use is expressly specified and permitted in the product documentation.
- ▶ It is only allowed to commission the product after it is established that the final product (e.g. a machine or a system) in which Rexroth products are installed complies with the country-specific regulations, safety rules and application standards.

## 2.6 Product- and technology-dependent safety instructions

The use of the devices must be restricted to their intended use in accordance with the list above. Furthermore, the data values specified in Sections „8.1. and 9.1 Device characteristics“ in Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup> must be observed.

The content of this manual is limited to describing the programming and parameterization of the devices. The basic functionality of the devices and their installation are described in the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>“. Knowing and understanding that manual is a mandatory prerequisite for new installations or modifications of the device function or device parameters.

### WARNING

**Any use of the devices contrary to the rules and conditions listed here can:** result in injury or death of persons, as well as damage to connected devices and machines

- ▶ The guidelines and standards of the respective application must be observed. The configured monitoring functions as well as their parameters and connections must be verified via a validation report.
- ▶ Never open the housing and/or make alterations on your own accord
- ▶ Never install or commission damaged products. Please complain any damage to the transport company immediately.
- ▶ Inputs and outputs for standard functions and the digital and analog data transmitted via communication devices cannot be used for safety-related applications.

### CAUTION

#### **Working with electrical components**

Destruction of electrical components and risk of injury due to electrical voltage.

- ▶ Perform wiring work only with appropriate qualifications and taking into account the safety instructions. For storage and transport, the conditions according to EN 60068-2-6 with regard to the values specified in Sections 8.1.2 and 9.1.2 of „Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>“ must be observed.
- ▶ The wiring and connection instructions from the “Installation / Assembly” section must be observed.
- ▶ Commissioning (i.e. the start of the intended operation) is only permitted if the EMC directive is complied with. The EMC test specifications EN 55011:2009 + A2:2010 and EN 61000-6-2:2005 were used as a basis.

1) RS = latest edition

### 3 General information about property damage and product damage



#### CAUTION

##### **Removal and installation of the devices**

Destruction of electrical components and risk of injury due to electrical voltage.

- ▶ Before installing and removing the device or disconnecting signal lines, the device must be de-energized. For this purpose, all live supply lines to the device must be switched off and checked for the absence of voltage.
- ▶ During the installation and removal of the device, electrostatic discharges on the terminal and plug connections going outwards must be avoided by appropriate measures. For this purpose, contact with these terminals should be kept to a minimum and grounding should be carried out beforehand and during work, for example by means of a grounding bracelet.

## 4 Scope of delivery

The scope of delivery includes

- the SAFEX-C.1\* compact safety controller
- the terminal blocks (RTB) for voltage supply and inputs/outputs
- 3 square stickers with the device serial number for optional and individual marking on the front of the housing by the user

The components listed under section „Accessories and spare parts“ in Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup> can be used as optional additional components.

The programming software “ctrlX SAFETY Engineering” necessary for the generation and verification of a PLC-based monitoring program is licensed with the acquisition of the ctrlX SAFETY SAFEX-C.1\* device. It can be installed according to the „Application description for the integration of the ctrlX SAFETY SAFEX-C.1\* devices in ctrlX AUTOMATION DOK-XSAFE\*-SAFEX-C.1XC-APxx-EN-P<sup>4)</sup>).

## 5 Requirements

### 5.1 Compact safety controller ctrlX SAFETY

The compact safety controller is a Master unit for reading in encoder data and switching states from external slave devices for implementing safety functions.

CtrlX SAFETY can send, receive and process safe data via FSoE and non-safe data via EtherCAT. In the EtherCAT network, the device only functions as Slave.

Besides the FSoE master protocol, the device also supports the FSoE slave protocol.

In addition, the device can be used as a ctrlX SAFETY<sup>link</sup> master.

### 5.2 Network connection

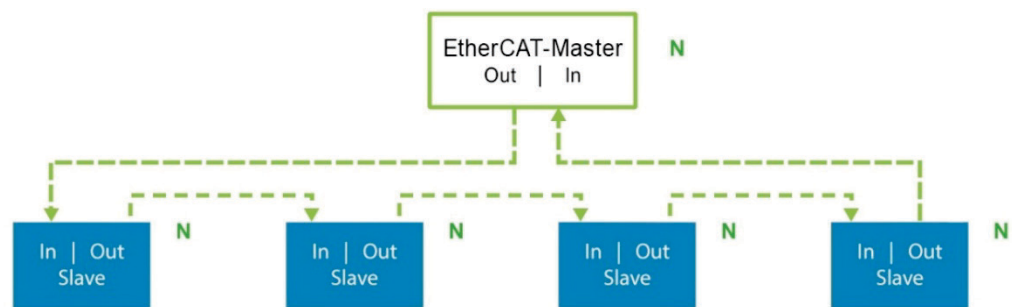
#### 5.2.1 EtherCAT

The EtherCAT network consists of a EtherCAT master (e.g. ctrlX Core) and a certain number of Slaves.

The data transmission takes place via Ethernet connections, which are routed between the EtherCAT master and each device and usually run in series from one device to another. Ethernet frames are sent via this network. Each network device must first read the contained data, filter out the data addressed to it and insert the output data into the frame. After all slaves are passed, the frame is sent back to the EtherCAT master.

Since each device has an influence on the transmission of a message, the network must be defined/specified precisely. This specification is done via the ESI files, which defines the devices and their properties.

The data transmission is always initiated by the master – it takes place in the EtherCAT network with the best possible transmission time of a few  $\mu$ s.



N= non-safe (Data Transfer) = EtherCAT

Fig. 1: EtherCAT Network

### 5.2.2 EtherCAT data transmission

In general, a distinction is made between cyclically transmitted process data and acyclic data such as configuration and diagnostic data, etc.

The cyclic process data is assigned to PDOs (Process Data Objects). The length and content of the PDOs can be either fixed or variable. The variable content is determined via PDO mapping. The possibilities of the PDOs are determined via the individual device description file (ESI file).

Acyclic data services are primarily SDOs (Service Data Objects), but can also be EoE (Ethernet over EtherCAT) or FoE (File over EtherCAT). Again, the possibilities of the acyclic services are determined via the individual device description file (ESI file).

### 5.2.3 FSoE

is the safety-oriented (safe) data transmission over the EtherCAT network. Useful data is bundled into data packets and supplemented with an additionally transmitted checksum. The fastest rate of transmission is every 1ms.

The transmission is also monitored via timers (Watchdog), which are checked in each device in the network. In this way, an interruption can be reliably detected.

The checksum is calculated using CRC16 (16-bit Cyclic Redundancy Check) and allows the detection of an error with a residual error probability of  $< 10^{-9}$ , which enables safe data transmission suitable for up to PL e or SIL 3.

The following units are suitable as FSoE Slaves:

- ctrlIX DRIVE<sup>plus</sup>
- IndraDrive
- SSB= Safe Sensor Box, Slave unit to read 6 axes
- SDU= Safe Drive Unit, Slave unit to read on axis
- SIO= Safe IO, Slave unit to read IOs
- EL 1904, Slave unit (to read inputs)
- EL 2904, Slave unit (to switch outputs)
- AX 5805, Slave unit (to read axis data)
- AX 5806, Slave unit (to read axis data)
- SAFEX-C as Slave unit for reading I/Os and local processing

In general, devices from other manufacturers can also be integrated as FSoE slaves, provided that they offer FSoE communication.

### 5.2.4 FSoE und EtherCAT

The Ethernet frame of the EtherCAT network can contain both standard and safe data. The safe data are called FSoE data and are assigned to the FSoE master and slave protocol stack. These data are transferred cyclically and are thus contained in the PDO of the respective participant.

The ctrlIX SAFETY safety controller is designed as an FSoE master and starts the safe transmission via FSoE. In addition, it is an EtherCAT slave device in the EtherCAT network.

A separate EtherCAT master starts the non-safety-related data transmission via EtherCAT.

The PDOs with the FSoE data contained in them are transmitted cyclically. The cycle time of the transmission is defined in the configuration of the EtherCAT master. As a rule, it should be set several times shorter than the cycle time of the FSoE master in order to ensure that the data is updated within the Watchdog monitoring time of the FSoE master.

The ctrlIX SAFETY safety controller (FSoE Master) starts the safe data transfer via FSoE, receives from the Slave groups the data from inputs and evaluates these data. The ctrlIX SAFETY can then implement safety functions, select safety functions in drives and switch outputs - this can be done directly via the module's own outputs, the outputs of the slave modules or by direct selection in drives via FSoE or ctrlIX SAFETY<sup>link</sup>.

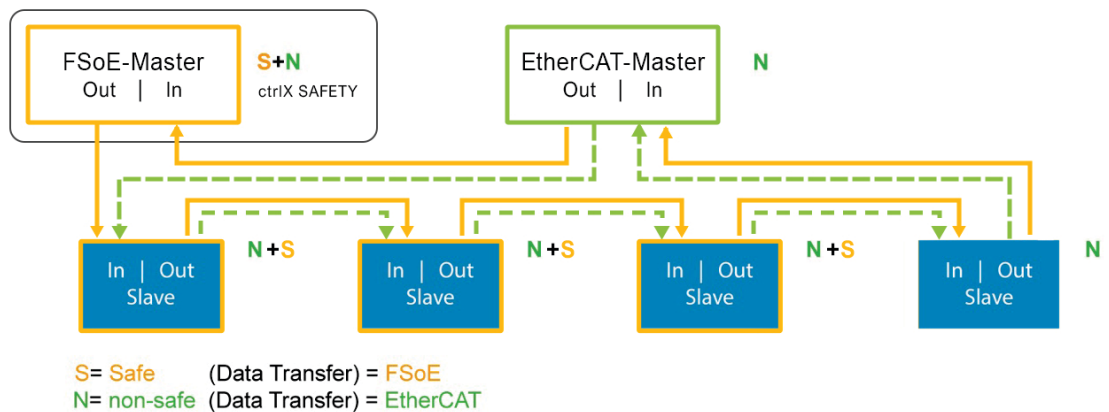


Fig. 2: FSoE Network

### 5.2.5 ctrlIX SAFETY<sup>link</sup>

The ctrlIX SAFETY<sup>link</sup> interface is a safe communication interface between ctrlIX SAFETY (SAFEX-C.1\*) safety controller and ctrlIX DRIVE<sup>plus</sup> drives. The minimum cycle time is 1 ms. A maximum of 16 slave modules can be connected.

## 6 Selection and parameterization of ctrlX SAFETY via ctrlX SAFETY Engineering

The program „ctrlX SAFETY-Engineering“ is a graphics oriented software to create a PLC based monitoring program for an ctrlX SAFETY system.

This programming software allows the graphic processing of consecutively running programs by means of function blocks, and the adjustment of sensor functions, actuator functions, and other technical functions.

### 6.1 About this manual

This manual describes the bases of the programming software ctrlX Engineering. The manual explains the most important dialog windows, procedures to be followed by using practical examples, which are structured in such a way that you can start with any chapter. Experience in working with a mouse, dialog windows, selection menus etc. are of advantage. Furthermore, you should be acquainted with the basic principles of a programmable logic controller.

### 6.2 Terms

Designation	Meaning
PLC (SPS)	Programmable Logic Controller, equals the German designation for Speicherprogrammierbare Steuerung (SPS). The term PLC is used exclusively in the ctrlX SAFETY system.
ctrlX SAFETY Engineering	Programming software for the graphical processing of consecutively running programs by means of function blocks, and for the adjustment of sensor functions, actuator functions, and other technical functions.
Function block	Block in a PLC control, which influences the programming sequence of a PLC program either physically or logically. A physical function block (hardware) is e.g. a button or an output. But a function block is also the logical link (e.g. AND or OR) of input and output signals within a PLC.
Function block diagram (function block language)	Graphically oriented, descriptive programming language based on function blocks according to IEC 1131 to visualize logical connections of the inputs and the outputs of the function blocks of an PLC control. The function block diagram (FBD) shows the function blocks and their logical link in graphical form.
Function block group	Classification of the function blocks according to their positioning capability in the function block diagram (input, output, logic).
Function block types	More exact identification of a function block within a group (e.g. "Emergency Stop").
Input/output	Position at a function block where a logical link to other function blocks is possible.
Logical connection	A certain connection between: <ul style="list-style-type: none"> <li>a.) an output and an input of a function block.</li> <li>b.) one input of the PLC and one input of a function block.</li> <li>c.) an output of a function block and one output of the PLC.</li> </ul>

Connector	Connection point between the beginning and the end of a logical connection with an input and an output of a function block.
Attribute	Non graphical function of a function block. An attribute consists of an identifier and a value.
Routes	Horizontal and vertical connections of logical connections in a function block diagram to avoid intersections with function blocks, and to connect logical connections with identical connectors in an early phase (according to the distance and according to the target function block).
Signal list	Signal lines to and from the PLC in tabular form.
Signal cell	Selectable area of the signal list that can be commented..
List of PLC input signals	Signal lines of the PLC in tabular form. In the programming software ctrlX SAFETY Engineering, the user can fix the PLC inputs. The inputs have a unique number and must be assigned to the inputs of a function block.
List of PLC output signals	Signal lines of the PLC in tabular form. In the ctrlX SAFETY Engineering programming software, the user can fix the PLC outputs. Like the inputs, they have a unique identification number.
Instruction list (IL)	Programming language similar to Assembler that can be loaded into a central ctrlX SAFETY master device. The programming software ctrlX SAFETY Engineering generates an instruction list based on defined function blocks and their attributes and connections.
Compilation	Translation and verification of the function block diagram created with ctrlX SAFETY Engineering and the associated parameters.
Configuration	Configuration is the general term for a monitoring program and the connected parameters for permitted deviations or minimum and maximum values. In this connection, it should be noted that a monitoring program is always accompanied by further data, the program can refer to.
Message window	Multiline output window embedded in a Windows toolbar. The message window displays errors, warnings and information from the program to the user. The message window can be switched on or off.

## 6.3 Installation

### 6.3.1 System requirements

To install the program, the following system requirements are necessary:

Minimum system requirements:

OS: Windows 8 or higher (32 Bit / 64 Bit)

Processor: Intel® Pentium® 4 or AMD Athlon™ Dual Core, 3,0 GHz or higher

Memory: 2 GB

HDD: 500 MB free memory

Recommended system requirements:

Processor: Intel® Core™ i3 or AMD Quad Core, 3,0 GHz or higher

Memory: 4 GB or more

The program uses .Net framework 3.5 and 4.0, but the installation wizard also installs the program if the files are missing. For .Net installation, either local files in the component folder, or files from the internet can be used. If no internet connection is possible, the program is installed, but the user must install .Net 3.5 and 4.0.

The installation wizard installs the VC 2010 distribution data.

The installation wizard also installs the following drivers:

FTDI CDM-Driver (RS485 - USB) – for the connection between PC and PLC to transfer programs from ctrlX SAFETY Engineering to the PLC hardware and its diagnostics.

### 6.3.2 Installation procedure

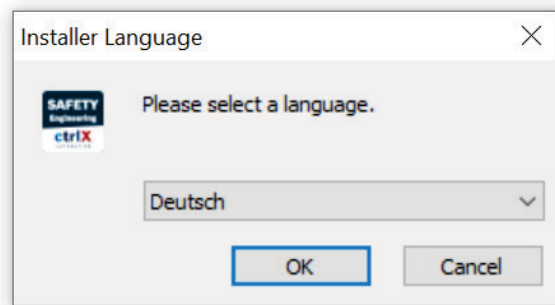
The installation of the programming software ctrlX SAFETY Engineering starts according to „Application description for the integration of the ctrlX SAFETY SAFEX-C.1\* devices in ctrlX AUTOMATION DOK-XSAFE\*-SAFEX-C.1XC-APxx-EN-P 4).

Administrator rights are necessary only for installation. Normal users can use the installed program.

Start the installation of the program by double-clicking on the file „Setup Rexroth cxse\_X.X.X.XXXX.exe<sup>1)</sup>“ with the left mouse-key. Then the following window appears.

By opening the menu you can select the installation language (English or German).

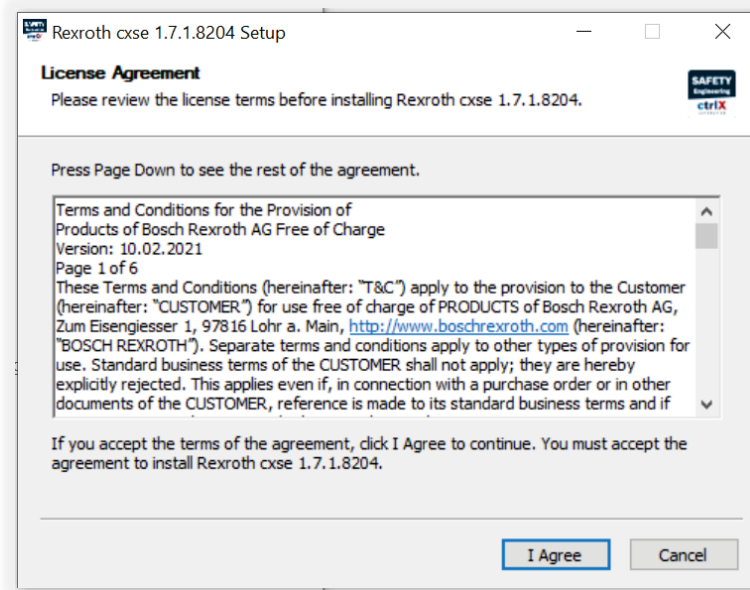
1) X = the latest version number of the programming software



After selecting the language, click on “OK”, to continue the installation. When you click on “Cancel”, the installation is completed, without installing the program. When you click on “OK”, the next window with the license agreement appears.

## **NOTE**

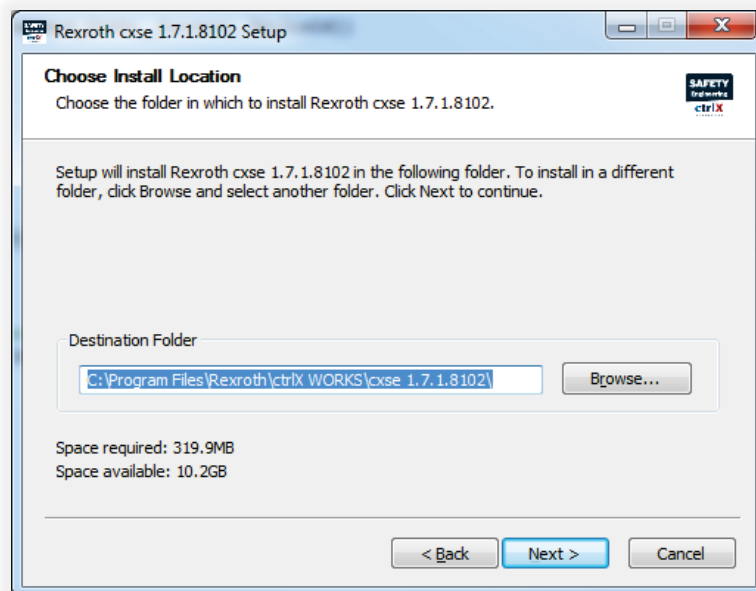
This window only appears during the first installation. For the next time, the language is stored, and the first window to appear is the window with the license agreement. In the window of the installation language, only the language for the installation is set, not the language of the user interface of **ctrlX SAFETY Engineering**.



To continue the installation, click on "I Agree".


If you do not agree to the license agreement, click on "Cancel". The installation is completed without installing the program.

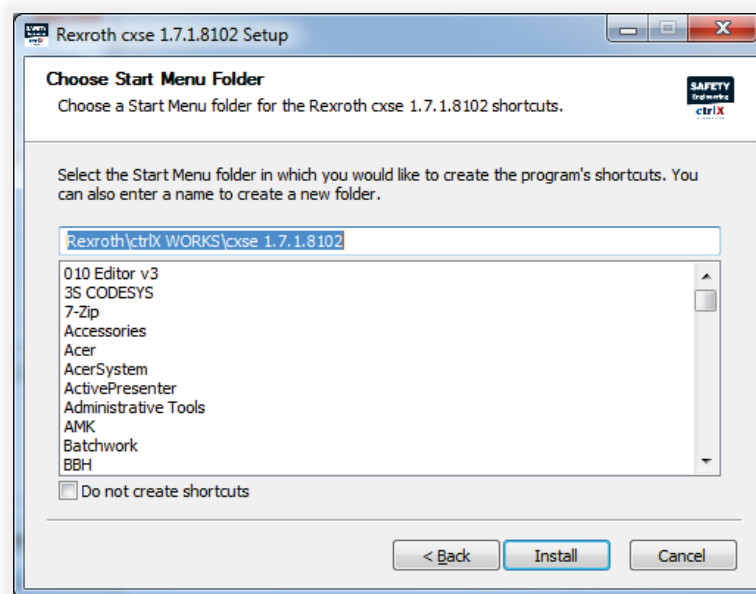
After you have clicked on "I Agree", a window appears where you can select the target folder where the program shall be installed.



Click on "Next", a window appears where you can select the start menu folder for quick access to the **ctrlX SAFETY Engineering** program. If you want to create a new folder for the program shortcut, enter its name.

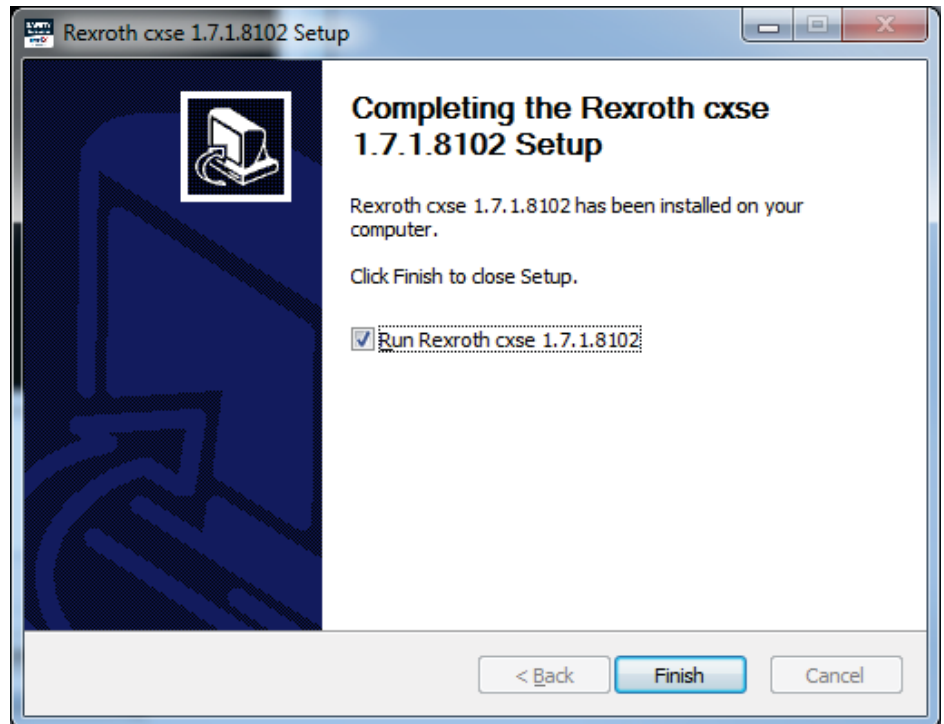
In addition to the start menu folder, a program shortcut is created on the desktop.

 If you do not change the defaults, a "Rexroth" folder will be created in the Start menu where the version of the program will appear.



After you have clicked on "Install", the installation starts.

After the installation is completed, the following window appears:

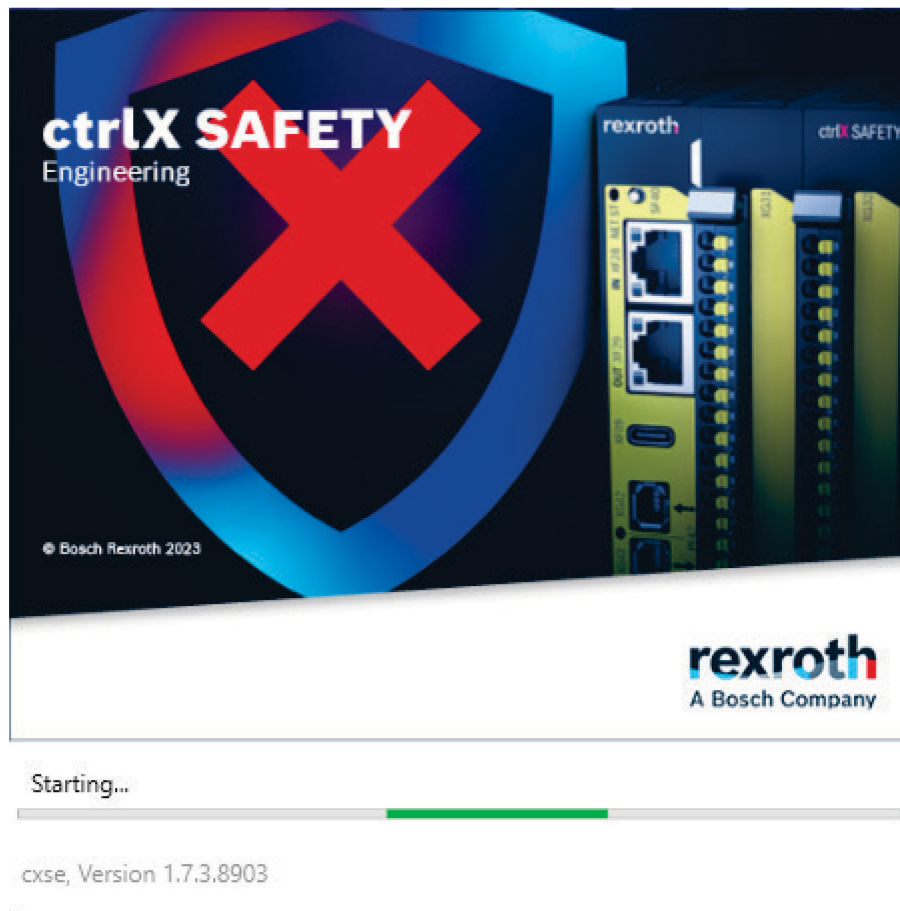


By placing the tick mark in the box, you can choose if the program shall be started immediately or later. If the tick mark is placed, after you have clicked on "Finish", the dialogue window closes after you have clicked on it, and the program starts. During installation, the desktop symbol to start the program is created. With this symbol, you can always start the program. If during installation, a quick access has been created in the start menu folder, the program can also be started in this folder via quick access.

### 6.3.3 Uninstalling

To uninstall the **ctrlX SAFETY Engineering** program, you can use the "Uninstall a program" function in the Windows Control Panel or the quick access in the desktop start new folder. To do this, right-click on the quick access and select "Uninstall". If you want to reinstall the program and at the same time change the installation language, you must delete the registration key "Installation language" under the branching HKEY\_CURRENT\_USER\_Software\_Rexroth\_ctrlX WORKScxsex.x.x.

### 6.3.4 Program start



To start the program, double-click on the desktop icon or start it from the Start menu folder.

## 6.4 User interface

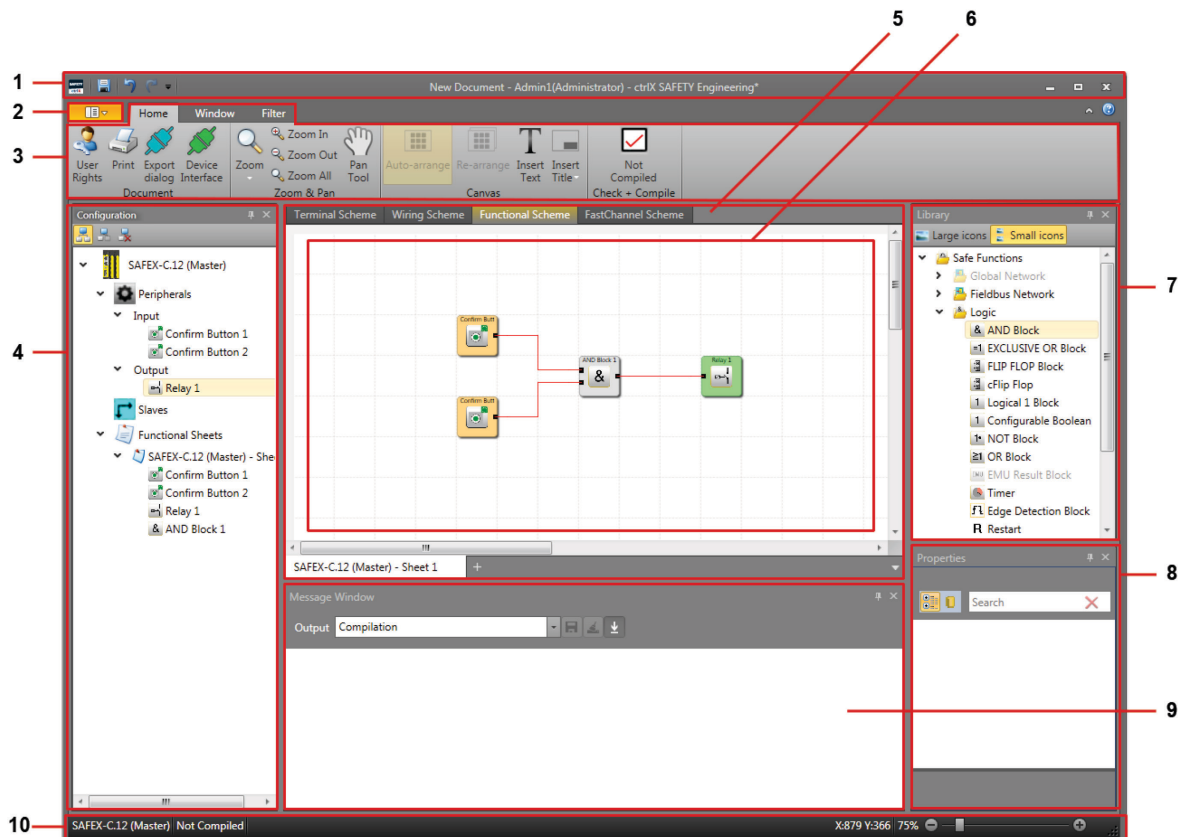


Fig. 3: user interface of ctrlX SAFETY Engineering application

### 6.4.1 Main window

The application window is the standard window of ctrlX SAFETY Engineering. Via the window function surface, the window's size can be adapted, and the window can be minimized, maximized or closed. It is divided in the following elements:

1. Title bar with toolbar for quick access
2. Main menu of ctrlX SAFETY Engineering
3. Ribbon menu (tabs: Home, Window, Filter with subgroups)
4. Configuration (Configuration window)
5. Control via document window with plan tabs on top and sheet-tab below
6. Work surface (Canvas)
7. Library (Library window)
8. Properties (Properties window)
9. Message window
10. Status bar

## 6.4.2 Customizing the main window

### Layout reset

You can reset the layout of the application to the default setting by clicking "Reset Layout" from the ribbon menu in the "Window" tab.

**Note that with this command the user layout is deleted and cannot be restored, i.e. all user settings are reset.**

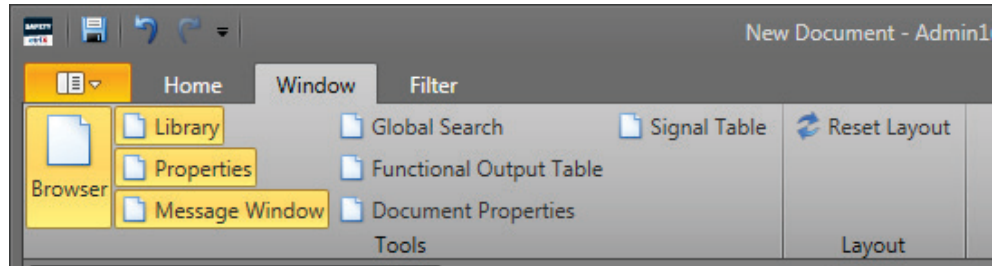


Fig. 4: Tab „window“, Setting the user layout via the group „tools“

### Docking

By docking, the application’s layout can be personalized. Every section (except “Plans” and “Sheets”) can be pulled out of the application window, and can be dropped in a different section, or in a register group.

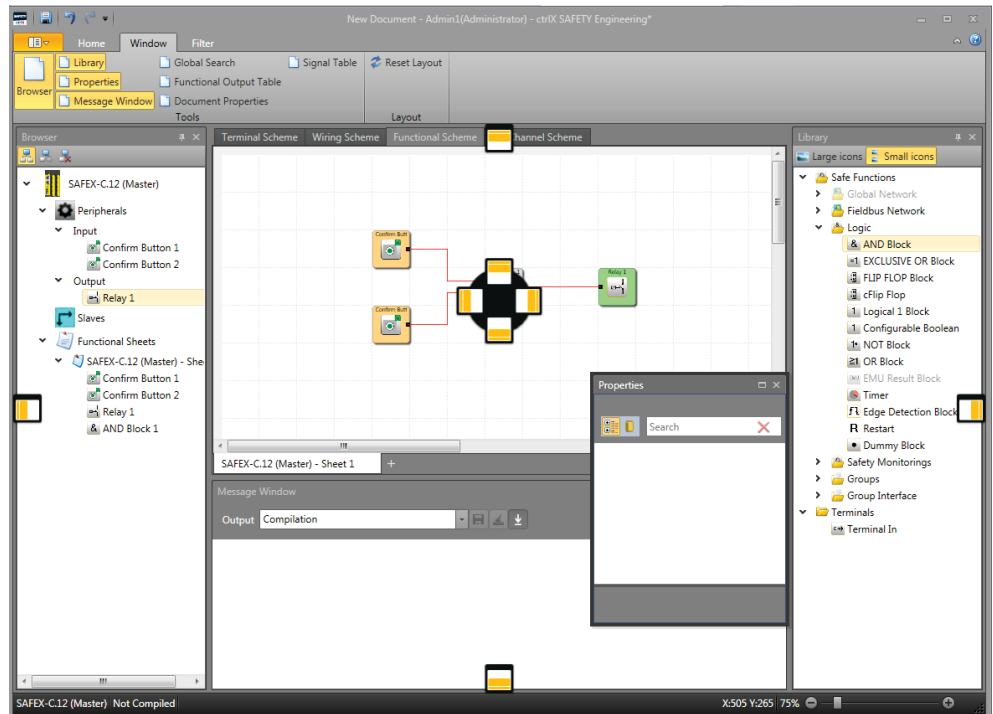


Fig. 5 Docking; Personalize the application window

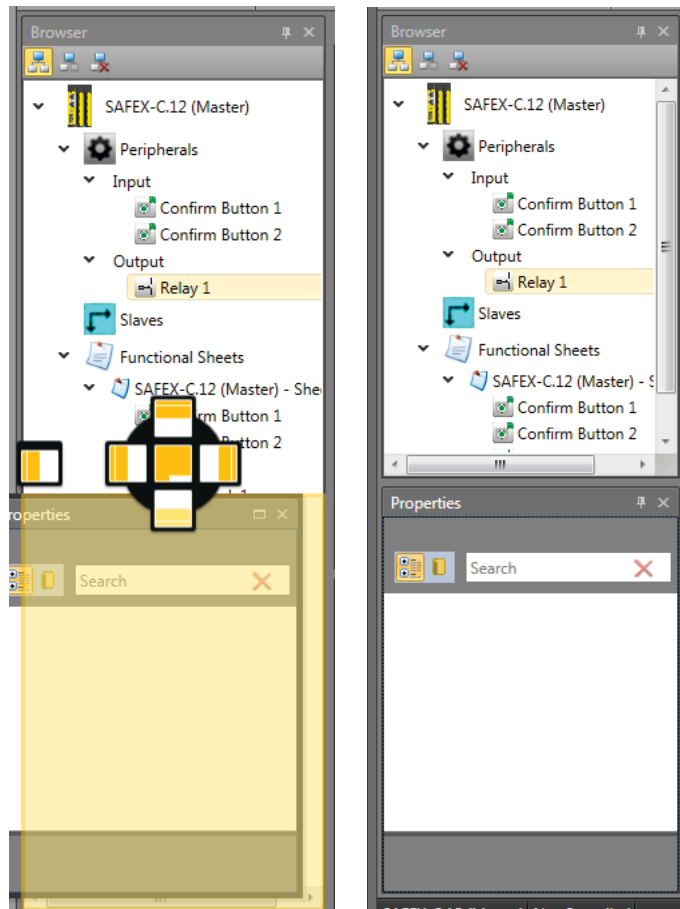




Fig. 6: Docking; example: properties (properties window) dropped on left side under „configuration“

Automatic hide

Every section containing the symbol for automatic hide  can be transferred to the background automatically. The user can switch off automatic hide, and can make the section visible again by again clicking on the symbol for automatic hide .

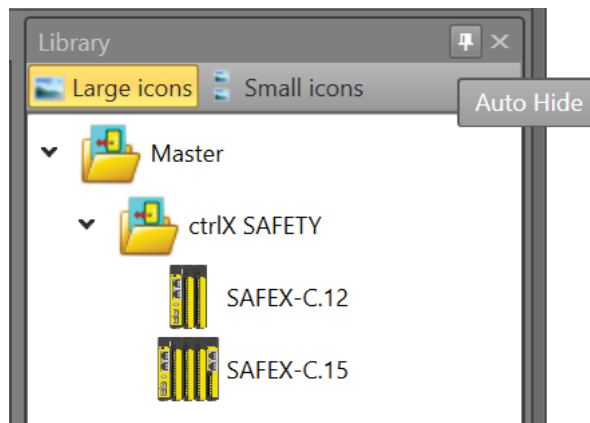
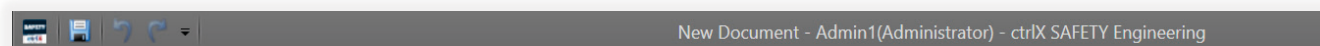





Fig. 7: Example: automatic hide of an area - library

### 6.4.3 Title bar



The title bar in the upper section of the application contains application icons, buttons for quick access, and the title of application. The buttons for quick access are „Save“  (via keyboard with Strg+S), „Cancel“  (Strg+Z) and „Repeat“  (Strg+Y).

The application title `Neues Dokument - Admin1(Administrator) - ctrlX SAFETY Engineering*` consists of the current document name, the currently registered user and the application name with an asterisk, which indicates that at least one change has been effected that has not been saved.

By clicking on the application menu, the context menu of the application window can be called. The context menu contains the familiar window functions.

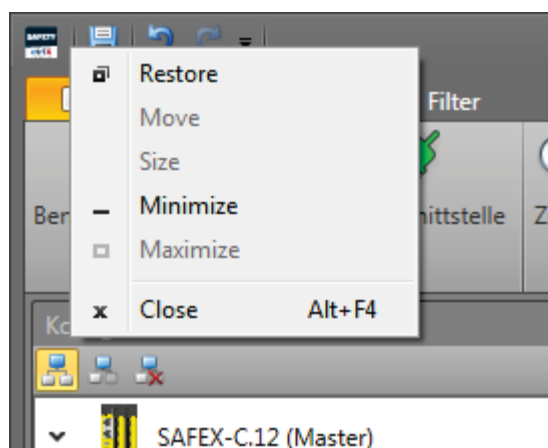
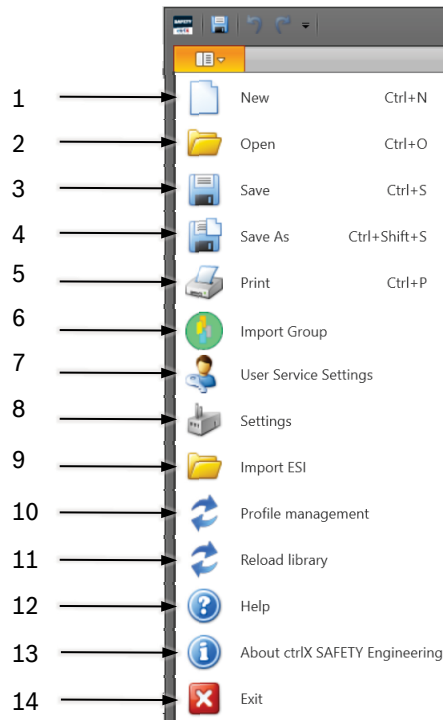


Fig. 8: context menu of application window

#### 6.4.4 Main menu



**Fig. 9: ctrlX SAFETY Engineering, main menu: document and application functions**

Via the start menu, basic document functions and application functions can be called, e. new document, save document, print, user management, settings etc.  
 „Recent files “ shows the documents used last (The last document is shown first).

##### 1. New

Creates a new empty project. When a new project is opened, the program asks the user, if the changes in the old document shall be saved.

##### 2. Open

Opens either an existing ctrlX SAFETY Engineering document or a document with a complete library. If a new document is opened, the program asks the user if the changes in the old document shall be saved.

##### 3. Save

Saves the document at the selected place. In case of a new project, a window with extended storage options “Save as”.

#### 4. Save as

Saves a document, and selects the document's name, type and storage location. If the folder contains a document with the same parameters, the program asks the user if the document shall be replaced.

#### 5. Print

Shows the printing options. You find the functional description under „6.4.16 Print“.

#### 6. Import group

Group import function

The import includes the verification of the sensor configuration and the already existing resources in the function plan.

#### 7. User Service Settings (in preparation)

Here, users can be changed. It appears then additionally in the main menu "Change user“.

##### Change User

This command appears after setting the check mark in the user service setting.

With this command a user can log in and log out.

Included are the users: administrator, programmer and user.

\*\*\*\*\* is not indicated separately. \*\*\*\*\*

#### 8. Settings

In the "Settings" window, application settings can be changed See chapter „6.4.17 Settings“.

#### 9. Import ESI

Import function to importing a device description file for one of FSoE slave modules.

#### 10. Profile management (currently not supported)

Management of the data profiles of the FSoE slave modules.

#### 11. Reload library

After importing a library (standard Libraries), it must be reloaded.

#### 12. Help

Opens the help window of ctrlX SAFETY Engineering.

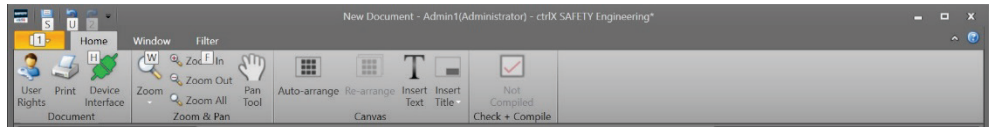
#### 13. About ctrlX SAFETY Engineering


„About CtrlX SAFETY Engineering“ gives short information about the Windows system and about the creation of the application. Also, compiling information is shown..

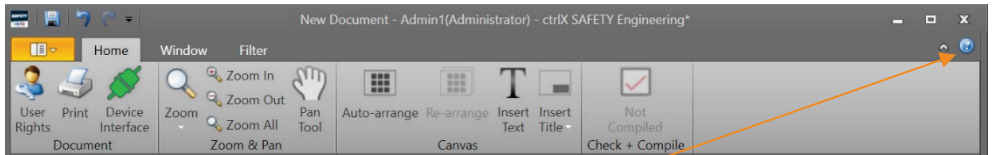
#### 14. Exit

Closes the whole program.

### 6.4.5 Menu of the ribbon



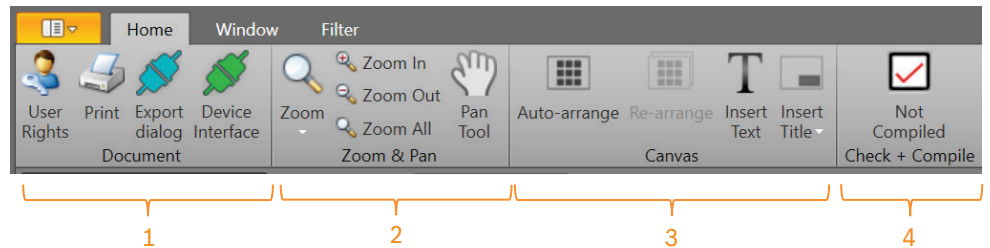
The menu of the ribbon is part of the main window and consists of several register tabs. The user can switch within the ribbon mode (minimize, maximize) by clicking on the  button in the menu's upper right-hand corner. If the menu ribbon was minimized, the user must click on the corresponding tab. This tab opens automatically, and closes again if it is no longer clicked on. The user can also call the tabs by pressing the ALT-button and the Quick Info-button shown on the menu ribbon.



**Fig. 10** menu of the ribbon, quick info buttons

Next to the switching mode is the "Help"  button , which is used to call up the ctrlX SAFETY help window.

Home



**Fig. 11** Tab „Home“ and its groups

#### 1. Document

- “**User rights**” shows a window where the user rights can be fixed.
- “**Print**” shows the printer menu.
- “**Export dialogue**” shows the export dialogue.
- “**Device interface**” shows the device dialogue.

#### 2. Zoom and pan

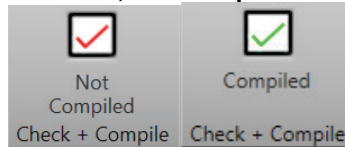
- The dropdown list “**Zoom**” gives you access to defined zoom values.
- The “**Zoom In [Enlarge]**” button increases the current zoom by 25 %.
- The “**Zoom Out [Reduce]**” button decreases the current zoom by 25 %.
- The “**Zoom all [Whole page]**” button can maximize the range to the page size.
- The “**Pan Tool**” serves to switch to the panning mode. When the function is enabled, the user can pan the range either with the left mouse button or with the middle mouse button.

### 3. Work surface (Canvas)

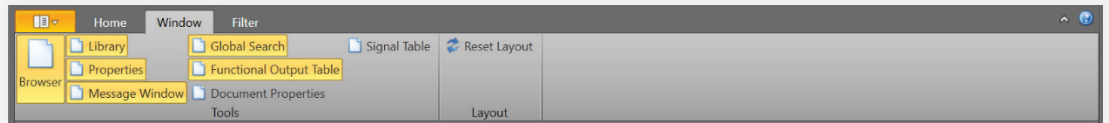
- The switch button “Auto-arrange“ [Arrange automatically] serves to switch within the mode for automatic arrangement. If the function is enabled, elements are arranged automatically. Not all plans support automatic arrangement.
- via the "**Re-arrange**" button, elements are immediately moved back to the previous position (available in terminal scheme and wiring scheme)
- The "**Insert Text**" button serves to activate the filing of text. If the function is activated, the user can drop text in the workspace by clicking the left mouse button.
- The drop-down menu "**Insert Title**" lists the available title templates. By clicking on the selected title template, the selected title template will insert it into all sheets of the entire document. The title template contains information about the project and the sheet (scheme). There are 3 different designs from which the user can choose.

### 4. Check + Compile

- The "**Compile**" button compiles the current document. After successful completion of the compilation, a green check mark appears in the "**Compiled**" text field. Otherwise, "**Not compiled**" is displayed with a red check mark.



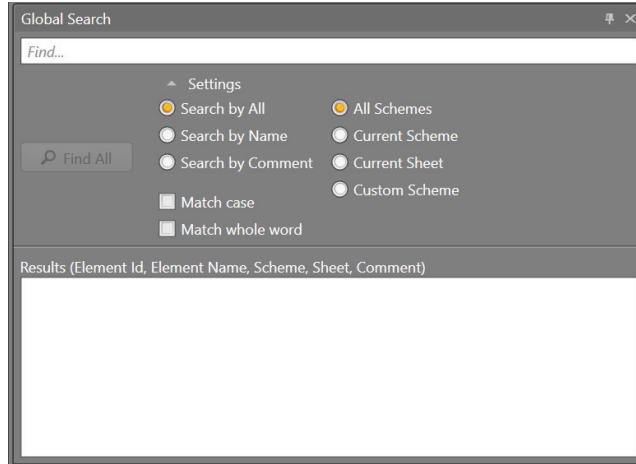
### Window



Via the corresponding switch button, the user can show or hide windows.

- The "**Configuration**" switch button serves to switch on and off the configuration window in the user interface..
- The "**Library**" switch button serves to switch on and off the library window in the user interface.
- The "**Properties**" switch button serves to switch on or off the Properties window.
- The "**Message window**" switch button serves to switch on or off the Message window.

- The „**Global search**“ switch button serves to enable the window for global search. For further information concerning this function, cf. chapter 6.4.15 „Global search“.

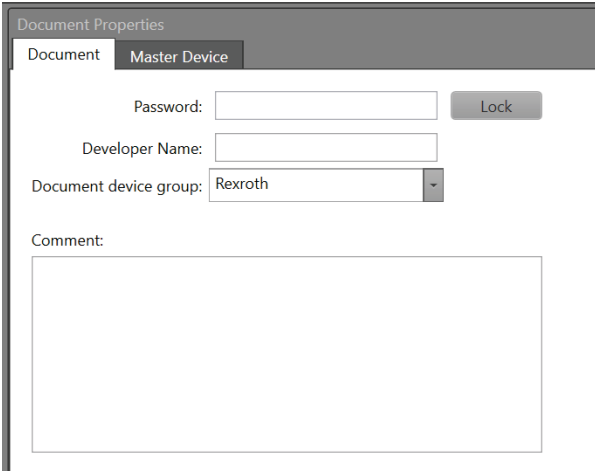


- The „**Functional Output Table**“ displays the following table:

Bit ID	Custom ID	High Active	Axis Number	Function Module	Comment

**Fig. 12 Window "Functional Output Table"**

- The „**Document properties**“ switch button serves to display the window for document administration.



The screenshot shows a software window titled "Document Properties". It has two tabs: "Document" and "Master Device". The "Document" tab is active and contains the following elements:

- A "Password:" label followed by a text input field and a "Lock" button.
- A "Developer Name:" label followed by a text input field.
- A "Document device group:" label followed by a dropdown menu showing "Rexroth".
- A "Comment:" label followed by a large text area.

**Fig. 13 Window „Document properties“ - Document**

The window contains the document tabs and the device tabs.

The document tab consists of:

- Password – A password for the document can be inserted via this field and is locked via the "Lock" button.
- Lock – can be locked and unlocked. If a document is locked, the user cannot edit the document. However, the user can select elements and switch between plans or sheets.
- Developer's name – name of the responsible programmer / developer.
- Comment – Via this input field, descriptive text can be entered. For example, this input field serves to enter program or parameter changes during the operating period of the currently used device.

The Master device tab, in example SAFEX-C.12 (Master), consist of information fields and connection settings.

- Application information – for further information concerning the edited fields, cf. chapter 6.6, „Validation report“.

Document Properties

Document SAFEX-C.12 (Master)

Application Information

**Descriptions**

End Customer  af

Labelling  af

Location  af

Installer  af

Configuration  af

Create Date  af

Functional Characteristics  af

Hardware  af

Comments  af

**Contact Details**

Installation Name  af

Installation Phone  af

Installation Fax  af

Customer Name  af

Customer Phone  af

Customer Fax  af

Supplier Name  af

Supplier Phone  af

Supplier Fax  af

Installer Name  af

Installer Phone  af

Installer Fax  af

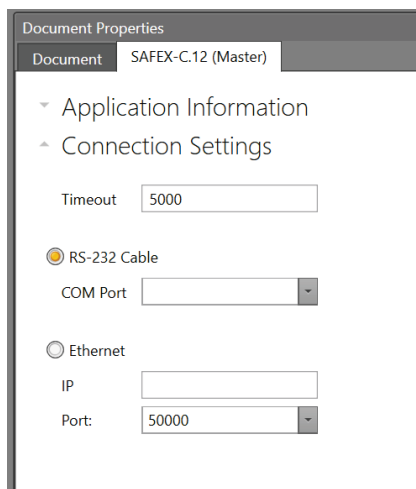
Version  af

AKZ  af

Connection Settings

Fig. 14: Window "Document properties" – Master device: application information

- Connection settings – For further information, cf. chapter 6.5.19 „Connection settings“.



**Fig. 15: Window "Document properties" – Master device: Connection settings**

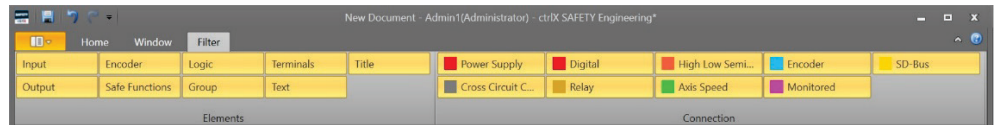
- The following window is shown or hidden with the "Signal table":

Device	Connector	Signal Type	Connected To	Peripheral
SAFEX-C.12 (	I0.0	Digital	DO 01	Confirm Button 1
SAFEX-C.12 (	I0.1	Digital	DO 01	Confirm Button 2
SAFEX-C.12 (	I0.2	Digital		
SAFEX-C.12 (	I0.3	Digital		
SAFEX-C.12 (	I0.4	Digital		
SAFEX-C.12 (	I0.5	Digital		
SAFEX-C.12 (	I0.6	Digital		
SAFEX-C.12 (	I0.7	Digital		
SAFEX-C.12 (	I0.8	Digital		
SAFEX-C.12 (	I0.9	Digital		

**Fig. 16: Window „Signal table“**

- With the switch button "Reset layout", the application's layout is rest to default (Size, location, position)

## Filter



Via the filter settings the legibility of the work surface can be granted by hiding the desired element types or connection types. It is possible to select from two filter categories: elements and connection. Every group contains several filters. If the function is disabled, the filter elements (or the connection) of a certain filter are no longer displayed on the work surface.

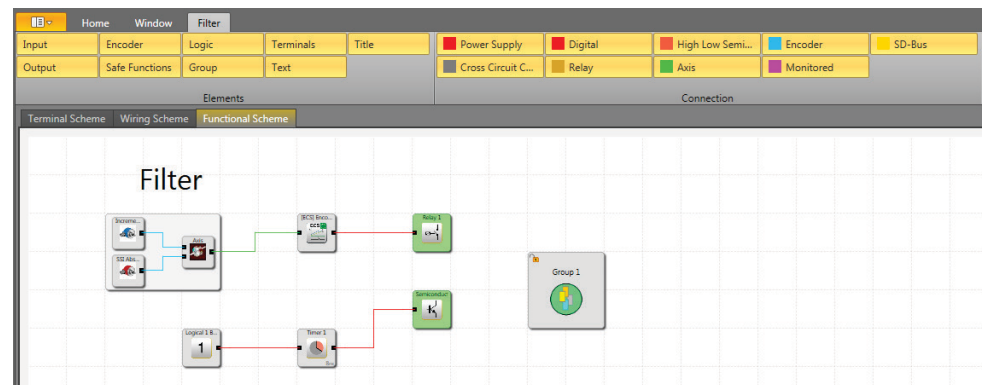


Fig. 17: view in functional scheme, all filters activated

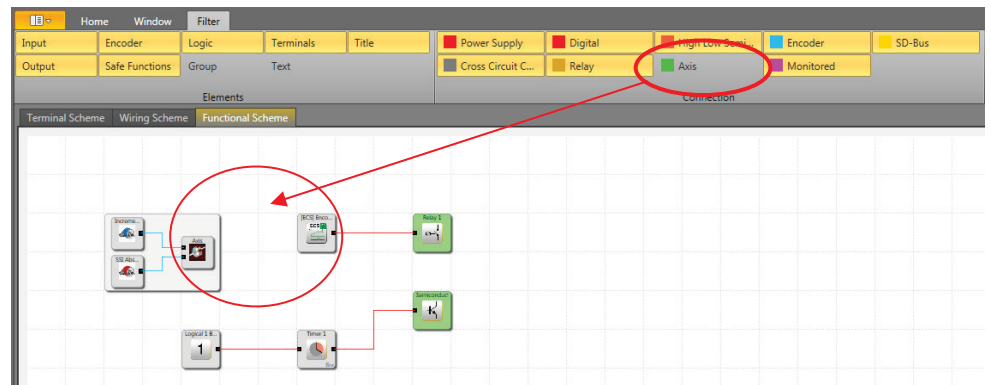
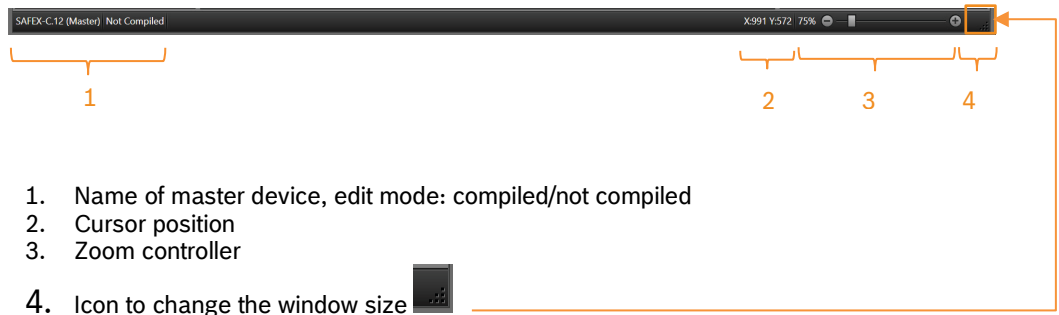


Fig. 18: view in functional scheme, „Axis speed“, „Group“ and „Text“

## 6.4.6 Status bar



The status bar is situated in the main window. On the left side it contains the Master device's name and the action mode, and on the right side it contains the cursor position on the work surface, the zoom control for the work surface and the symbol for size change. The symbol for size change indicates that the user can change the size of the main window. The action mode displays the current action the user performs on the work surface.




1. Name of master device, edit mode: compiled/not compiled
2. Cursor position
3. Zoom controller
4. Icon to change the window size 

Fig. 19: Structure of status bar

## 6.4.7 Mouse and keyboard commands

### 6.4.7.1 Mouse-independent actions

Left mouse click on a function block: selection / deselection of the corresponding block.

## **NOTE**

Several selections can be made either by pressing the Shift – button (adding a block to the selection) or via the Ctrl-button (removing of a block from the selection).

- Cursor above the block or the connection: emphasis of the block or of the connection
- "Shift" button + left mouse button on a function block: adds a block to the selection
- Ctrl + left mouse button on a function block: removes a block from the selection
- Delete button: deletes the elements of the current selection, including their connections
- Right mouse button on object: display of context menu
- Left mouse button on connection: emphasis of the current connecting line.
- Scrolling with the mouse wheel. Scroll up /down through the work surface
- Move middle mouse button and mouse: panning of work surface
- "Shift" button + scrolling with mouse wheel: scroll to the left / to the right through the work surfaces
- Ctrl + scrolling with mouse wheel: dynamic zooming in the work surface
- Hold left mouse button and move cursor: moving an element on the work surface

### 6.4.7.2 Keyboard commands

Ctrl + N: New document

Ctrl + O: Open a document

Ctrl + S: Save document

Ctrl + Shift button + S: Save document as

Ctrl + P: Print

Ctrl + R: Open documents used most recently

Ctrl + Z: Undo

Ctrl + A: Select all

Del [Entf]: Delete

Ctrl + C: Copy selected elements

Ctrl + X: Cut selected elements

Ctrl + V: Paste selected elements

Backspace key: Remove previous connection point while drawing a connection

Esc: Cancel a connection started with the first click.

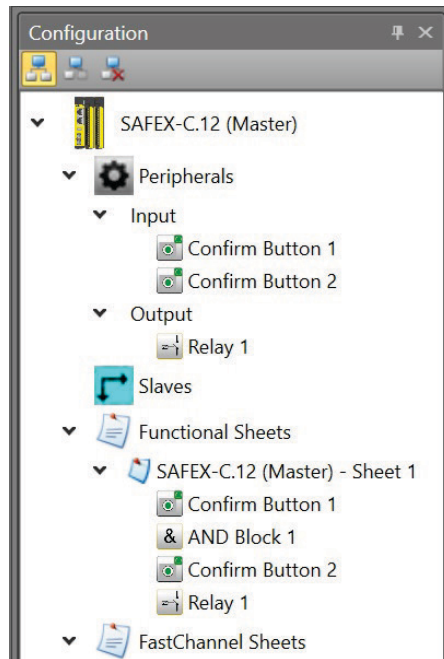
Ctrl + F: Calling of dialog window „Global Search“

Ctrl + F: Display of the search elements (only if message window is active)

Ctrl + tab key: Shifting between plans

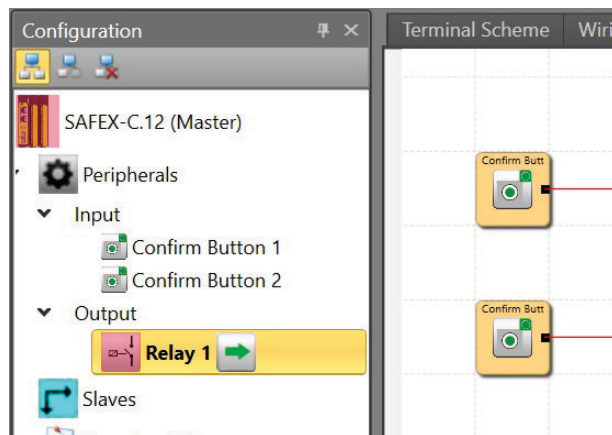
F1: Display help concerning ctrlX SAFETY Engineering (In the individual windows, the help opens in the corresponding chapter).

### 6.4.8 Configuration (Configuration window)



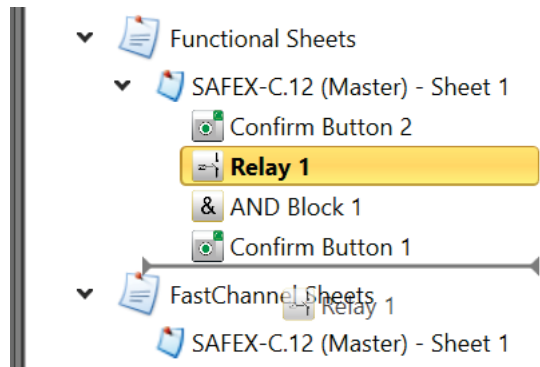
The browser section gives a survey of the whole document. Devices, elements and function sheets are displayed as nodes in a tree structure. The library section automatically adjusts its content to the element currently displayed in the configuration window. Every node in the configuration window can be faded in or hidden. The user can rename every node – either by a double click on the node or via the context menu. Several selections can be made by holding the Ctrl button or the “Shift” button. This additional selection is marked in the configuration by switching the node names to bold font. The selection in the Configuration is adjusted to the selection on the work surface.

If a functional scheme has been selected, and if inputs, outputs or sensor elements are inserted in the functional scheme, these elements are marked with a green arrow. The green arrow indicates that these elements can be drawn into the functional scheme and that they can be inserted there.



**Fig. 20: Inserting an output element in the functional scheme using the example of „Relay 1“**

By pulling the elements and dropping them at the desired place, the user can change the sequence of inferior elements within a superior node.



**Fig. 21: Moving an element within a parent node by dragging and dropping using the „Relay 1“ example**

#### 6.4.9 Control via document tabs

The ctrlX SAFETY Engineering contains a document window, which includes the following:

Plan tabs:

- Terminal scheme
- Wiring scheme
- Functional scheme
- Global network
- Local network
- FastChannel
- Groups

Sheet tabs:

- One sheet for each device

The plans and sheets are displayed by individual tabs in the document window. By navigating via the document tab, the user can switch between plans and sheets. Plan tabs are situated at the top of the window, and sheets are situated at the bottom of the window. Please observe that by default only the plan tabs, the terminal scheme, the wiring scheme and the functional scheme are visible. The other tabs (networks, FastChannel with ctrlX SAFETY<sup>link</sup>) are displayed only under particular circumstances. Every sheet belongs to a device. If a Slave device is selected in the configuration, only the plans and the sheets of this slave device are visible. To display the sheets of other devices, the user must select the devices in the configuration.



With the shortcut „Ctrl + Tab-key“ you can switch between the plans.

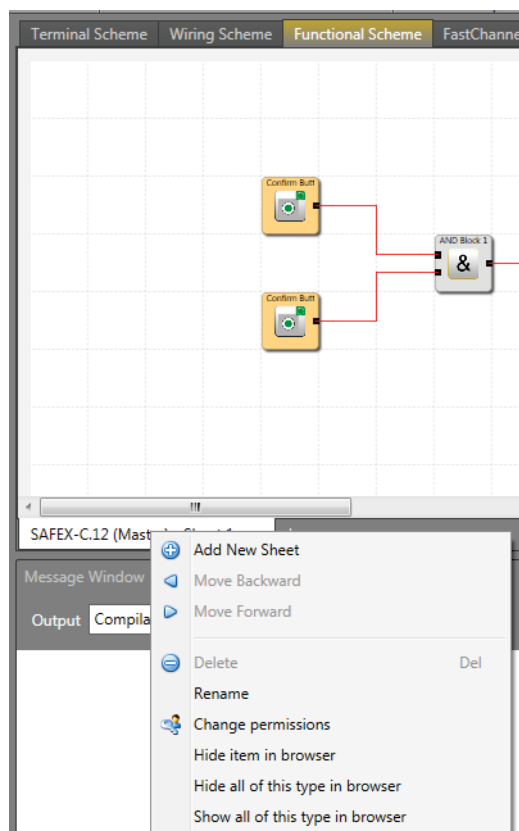
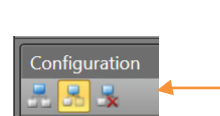


Fig. 22: Sheet- context menu

- **Add new sheet** - adds a new sheet to the current plan.
- **Move Backward [Shift to the left]**- shifts the current sheet one position to the left.
- **Move Forward [Shift to the right]** - shifts the current sheet one position to the right.
- **Delete** - deletes the current sheet. This command is not available if only one sheet exists.
- **Rename** - renames the current sheet.
- **Change permissions** - shows the permissions dialog.
- **Hide item in browser** - the selected elements are hidden in the tree view (view filter must be selected in the configuration)



- **Hide/show all of this type in browser** - If this option is selected, the upper menu of the configuration can hide, show or reset these elements in configuration

### 6.4.10 Plan types

In the document window, the plans and sheets are presented by individual tabs.

#### Terminal scheme

The section “terminal scheme“ shows a simplified schema of selected devices and peripheral devices of the ctrlX SAFETY and also has an editor function where the user can add, remove, replace and move objects. These actions are used to edit the project.

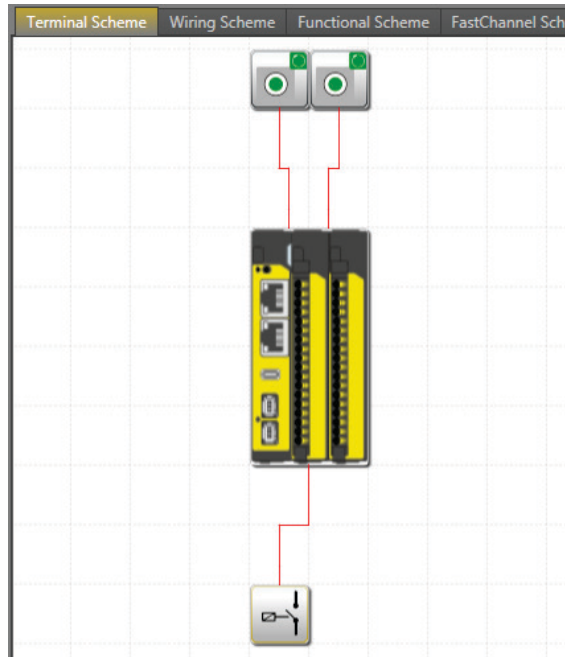


Fig. 23: View "Terminal scheme"

Terminal scheme: In the first step a master device must be selected.

If function blocks are inserted into the connection diagram, the elements are automatically coupled with the device. If several devices are indicated in the connection diagram, the user must add peripheral devices to the corresponding device. Otherwise, the dialogue for device selection appears.

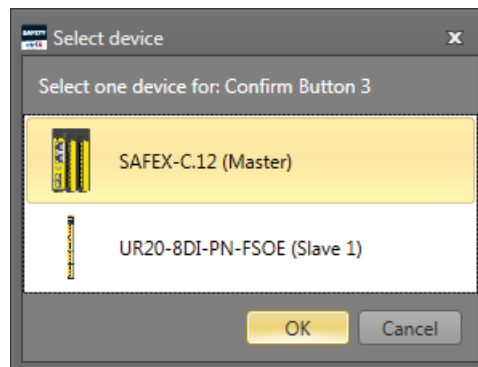



Fig. 24: "Select device" Window

Wiring scheme

Under "Wiring scheme" the assignments of the external connections in a ctrlX SAFETY system to the selected sensors and actuators are shown. When creating a new document (Menu > New), all possible inputs and outputs as well as additional sensor interfaces (encoders, analog sensors) are shown here.

 Although automatic arrangement is enabled, in some cases it may happen that connections are displayed unfavorably. However, this does not influence the functioning! If the corresponding element is moved, the connection wiring is redrawn and possibly appears in a clearer way.

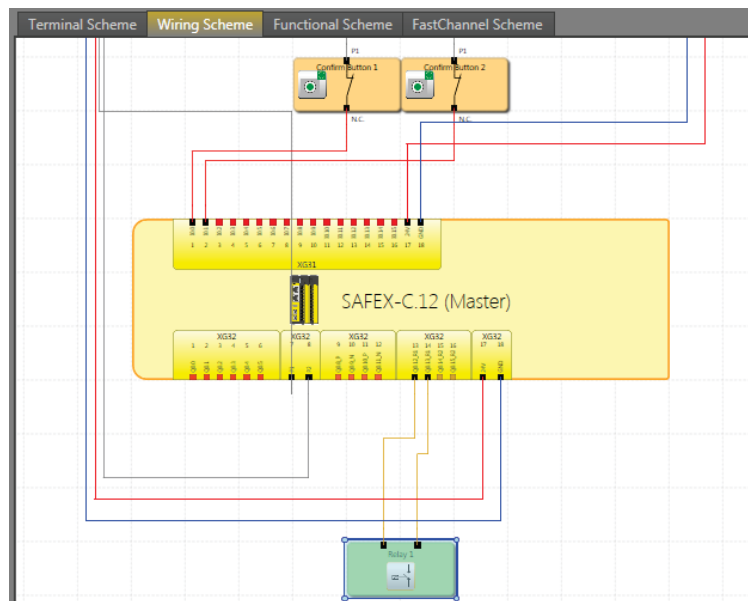



Fig. 25: View "Wiring scheme"

- 24 V:** This line shows a permanent tension of 24 V DC. The ctrlX SAFETY master device requires a 24 V DC power supply.
- GND:** This line shows the permanently installed mass and is a (relatively) constant potential that can serve as a reference for other potentials.
- Py (P1/P2):** Wiring of the test pulse output P1 and P2

 In this view no logical elements may be defined. The corresponding commands are available in the functional scheme.

Functional scheme

In the function block diagram, the connection is made between input, control, output and logical blocks.

This means that the output connectors of the input elements correspond to the input data of the function block diagram. Accordingly, the input connectors of the output elements must be seen as the output data of the function block diagram.

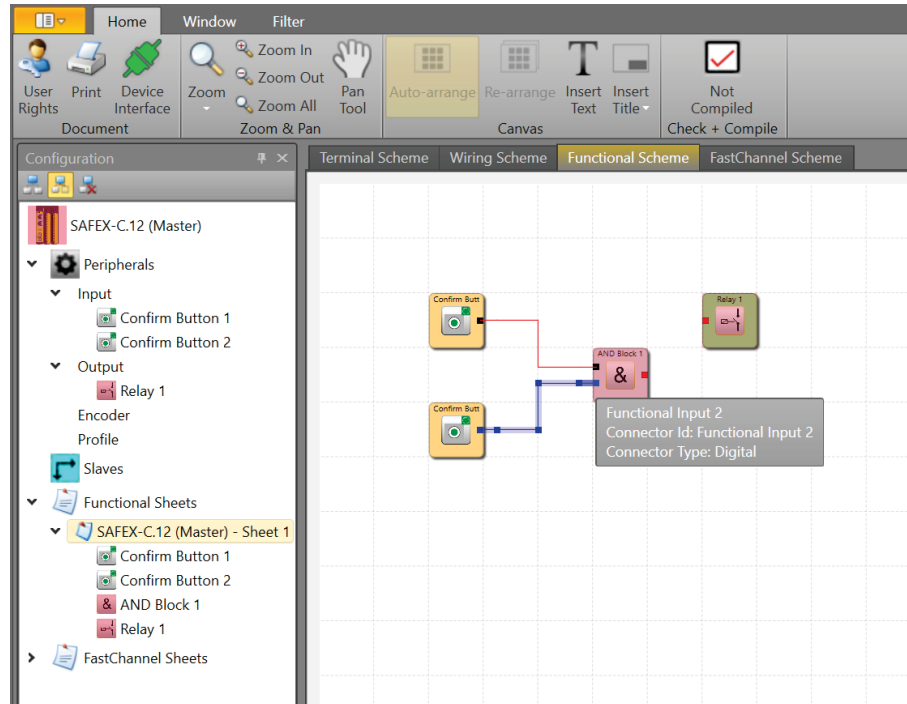


Fig. 26 view functional scheme, marked functional input

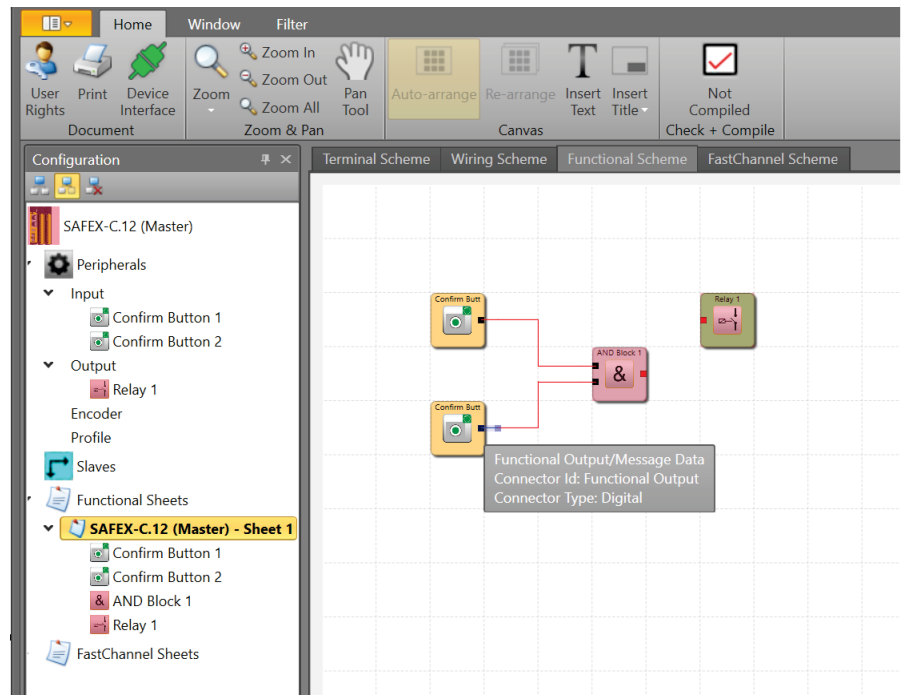
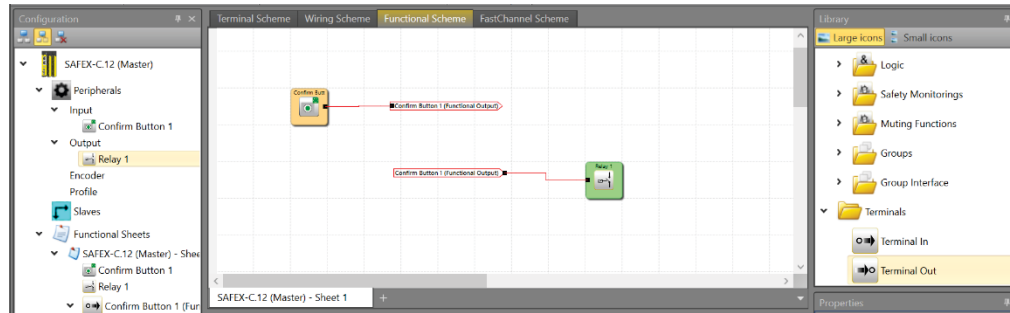



Fig. 27 View functional scheme, marked functional Output/ message file

To develop a clearly structured function block diagram, so-called connectors (connection point input/output) can be defined. These constitute a determined connection between input and output connectors of the function blocks.



**Fig. 28 View terminal scheme, structured layout of the function block diagram through the use of connectors**

One or several flag output block(s) (output terminal) can be defined for a flag setting block (input terminal) (see chapter "Connections").

 Use the comment field in the window "Properties" to enter the connecting points. This information simplifies the use of additional connecting point outputs. This contributes to a clear arrangement

#### Groups

"Groups" contains one sheet per group for every group block from the functional scheme. After a group block has been created, this function is available in the functional scheme plan. For further information concerning the creation of groups cf. chapter „6.10.8.2“.

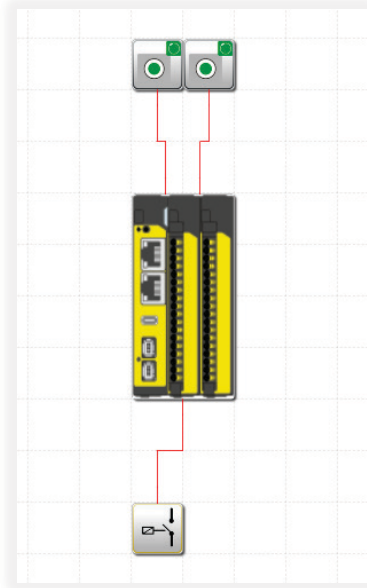
#### Global network

All networks are displayed in the "Global network" overview. Master connections and connections with slaves and fieldbus are displayed. Further information can be found in chapter „6.9“.

#### Local network

The other networks are device-independent and have their own diagrams that are displayed for the corresponding device. This diagram is called "Local Network".

### 6.4.11 Work surface (Canvas)

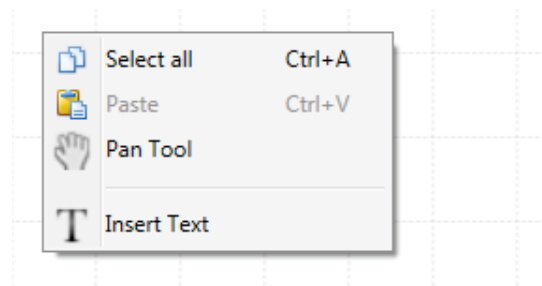


The work surface is the basic drawing tool. Every sheet is displayed in a proper work surface. Helpful tips:

You can pan the work surface by pressing the middle mouse button, even if the panning mode is not active.

The zoom can be changed by scrolling with the mouse wheel while pressing the Ctrl key. Using the mouse wheel, the user can scroll horizontally through the work surface.

Every work surface saves its own zoom factor.



**Fig. 29** context menu of the work surface

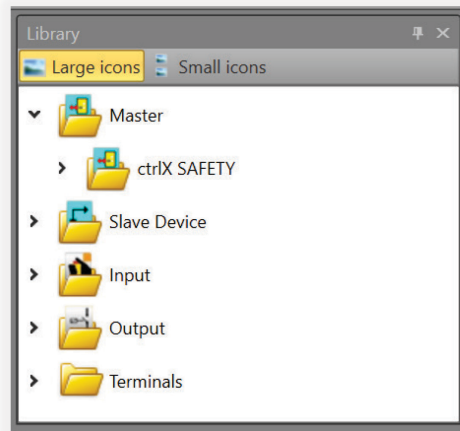
With **Select all**, all elements and connections or a work surface are selected.

With **Paste** all elements and connections from the clipboard are inserted (if available).

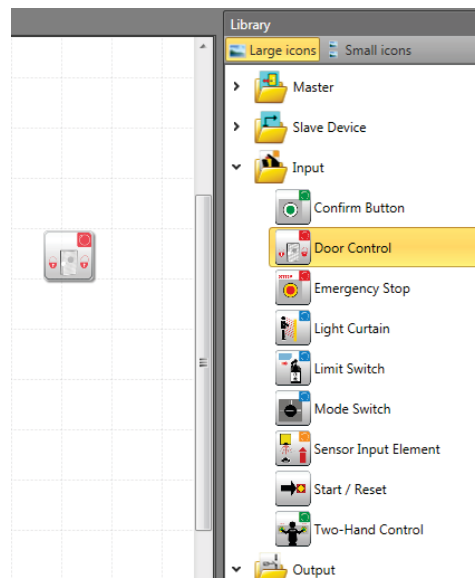
With the **Pan Tool**, you can switch within the Pan mode.

With **Insert text**, the text at the current position of the cursor be inserted into the work surface.

### 6.4.12 Library

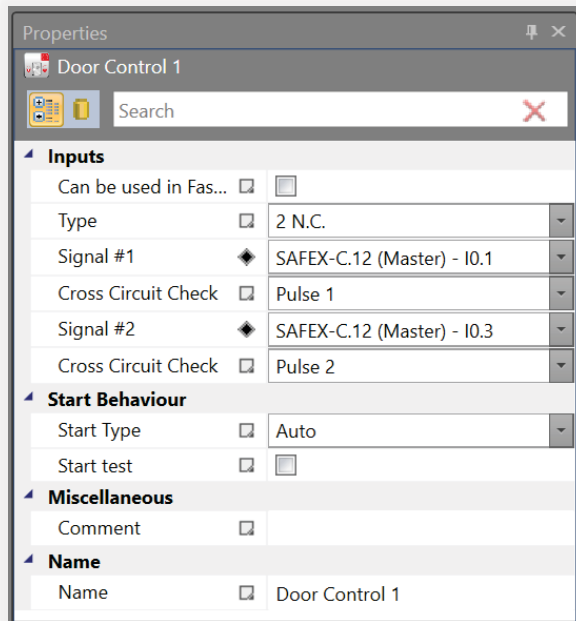


The window “Library” is the main tool for the user to insert elements into a document. The window “Library” consists of drop-down folders. Every folder contains one element or several elements. Folders and elements are filtered by current plan, current sheet and currently selected element in the configuration or work surface. With the buttons “Large icons” and “Small icons” situated at the top of the window, you can switch between the view sizes of the elements. To insert an element into a document, the user must drag the element from the window “Library” to the work surface and drop it there.




**Fig. 30 Drag to add an item from the library to the canvas**

### 6.4.13 Properties window



The window “Properties” serves to change the property values of elements. The content of the property window is updated automatically and shows the currently selected element. By default, the properties are grouped in categories. To reverse this setting, the user must click

on the “Uncategorized” button . With “Search element“

, the desired property can be found fast and easily.

All properties have default values. If the property value is set to the default value, a white symbol appears beside the name of the property. If a value is set that does not correspond to the default value, the symbol is black. After clicking on that symbol, the user can reset the value to default.

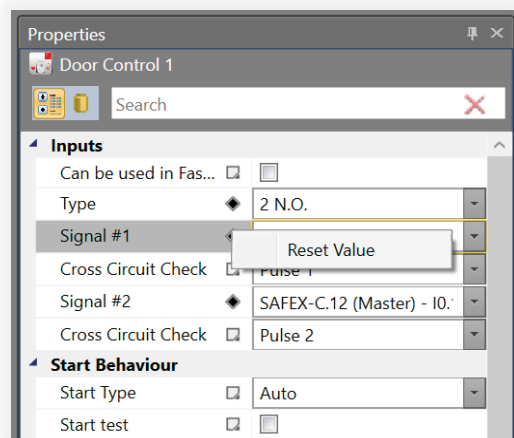
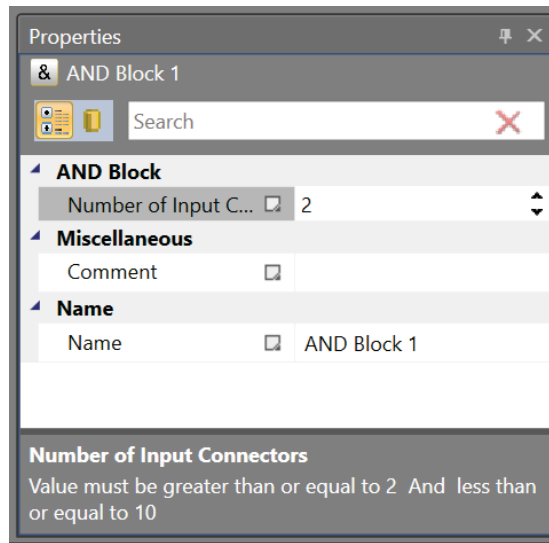



Fig. 31 Properties window, Reset value

The bottom bar of the Properties window displays additional information about the currently selected property. (if available)



**Fig. 32 Window „Properties“ with information about the currently selected property (Example „And Block 1“)**

In the window “Properties” you can show the properties of a selected object and change them. In this section different editing fields are displayed, depending on the requirements. These editing fields include input fields drop-down lists, and links to individual software dialogues. You open the window “Properties” by clicking on the “Properties” button in the “Window” tab of the menu ribbon.

 The comment field can contain several lines. With the “Enter” key, you proceed to the next line.

Structure of the properties window

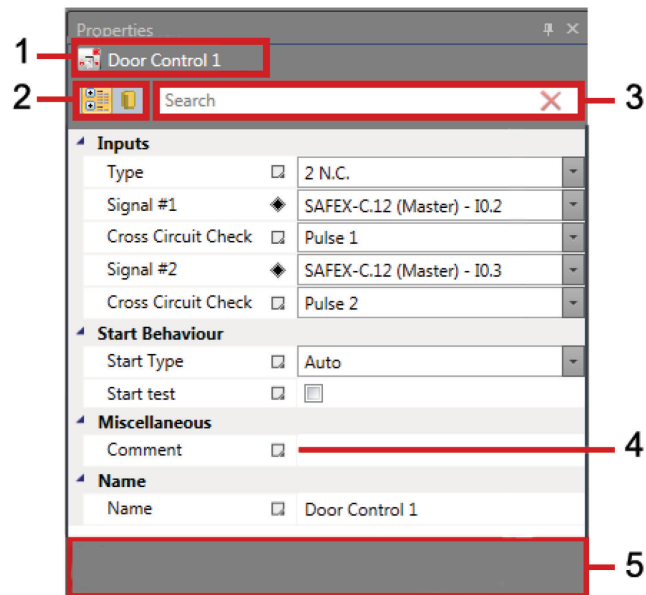


Fig. 33 Structure of Properties window

1. The name of the selected object.
2. Selection fields to change the order of the property list:
  - *Categorize / Uncategorized*- List all properties and property values for the selected object by category. You can hide categories to reduce the number of properties displayed.
3. Search field to filter properties according to entered text.
4. Button to open the pop-up-menu „Extended Properties“.
5. The description of the selected property, if available.

### 6.4.13.1 Menu „Extended Properties“

With „Extended Properties“, the user can execute property-specific commands.

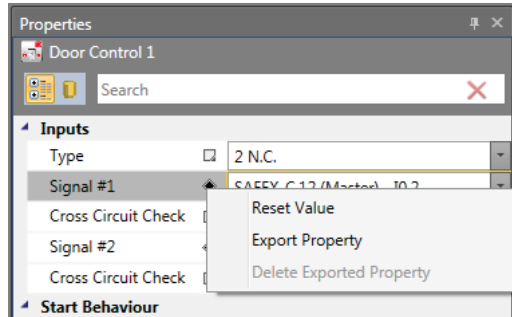


Fig. 34 Properties window with extended options

**Reset Value**– The user can reset the selected property to a default value.

**Export property** – The user can export the selected property to any element superior in the hierarchy.

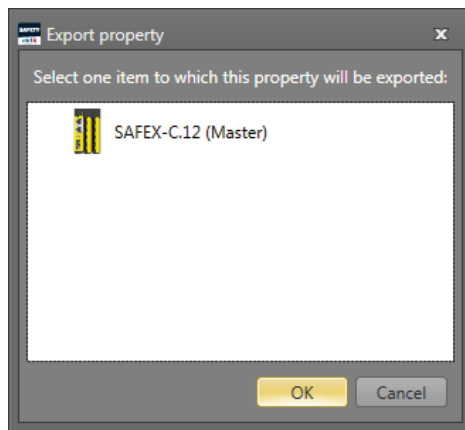


Fig. 35 Dialogue "Export properties "

**Delete exported property** – The exported property is deleted from the element

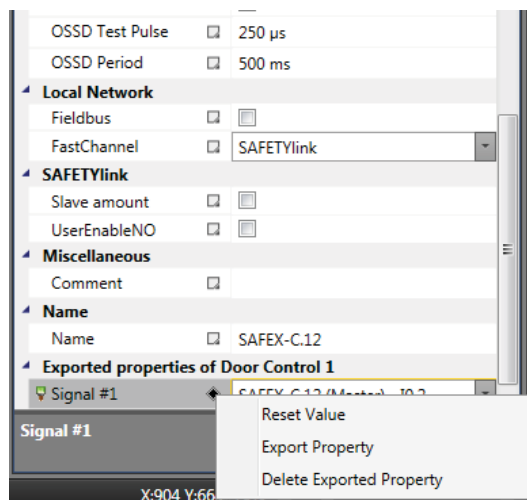


Fig. 36 Exported property on a master device

### 6.4.13.2 Validation of properties

#### Input validation

The input validation controls if an entered value is situated within the section specified by the properties, and if this value contains invalid characters. If the value is invalid, a red rectangle is drawn around the editor.

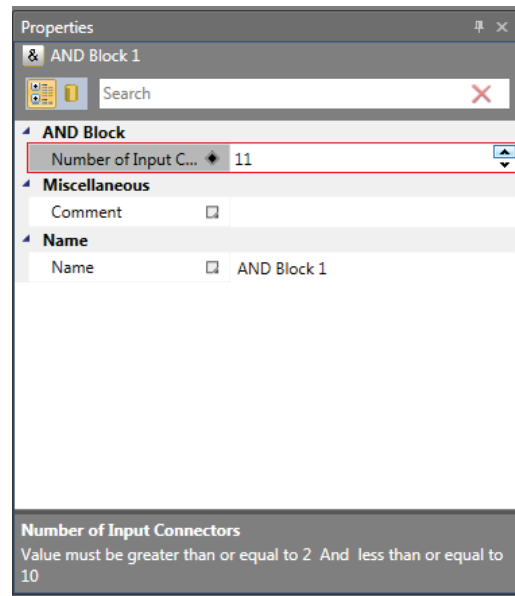


Fig. 37 Value of the property „Number of Input Connectors“ is not within the range

#### Value validation

The value validation controls if an entered value fulfils the conditions defined by other properties. If the value is invalid, the editor’s background turns red.

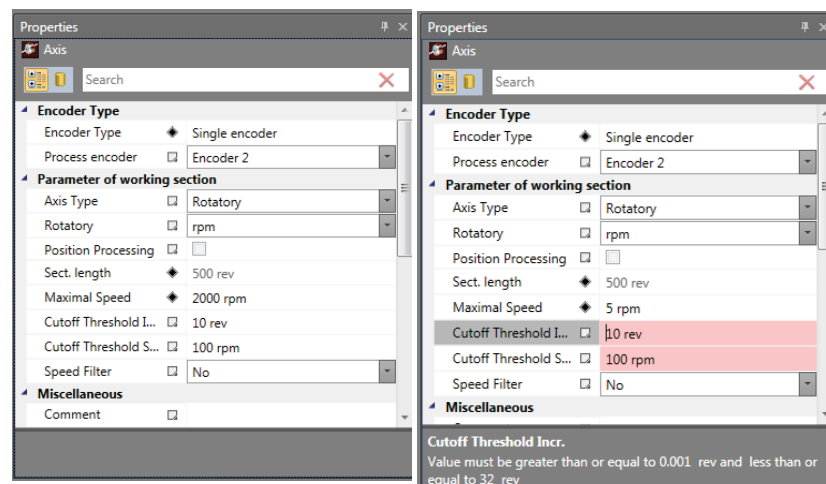
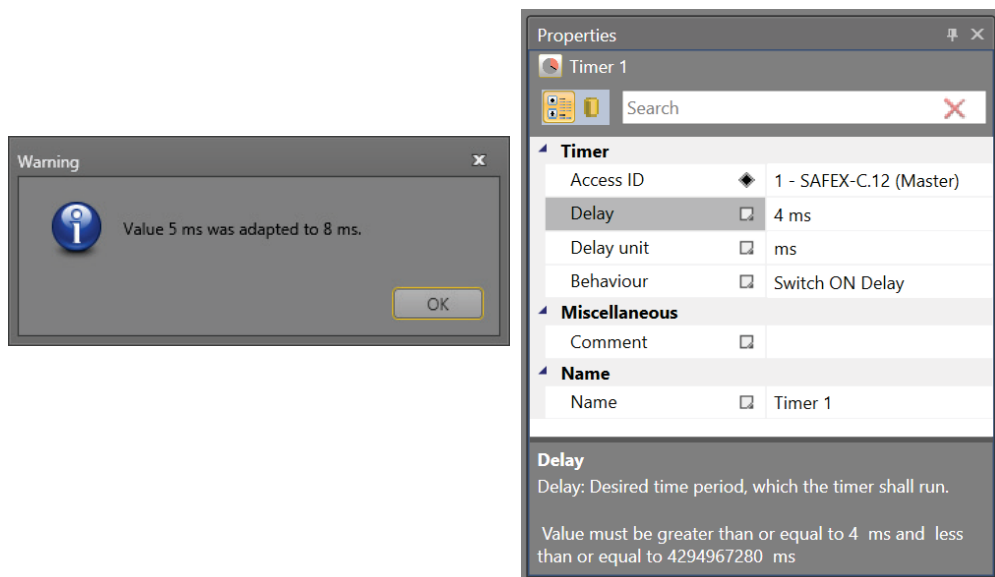


Fig. 38 Example of a value validation. After the property “maximum speed “has been changed in 5, the property “Cutoff threshold” is invalid.

## Adaption

With the special validation function “Adaption”, a property value can be evaluated. If the value does not comply with the function’s restrictions, the function updates the value, and a message window appears, giving the reason why the value was invalid.



**Fig. 39 Example of Adaption: After the property value of " Delay" has been changed in 5 ms, the value has been analyzed by the adaptation function and has been changed to 4 ms.**

#### 6.4.14 Message window

The message window serves to output status messages and error messages, to display results of the evaluation of the function plan. Furthermore, the message window is an important instrument to check function block data within their respective contexts.

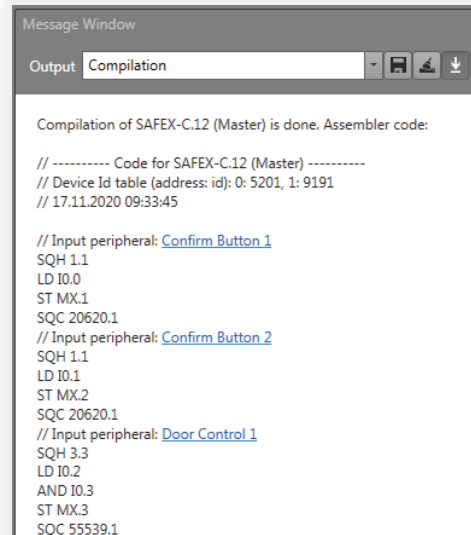


Fig. 40 View of the message window with the "Compilation" sample output

#### Selection of message information via output

Status and error messages are output via "**Application**".

"**Compilation**" - Control of the function block data within their context.

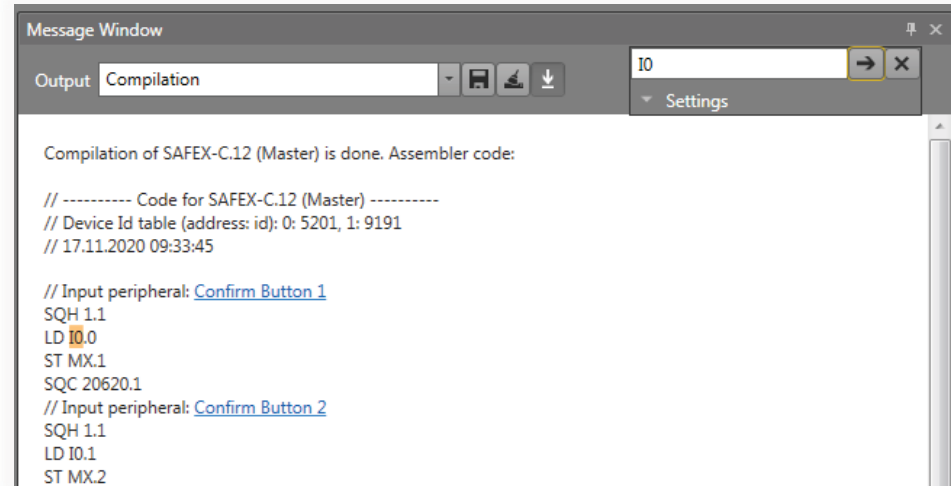
"**Device interface**" - display of results of the evaluation of the function block diagram.

#### Quick jump to an element


By clicking on the colored block IDs in the message window, it is possible to jump to an element. The working surface scrolls to the desired position, and the element is visible.

## Search field

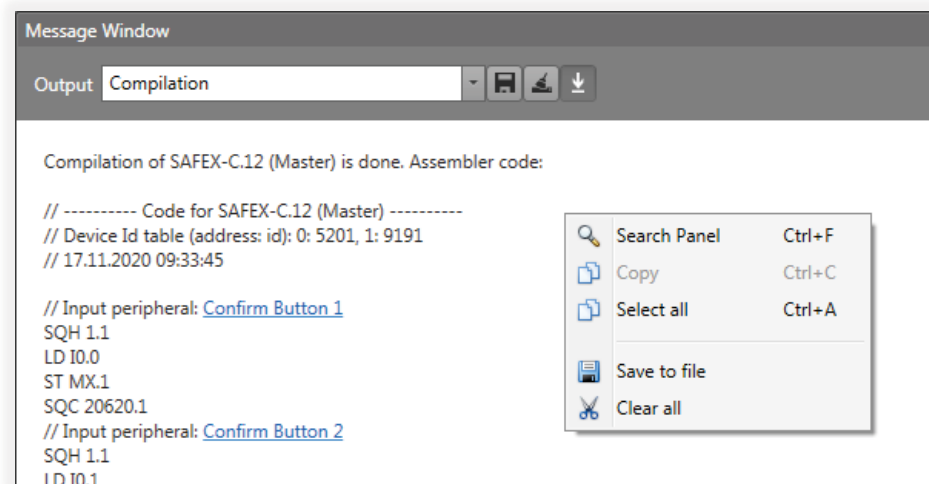
Use Ctrl + F to open the search field. Note that this key combination only functions if the message window is active. The search field can also be called via the context menu.



**Fig. 41** Message window with search field

Via the search field, the user can search the compiled code. To show the next match, either click on the “Search” button  or use the F3 key. By clicking on “Settings”, additional settings can be displayed or hidden. By selecting the boxes, the user can determine the search method.

- Context menu in the message window



**Fig. 42** Message window with context menu

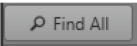
“**Search Panel**“ shows or hides the search field.

“**Copy**“ copies the selected text in the clipboard. The text is available for inserting.

“**Select all**“ selects the whole text.

“**Clear all**“ deletes the whole text.

### 6.4.15 Global search

Global Search is an important search instrument. The text entered into the search field is searched for on the basis of settings. To show all hits of the desired text, either click on the “Find All” button  or press Enter.

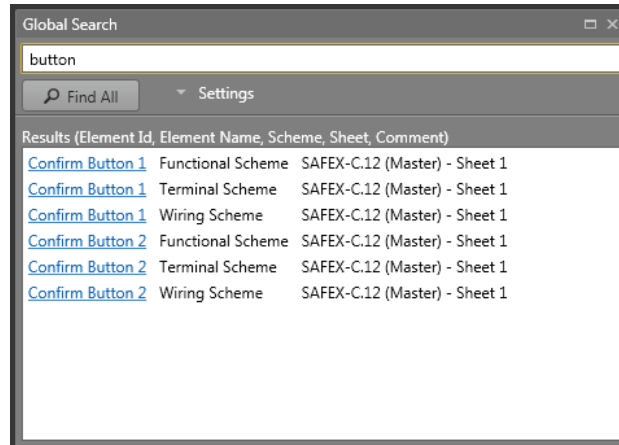


Fig. 43 Window „Global Search“

### Search settings

By default, the search settings are hidden. To show the settings, click on “Settings”

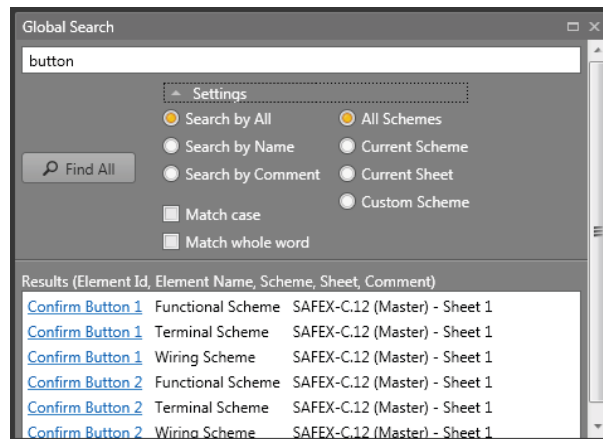


Fig. 44 Define search settings

Beside the familiar settings, e. g. „Match case“ or “Match whole word“, the global search can also search for name or comment. Additionally, it can be fixed from which plans results shall be displayed.

### Quickly jump to an element

If you click on the block-ID, the program immediately jumps to this block.

### 6.4.16 Print

Via "Print" created plans can be printed out. The printer can be selected and the printer's properties can be set. You can set the number of copies to be printed and select the pages to be printed.

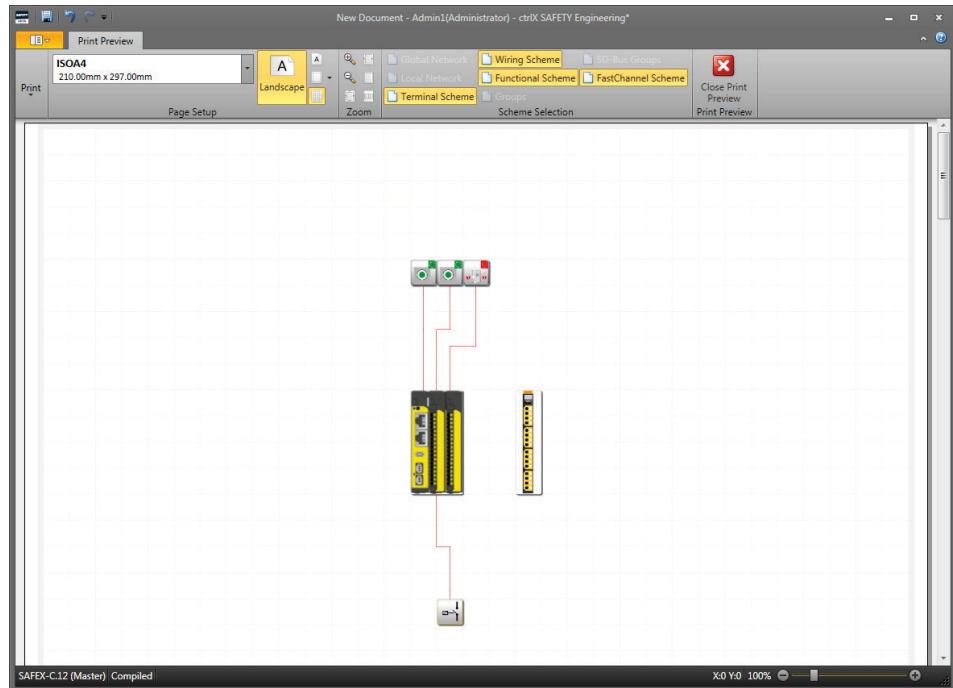


Fig. 45 Tab „Print preview“

#### Menu group „Page setup“:

**Page size, orientation** – landscape or portrait

**Margins** – left, right, top, bottom

**Grid** – to switch on or off the printout via the "Print Grid" button.

#### Menu group „Zoom“:

**Zoom In** – enlarges the content in the preview window (+10 %)

**Zoom Out** – reduces the content in the preview window (-10 %).

**Actual Size** – sets the size of the content at 100 %.

**Page Width** – shows the page in full width.

**Whole Page** – shows the whole page in the preview window.

**Two Pages** – shows two pages simultaneously.

#### Menu group „Scheme Selection“:

**Button Terminal scheme** – sets if terminal scheme is printed or not.

**Wiring scheme** – sets if wiring scheme is printed or not.

**Functional scheme** – sets if functional scheme is printed or not.

**Close Print Preview** – closes the print preview window.

### To print a plan from a document :

1. Click "Print" in the "Start" menu (or select the print command in the Quick Access Toolbar by using **Ctrl+P**).
2. Before printing, check the print preview of the terminal scheme, of the wiring scheme or of the functional scheme.
3. Select the printer from the list showing the operational printers.
4. Set the number of copies and pages.
5. In "Page Setup" you can select the page size, the orientation and the margins. You can also switch on or off the grid on the print. For further printer properties click on "Printer Properties"



6. Click on the "Print" button . If you want to edit a plan or a diagram, or if you want to



continue working, close the print preview .

7. Under "Zoom" you can set the size of the print preview.

### 6.4.17 Settings

In the Settings Window the user can change the application settings. To change the category, click on the desired tab on the left side of the program.

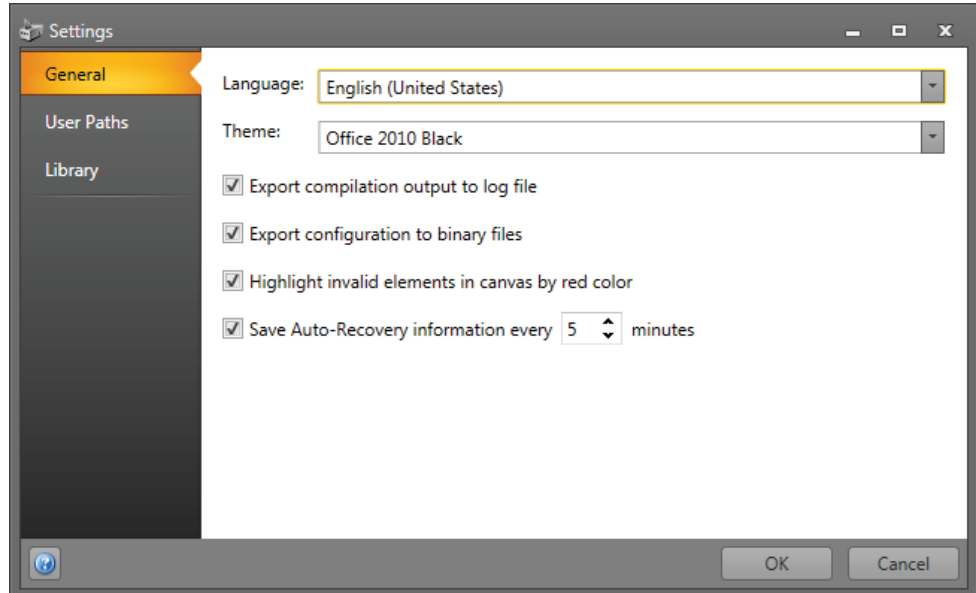


Fig. 46 Tab „General“ in the user window „Settings“

#### General:

**Language selection** – Setting German, English

**Theme** – Setting the color scheme of the surface (**light or dark**)

**Check-on or Off** of the following functionalities:

- saving of the compilation result in a log file
- saving of the configuration in a binary file,
- "Highlight invalid canvas elements in the canvas with red color" to enable validation in the canvas.
- Auto Recovery Information save every x minutes.

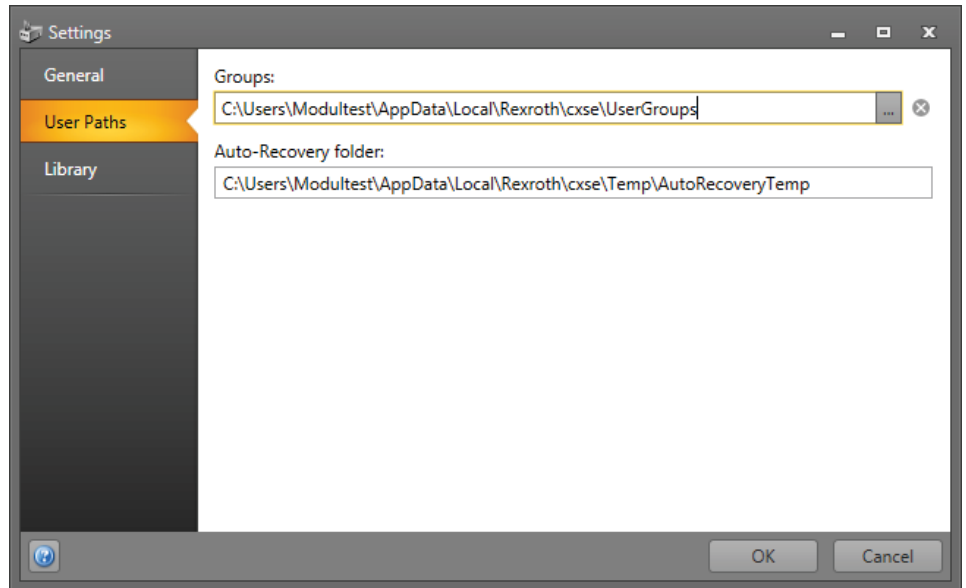


Fig. 47 Tab „User Paths“ in the user window „Settings“

**User Paths:** save group target and Auto-Recovery file

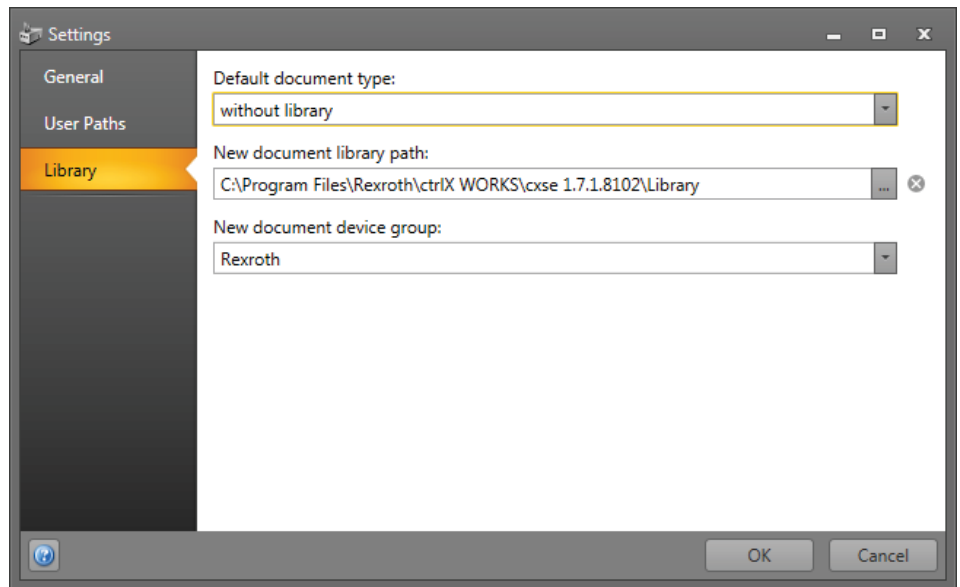


Fig. 48 Tab „Library“ in the user window „Settings“

**Library:** Setting of document type, path and device series.

**Standard document type** – Differences can be made when selecting the document:

- without library \*.spl2:  
Very small file size, program can be opened with same or newer SafePLC<sup>2</sup> with same range of function.
- With library \*.spl2l:  
Very large file size, program can be opened with same or newer SafePLC<sup>2</sup> regardless of range of function.

## ***NOTE***

- ▶ Here, all necessary libraries are saved. Thus, functional uniformity is given, although possibly in a new version the function has been changed .

**New document library path** – Setting the storage location of the new library file \* .splib.

**New document device group** – In case of several device groups, the device group of the new document can be preselected, e.g. for different series..

## ***NOTE***

- ▶ Please note that changing the device group requires a restart of the application.

### 6.4.18 Auto Recovery

The programming software **ctrlX SAFETY Engineering** has an integrated Auto-Recovery function. This function saves the document process of the open file within a customizable fixed interval (1 to 60 minutes). If the program closes unexpectedly, e. g. during a power failure or an unexpected crash, the files can be restored. This **ctrlX SAFETY Engineering** function saves the document process in the temporary file directory whose path is indicated on the tab "User Paths".

#### Restart of ctrlX SAFETY Engineering

The Auto Recovery feature allows the user to save, delete, or skip the temporarily saved document to make the selection the next time **ctrlX SAFETY Engineering** is started. But no data will be saved if the **CtrlX SAFETY Engineering** is closed normally.

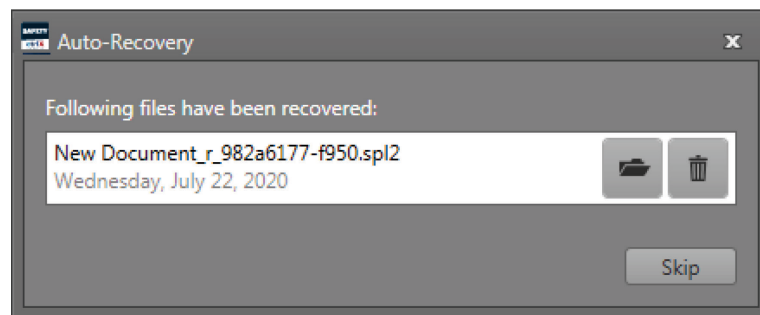


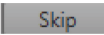


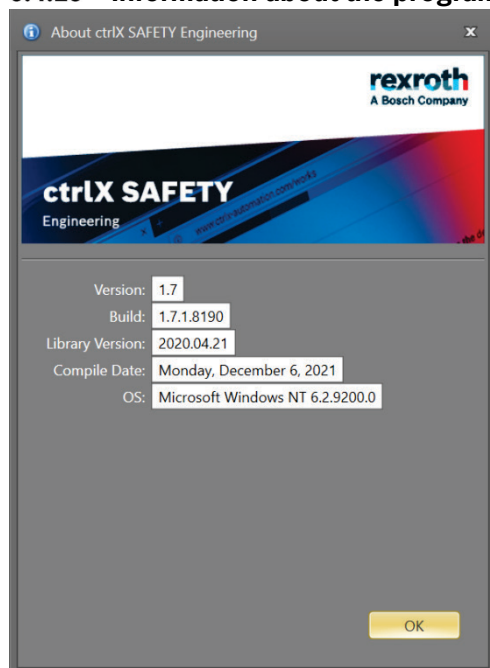
Fig. 49 Window "Auto-Recovery"

**Open file**  - This allows to continue the process with the selected recovery file. At the next restart of **ctrlX SAFETY Engineering** other stored recovery files survive.

**Delete file**  - Delete recovery file and continue program with empty document. If only one recovery file exists, a next selection is not necessary.

**Skip**  - Skips the recovery selection and continues the program with an empty document. Recovery selection holds files for next start.

### 6.4.19 Information about the program



**Fig. 50 Information window about ctrlX SAFETY Engineering**

Under „About ctrlX SAFETY Engineering“ short information is given about the Windows system, the application development, and about compilation. Below, typically, sales information and the web address as well as open source software are indicated.

## **NOTE**

### **Open Source Software**

- ▶ The file third parties.txt, located in the root directory of the installed ctrlX SAFETY Engineering application, lists all open source parts with their license types.

### 6.4.20 Exit

With "Exit" or "X" button, the user exits the program software ctrlX SAFETY Engineering.

#### 6.4.21 Window „User Rights Dialog“ (in preparation)

This window is only accessible for administrators. The window opens after a click on the "User rights" button under the "Start" ribbon tab. The "User rights dialog" window consists of the tabs "Users" and "Groups".

In the window User Rights dialog the administrator can change the user rights for every object in the plan. The program works with three specific rights that are valid for each object:

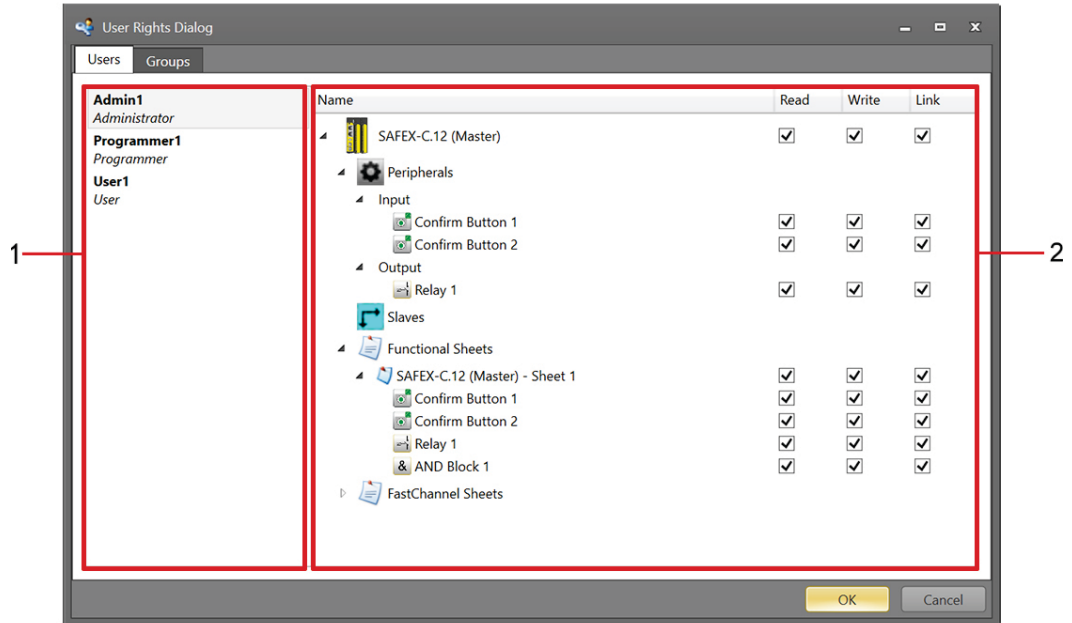
1. Read Permission: The properties of an object can be read.
2. Write Permission: The properties of an object can be changed.
3. Linking Permission: An object can be linked to another object.

### **NOTE**

- ▶ Administrators are standard users of the ctrlX SAFETY programming software and have all permissions.

### 6.4.21.1 Tab „Users“

In the tab “Users” the administrator can change the rights for the other users.



**Fig. 51** Tab "Users" in the window „User Rights“

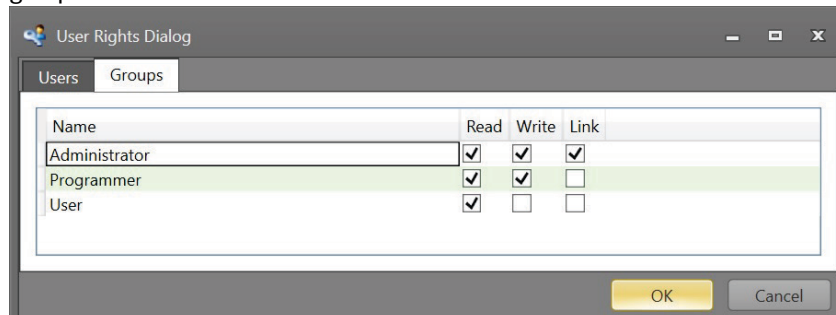
1. List of users with the name of the user group to which they belong (e. g. administrator, programmer, user). If the default user rights are not cancelled, every user has default rights he or she assumes from the user group.
2. List of elements and of rights of the current selected user.

## NOTE

You can change the rights for every block or every group separately by clicking the right mouse button on the block or on the group and selecting “Change Right”.

### 6.4.21.2 Tab „Groups“

With the tab “Groups” the administrator can change the standard rights of individual user groups.



**Fig. 52** Tab "Groups" in the window „User Rights Dialog“

## 6.5 Process

The program **ctrlX SAFETY Engineering** is a graphics-oriented software to create an PLC-based monitoring program for ctrlX SAFETY controller. With the device, it is possible to reliably monitor drive motors as digital, local and via FSoE slave devices. The process described below, has proven most successful for ctrlX SAFETY controller, but it is not compulsory.



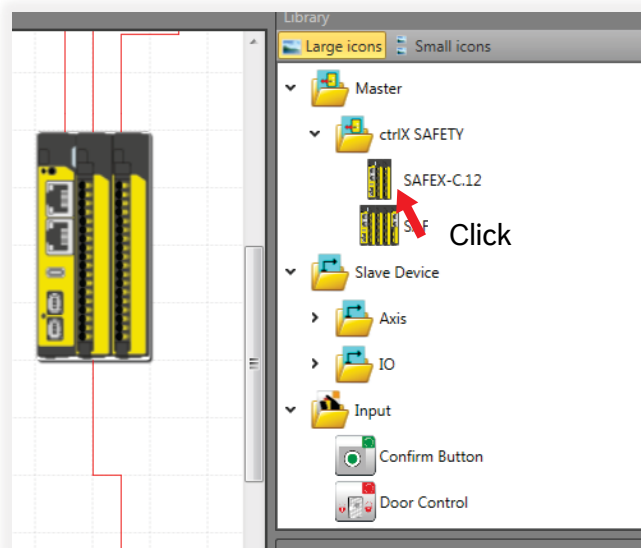
The program requires the write permission and the read permission of the user registered on the PC used for programming. The application can be executed as an administrator. Missing access authorization can either have unwanted effects on troubleshooting in the function plan, or it can cause problems if logic diagrams are saved in directories with restricted rights.

With administrator rights, there are no restrictions on changing the project in ctrlX SAFETY Engineering.

### 6.5.1 General workflow

Drag a symbol from the library or from menu option in the work surface to insert it into the selected plan or diagram. If this is possible, the element automatically adds a block in the work surface. The proposed working steps correspond to the reflections that should be made when planning a safety-relevant monitoring system for a drive axle.

#### „Drag & Drop“



**Fig. 53** Example of „Drag & Drop“

The easiest way to insert a block or a device is “Drag & Drop”.

### The basic steps are:

1. Move the pointing device to the object.
2. To “grab” the object, press and hold the mouse key or the key of the pointing device, with the Esc key the process is reversed.
3. Use the pointing device to “drag” the object to the desired place.
4. By releasing the button you can “drop” the object

### To create an application, proceed as follow:

#### 1. Select the device type to be programmed:

After **ctrlX SAFETY Engineering** has been started or a new terminal scheme has been created, an empty work surface appears. All available devices are in the library. Only when a device has been added to the terminal scheme via "Drag & Drop" does a device preview appear in the configuration window and the following data, among others, are displayed: programming interface, digital I/O, outputs, inputs, etc. To continue with the procedure, a device must be selected for adding.

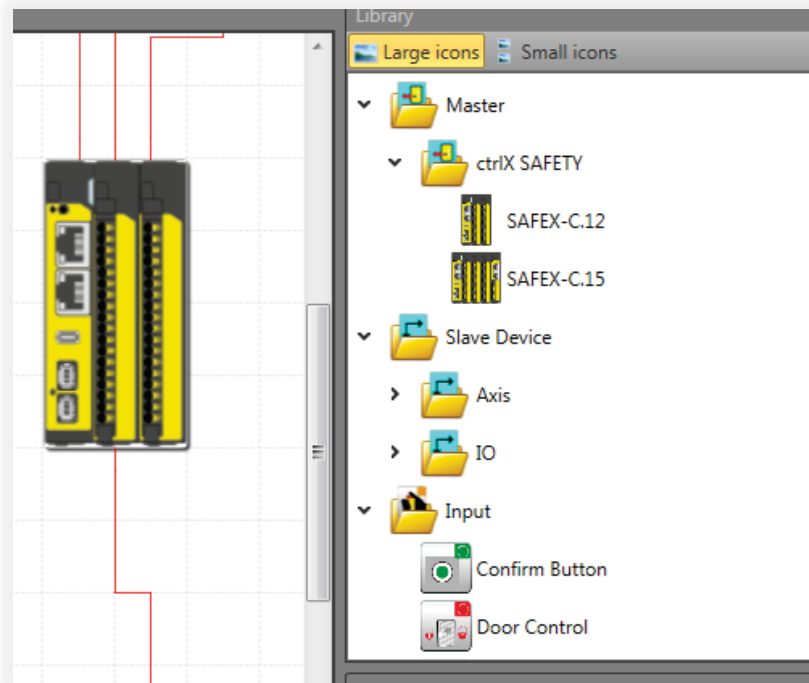


Fig. 54 Terminal scheme – device preview

Add a slave device:

If a Master device has been added in the Terminal scheme, a Slave device must be selected in the browser tree of the library to add a secondary device. Otherwise, the Master device is replaced. Before replacing the Master device, the program shows a warning message.

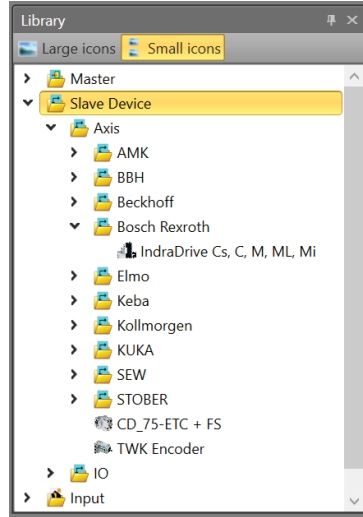


Fig. 55 Selection of an slave device

**NOTE**

Due to the resources involved, and because of their administration in the program environment, is not recommendable to change the type of equipment later on.

The following "Properties" window can be used for every input cluster to assign a name and to select parameters. For the setting "Cycle time" 4, 8, 12 and 16 ms can be selected.

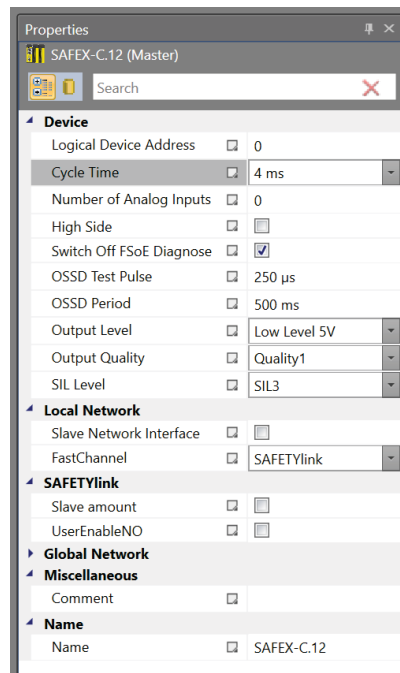


Fig. 56 Properties window of the device

## ! WARNING

If the cycle time is increased, the response time of the entire system increases accordingly.

► After changing the cycle time, all time-based elements must be checked.

## 2. Fixing the device in the Terminal scheme

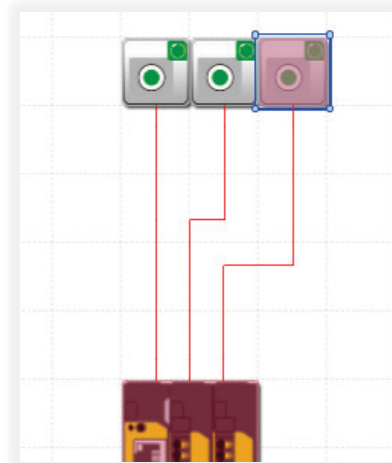
Under “Terminal scheme“ a simplified scheme with selected devices, encoders, inputs and outputs of the ctrlX SAFETY system is shown. The necessary modules are linked automatically after they have been inserted.

The following process is recommended:

1. Select the corresponding type of device (master or slave) in the browser tree of the configuration.
2. Select a input or output module from the library.
3. In case of slave devices with the monitoring of speed and position, the definition of encoders and their parameters is necessary.

## NOTE

A red symbol indicates a missing setting.



**Fig. 57 Confirm button with missing setting (red)**

For an element with analog processing, the interfaces must be set.

The selection of input modules (confirm button, door control, emergency stop, light curtain, etc.) is done via the "Input" folder in the library. Add the necessary output

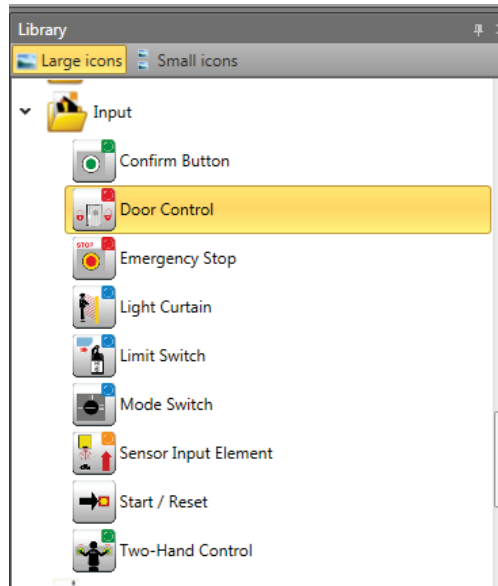


Fig. 58 Selection of input modules via the library

modules (semiconductor, relay etc.) in the same way.

The wiring scheme shows the connections between sensors and actuators with the indicated connectors. After the necessary peripheral devices have been selected, they are connected to the system.

## NOTE

- ▶ When inserting the input or output blocks, it is not necessary to connect them manually to the device, as is the case with the function blocks in the functional scheme. These connections are made automatically in the terminal/wiring scheme.

### 3. Definition of devices in functional scheme

The functional scheme shows the logic modules and their interconnections. Devices that have not yet been incorporated into a functional scheme are marked with a green arrow. The arrow indicates that these elements can be dragged and into the functional scheme and can be inserted.

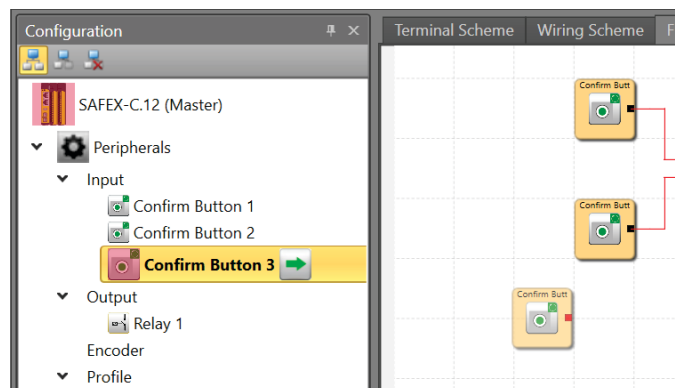


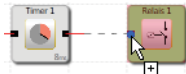
Fig. 59 Insert a input module

#### 4. Definition of Monitoring functions and logic modules in the functional scheme

The functional scheme shows the logic modules and their interconnections.

Programming of the functional scheme by:

- Logic elements and processing elements
- Timer, Flipflops (triggering elements) and terminal blocks
- Monitoring modules for drive monitoring (Drive monitoring only possible if the corresponding sensors have been defined.)



After their selection, the necessary modules are interconnected.

For this purpose, drag the cursor over a “Start connector“. Use the left mouse button to click on the start connector.

By doubleclicking, the start connector is connected to a “target connector“. For further information, cf. the chapter 6.5.14 „Circuit“.

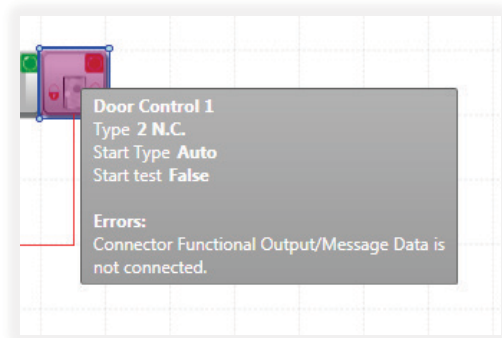


Fig. 60 Information window

#### 5. Compilation of the monitoring program

After programming has finished, the functional scheme is compiled and is converted into a machine readable format.

This process consists of the following steps:

- Check for open connectors in the functional scheme
- Check of the limit conditions for the monitoring functions
- Check if the pulse numbers P1 and P2 are correctly distributed via the cross connections
- Creation of a transferable IL [AWL]- Programming codes for the device

#### 6. Program transfer to the safety device by clicking on the device interface

After the dialogue window of the device interface has been opened, the software automatically compiles the program. The program transmission process consists of:

- Setting the COM output or setting of the IP address
- Transmission of the AWL (IL) programming code
- Enter the serial number of the safety device (only if TCP/IP connection is used)  
To be found on the type plate of the safety controller.
- Test of the program in the safety device
- Creation of the validation report and validation of the configuration

### 6.5.2 Network planning

Before the network is installed and programmed, it is recommended to create a plan of the FSoE network. For this purpose, the first steps are listed and the sequence is explained using examples.

Application examples can be found in the document Application description for the integration of the ctrlX SAFETY SAFEX-C.1\* devices in ctrlX AUTOMATION DOK-XSAFE\*-SAFEX-C.1XC-APxx-EN-P<sup>4)</sup>.

The following steps are necessary:

1. Determination of the FSoE master and its directly connected elements (I/Os)
2. Determination of the FSoE slaves and its directly connected elements
3. Determination of EtherCAT master (→ e.g. ctrlX CORE, Third-party control with EtherCAT master)
4. Determination of EtherCAT slaves (→ e.g. SIO)
5. Determination of the structure of the FSoE network (this is equal to the EtherCAT network structure)
6. Determination of the network parameters with
  - Module address (freely selectable, unambiguous status number in the network)
  - Cycle time (corresponding to the slowest module in the network)
  - Addresses (master = 0, slave x - consecutively numbered)
  - Connection ID (freely selectable, unambiguous status number in the protocol - determines the communication sequence)

After the network structure and its parameters have been determined, the network can be programmed via ctrlX SAFETY Engineering.

Please also use the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup> and the technical data and specifications of the manufacturers to determine the parameters.

## **NOTE**

- ▶ Malfunctions of the FSoE network can cause loss or impairment of safety functions!



## **! WARNING**



Incorrectly assigned or set parameters can cause network! (e.g. data loss or time delay of input data).


The operation and parameterization of the ctrlX SAFETY series is explained using the example of a hall door:


Example: hall door

Our example concerns two adjacent halls (Hall 13 and Hall 15), in which the FSoE slaves manage data and transfer data to the FSoE master. This is located in a remote location in Hall 12.

Between hall 13 and hall 15, an automatic gate is situated, whose position is monitored via an (non-safe) sine-cosine encoder (axle)  and position switches  (digital switch via digital input). In addition, the gate may only be released when the central access barrier is closed (external data via EtherCAT Slave).

The FSoE slaves in the halls offer the operating personnel the possibility to request the opening of the door  and, of course to requests a stop via emergency stop .

Partially, the modules are integrated in the switch cabinets  situated in the different halls. The switch cabinets are interconnected via EtherCAT cables.

A light curtain  is installed in hall 13 to cause a shutdown when a vehicle enters (collision avoidance).

Sketch:

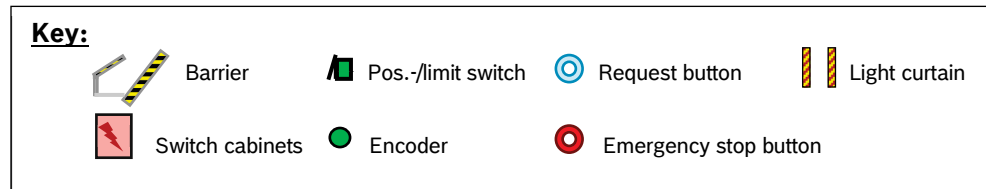
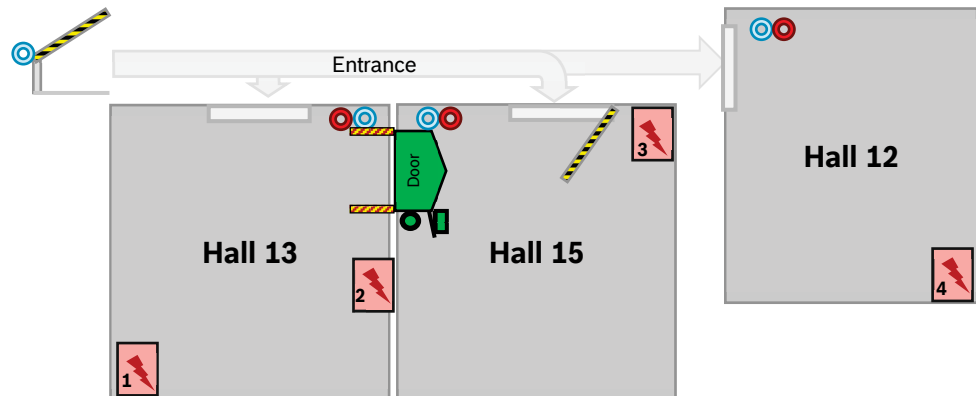

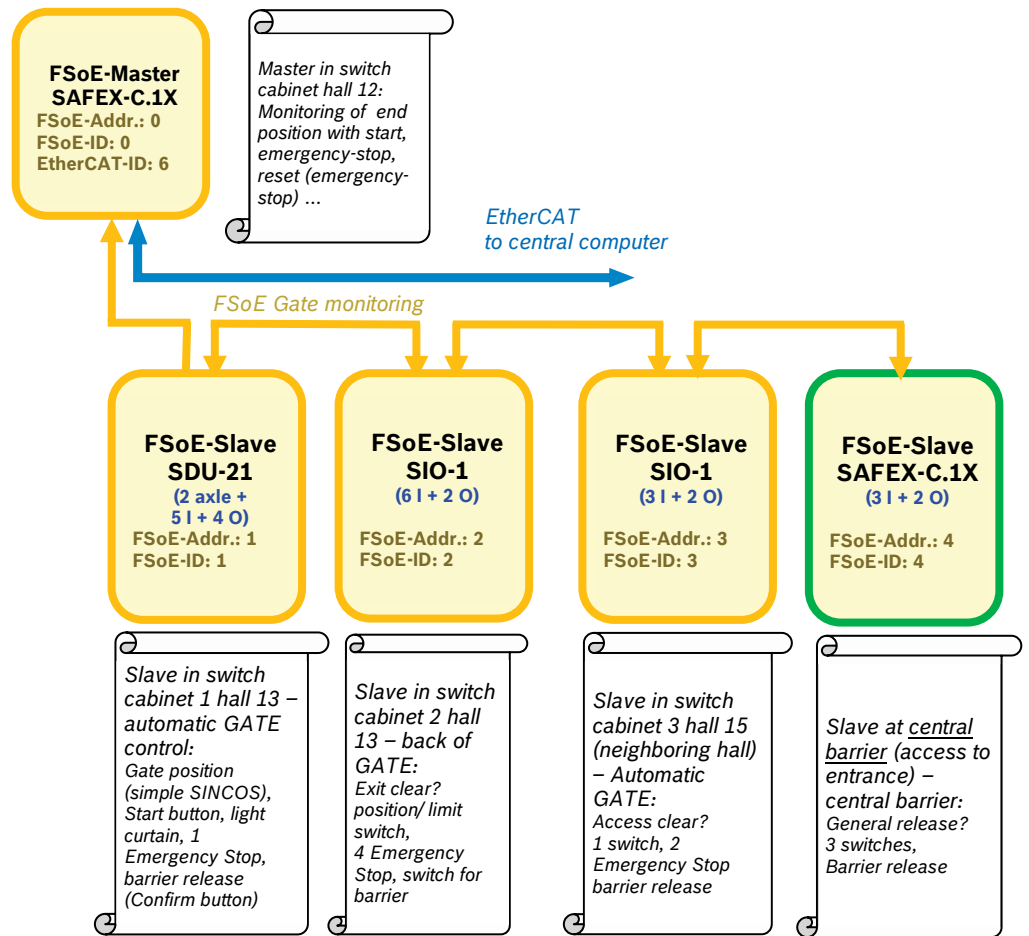


Fig. 61: Example - Sketch

Furthermore, barriers  only clear the way in the safe case (via FSoE slave outputs). The data transfer between Master and Slaves is effected via FSoE.

FSoE network plan:

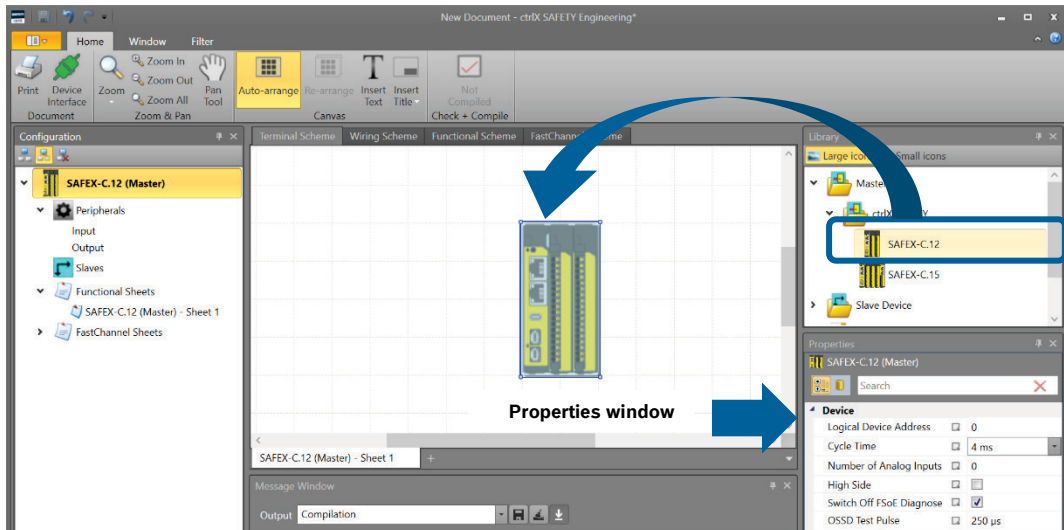


**Fig. 62: FSoE network plan**

### 6.5.3 Selection of ctrlX SAFETY controller / network components

After the start of the program ctrlX SAFETY Engineering, the suitable variant of the ctrlX SAFETY controller must first be selected from the „Library“. This is done by dragging (example: SAFEX-C.12) into the work surface (canvas) and the tab „terminal scheme“.

Via the property window (bottom right), the parameters of the selected controller (e. g. cycle time, ID, etc.) can be determined.



**Fig. 63: Selection of a master**

For our example a SAFEX-C.12 is inserted here and entered in the following parameter:

<b>Logical Device Address:</b>	<b>0</b>	<b>(selectable – see plan)</b>
<b>Cycle time:</b>	<b>4ms</b>	<b>(from data sheet)</b>
<b>Local network:</b>	<b>EtherCAT</b>	<b>(EtherCAT to central computer)</b>
<b>Serial number:</b>	<b>4</b>	<b>(Back of the assembly)</b>

After the insert of the ctrlX SAFETY SAFEX-C.12 controller, the selection folder for slave devices (FSoE and EtherCAT) is automatically shown (before the folder is hidden).

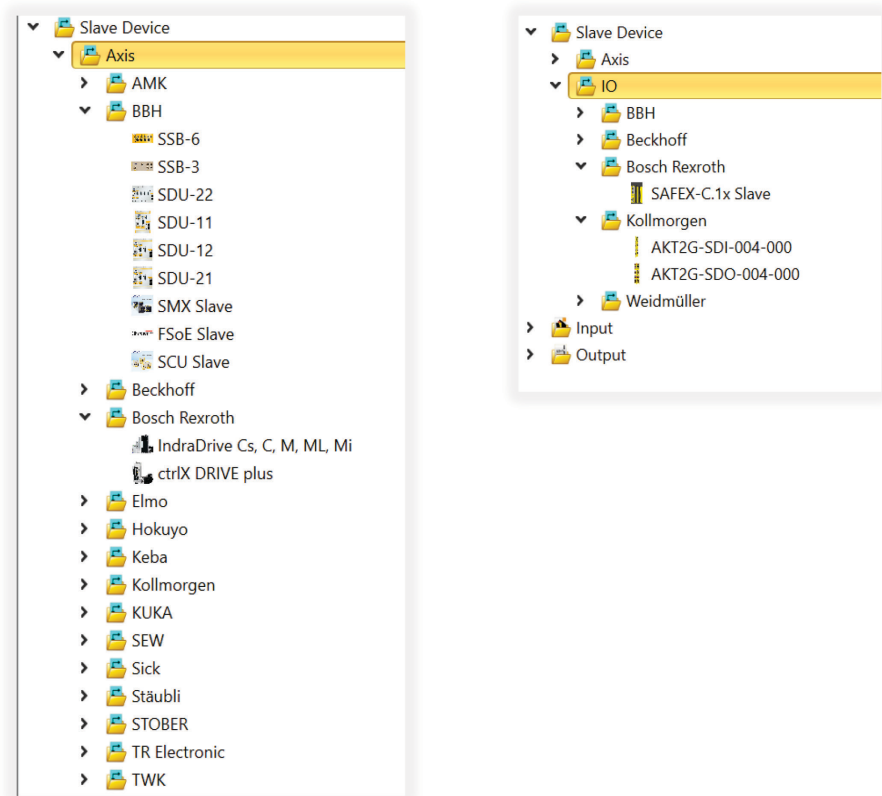
Afterwards, the Slave devices for axle monitoring and IOs can be added. In the same window also the inputs and the outputs of the device can be selected.

#### Slaves for read-in of axle data:

- SSB... (Safe Sensor Box – reading in of encoder data of 6 encoders BBH)
- SDU... (Safe Drive Unit – reading in of encoder data of one encoder BBH)
- AX... (– evaluate encoder data of one encoder)
- SDC (Safe Drive Control – read external encoder data (option encoder))

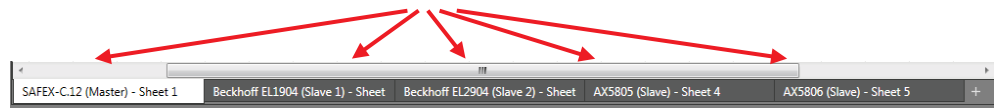
#### Slaves for I/Os:

- SAFEX-C.1x-Slave (– read external I/O data)
- Indra Drive MPx20/21 (– read external I/O data)
- EL ... (I/O device)
- SIO-... (Safe I/Os – input data and output data BBH)



**Fig. 64 Selection of Axis and IO slaves**

These units are predefined and are available at the installation of the ctrlX SAFETY Engineering. Other devices can be inserted by the user (see below). In the wiring scheme, a proper sheet is created for each incorporated device.



**Fig. 65 One sheet per device**

According to the example of the network plan, the following slave devices are inserted:

- SDU- automatic gate – switch cabinet 1, hall 13
- SIO- back of gate – switch cabinet 4, hall 13
- SIO- automatic gate – switch cabinet, hall 15
- SAFEX-C.1X- reading the data of the central barrier

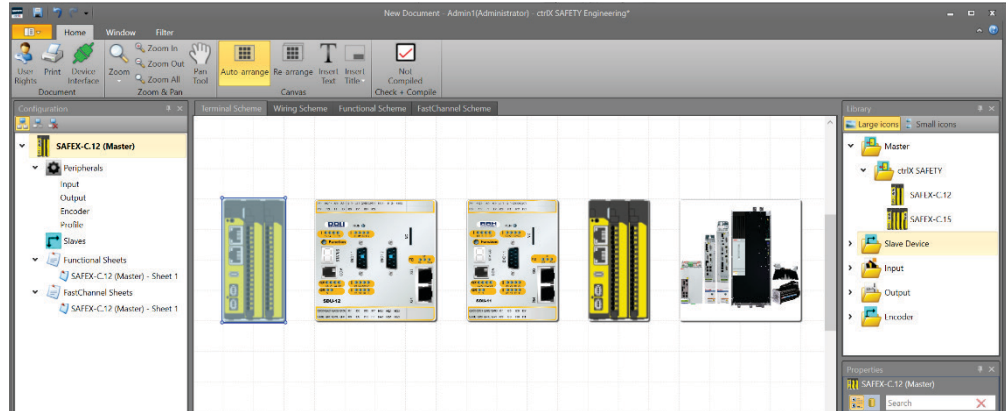


Fig. 66 selection of devices

### 6.5.4 FSoE settings of the ctrlX SAFETY controller / network options

The ctrlX SAFETY master is automatically set to FSoE and has the preset logical device address 0. In the „properties” window of the master device it is possible to activate or deactivate the “switch off FSoE diagnostic”. (see Fig. 67: network selection)

### 6.5.5 Optional Fieldbus interface / Ethernet 2 interface

With the ctrlX SAFETY there is the possibility to configure an additional fieldbus interface (Ethernet 2 - interface). The field of “Slave Network Interface” must be activated if the module is used as FSoE slave device.

1. First, the "Local network" setting must be selected in the master device.

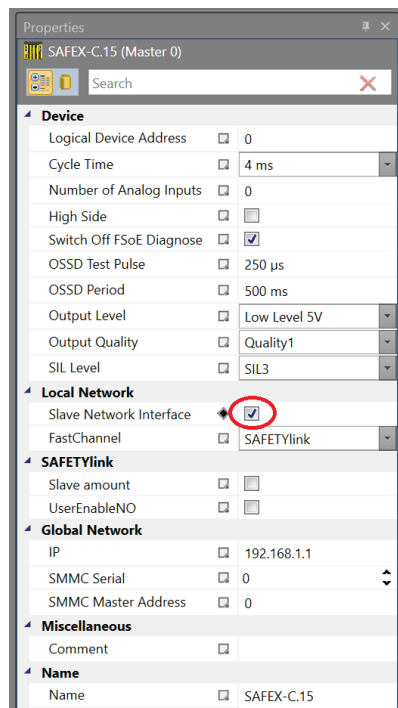


Fig. 67: network selection

2. Afterwards, in the configuration window "Local network" the symbol „Primary/secondary interface“ can be clicked on to change settings in the „properties“ window. There the additional "Protocol type" can be selected via Network.

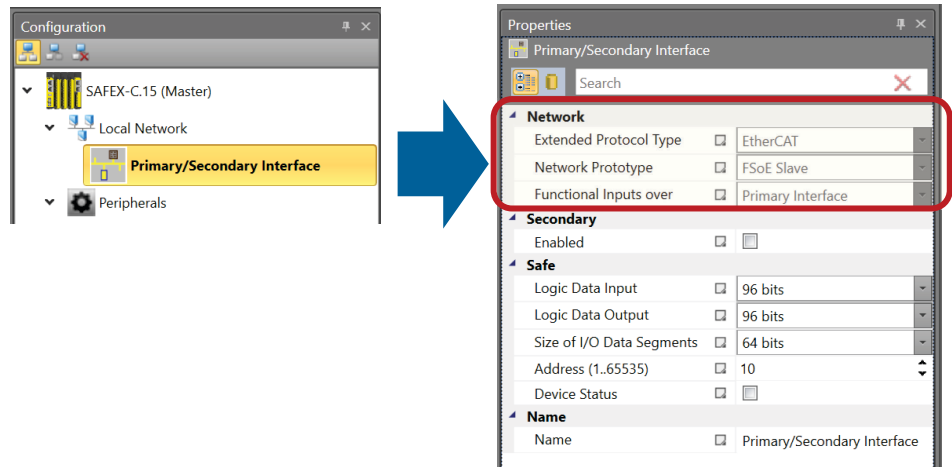


Fig. 68: EtherCAT network

3. In case of inserted Slaves, the FSoE properties must/can be set in the FSoE section in the window "Properties". For this purpose, the respective Slave unit must be selected /clicked on again with the mouse.
4. If the additional fieldbus interface is used, it must first be activated.

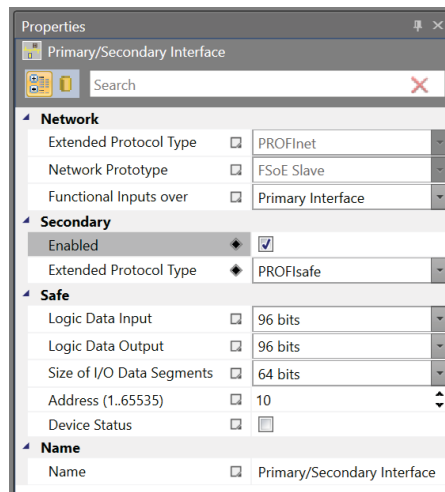
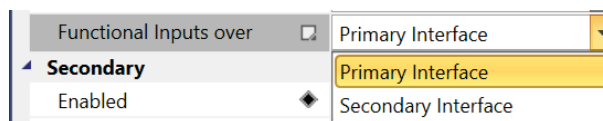


Fig. 69 network, activation of the secondary interface

5. If the functional inputs (not safe) are used, the interface that is used must be parameterized.



The following data can be set:

- Slave Address (number)  
→ To determine the slave ranking in the FSoE network.
- Watchdog time (in ms)  
→ To determine the max. permissible delay per device.
- Connection-ID (ID)  
→ To determine the communication assignment (protocol).

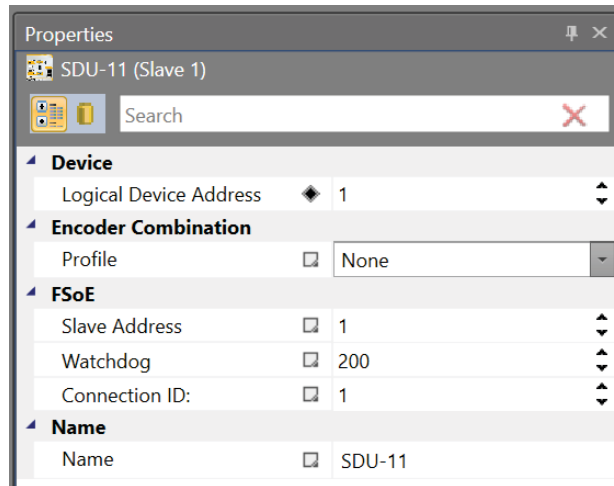


Fig. 70 FSoE option for slaves

For the respective devices from our example, these are the following properties:

	SDU	SIO-1	SIO-2	SDC	Comment
Logical device address	1	2	3	4	as fixed in plan
Cycle time	8 ms	8 ms	8 ms	8 ms	as per master cycle
FSoE-Slave-Adr. and ID	1	2	3	4	as fixed in plan
FSoE-Watchdog	200 ms	200 ms	200 ms	200 ms	

### 6.5.6 Determining the inputs and outputs of the devices

After the devices are selected, their inputs and their outputs are determined in the ctrlIX SAFETY Engineering – tab „Wiring scheme“.

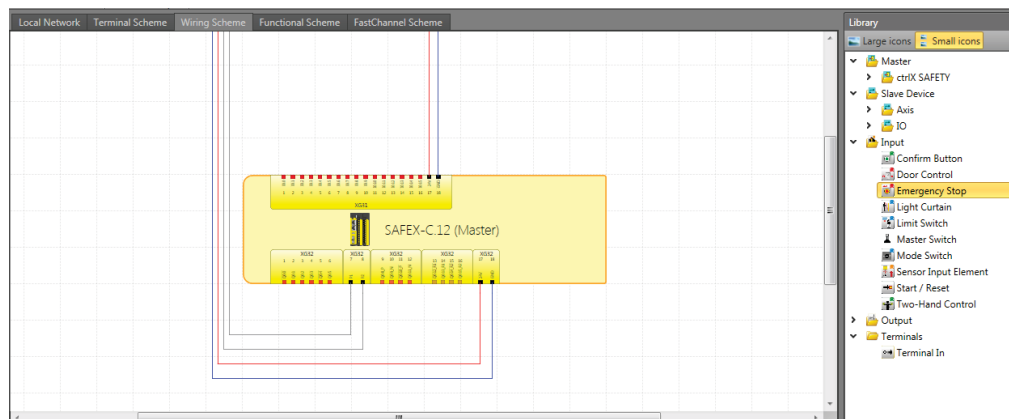
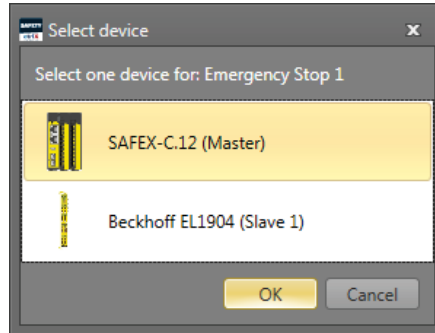


Fig. 71 Insert I/O element

By selecting and dragging it into the main window, an input element or an output element from “Library” (upper right window) is incorporated.

The selection dialog is used to specify the device with which this element is to be (automatically) connected.



**Fig. 72 Assignment to device**

The connection from the element to the input / the output of the units in the wiring scheme takes place automatically.

## NOTE

- ▶ This assignment by ctrlX SAFETY Engineering must be implemented accordingly by the wiring. The ctrlX SAFETY control (SAFEX-C.1x) is programmed accordingly and changes into the error mode if necessary.

For our example we had determined the inputs and the outputs. Now, the inputs and the outputs are set:

- Master with Start (confirm button) button, Emergency-Stop button, Start/Reset button, 2 safe outputs

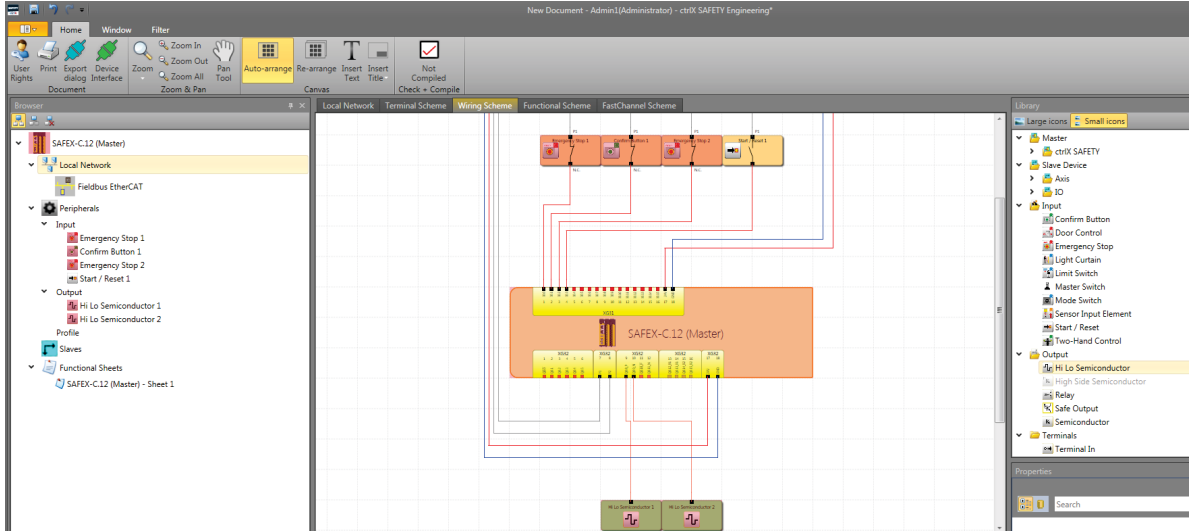


Fig. 73 I/O- elements inserted (Master)

The assignment must be done separately for each device including all slaves.

**⚠ CAUTION**

► Inputs and Outputs of slave device cannot be linked in the main configuration!  
A new document must be created for this purpose. (description see chapter 6.5.7)

### 6.5.7 Slave configuration

The assignment of inputs and outputs must be made for each slave separately.

Before you can configure the inputs and outputs of the slave, you have to click the respective slave device again with the mouse in the FSoE master configuration. The properties window appears and a profile can be selected.

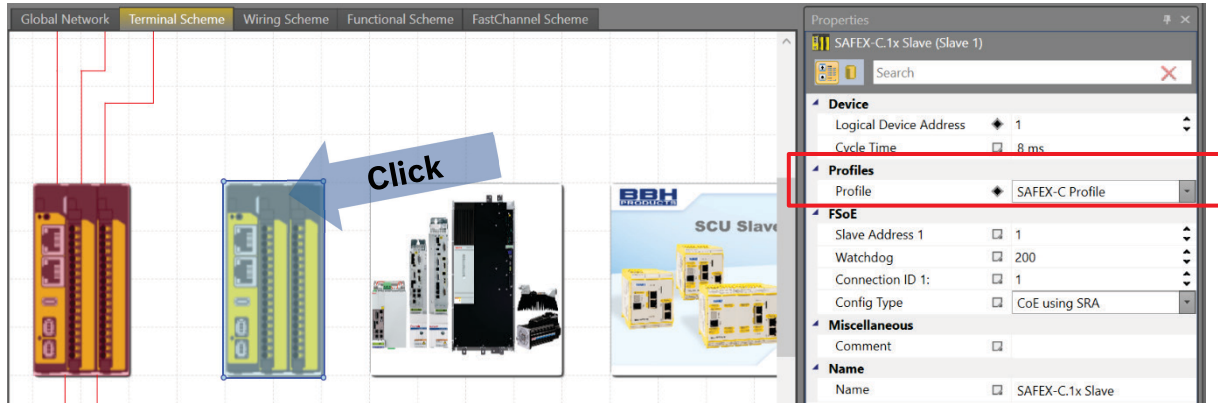


Fig. 74 Slave profile setting in FSoE master configuration

The profiles now appear in the library window (left). Drag the respective profile of the slave into the functional scheme.

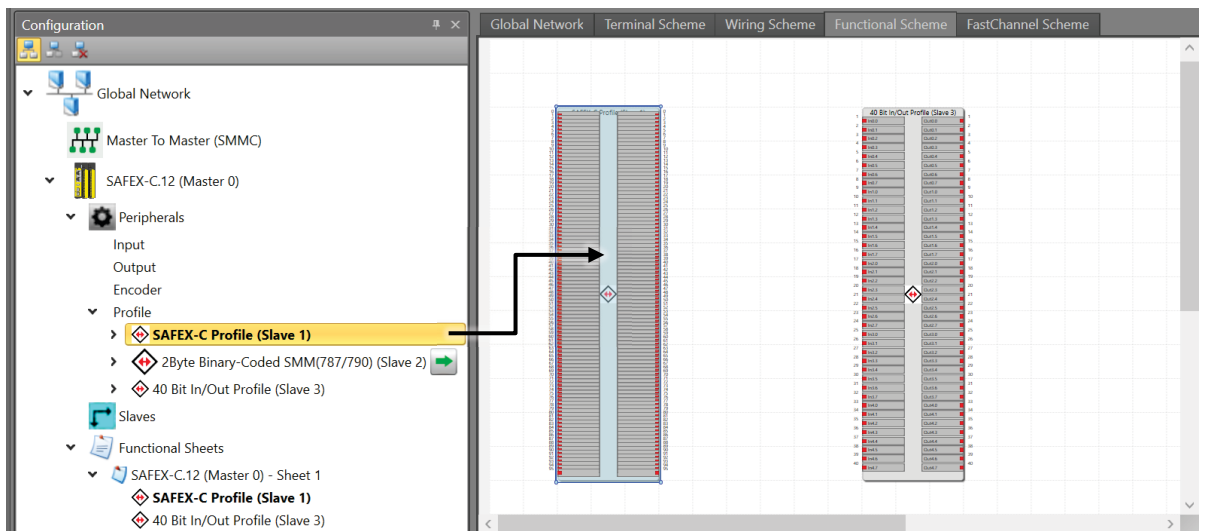


Fig. 75 Slave profiles in functional scheme

### 6.5.7.1 Slave profile creation

After creating the slave profiles in the FSoE master configuration, open a new document.

Add a slave device as master (Master>ctrlX SAFETY> SAFEX-C.12 ...) and define the input and output elements.

- Assignment from our example: Slave 1  
**Slave 1 with Emergency Stop, Start-/Reset button, light curtain + 4 outputs (relay + semiconductors for 2 switch cabinets with each one signal lamp)**

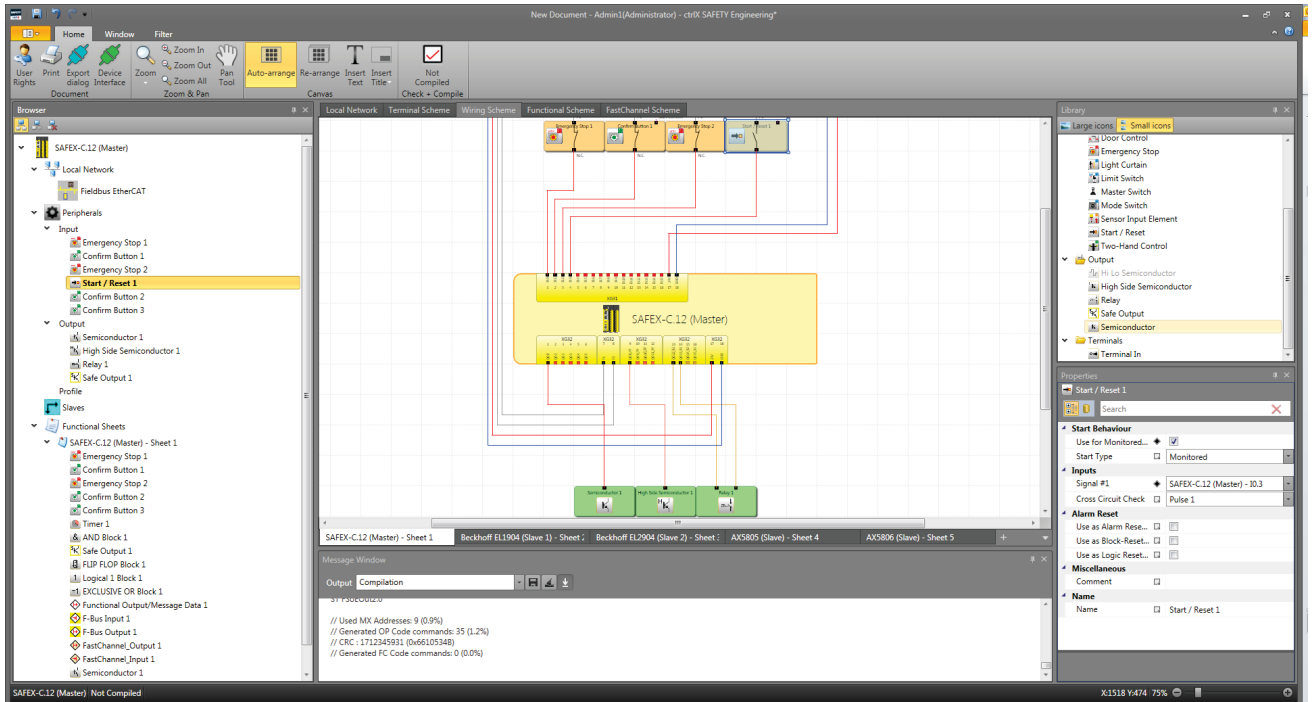


Fig. 76 New document, wiring scheme> IO elements inserted (Slave 1)

The (safety) functions can be determined in the tab "Functional scheme" tab. (see chapter 6.5.8)

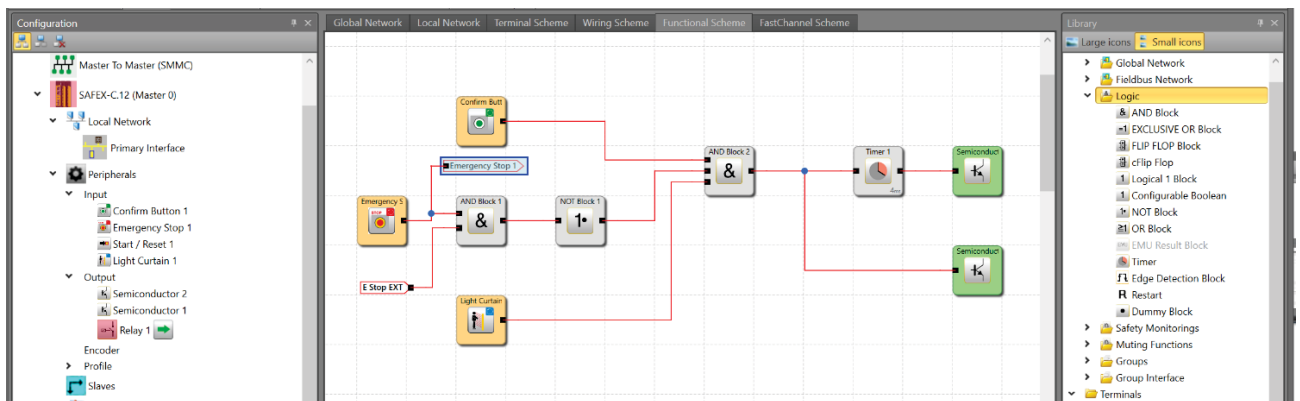


Fig. 77 Determining the safety functions of slave 1

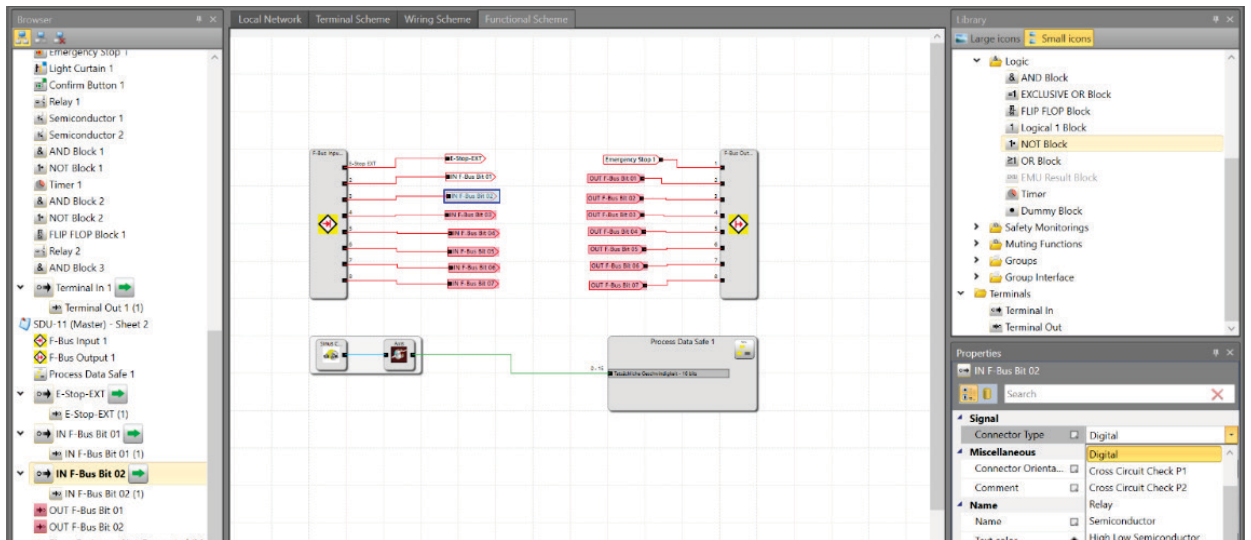


Fig. 78 Creating the safe F-Bus inputs and outputs for slave 1

Up to 12 bytes can be flexibly created in the F-bus profile.

## NOTE

- ▶ The data width refers to the slave profile from the FSoE master configuration and the number of available bytes is limited to 96 bits IN/OUT.

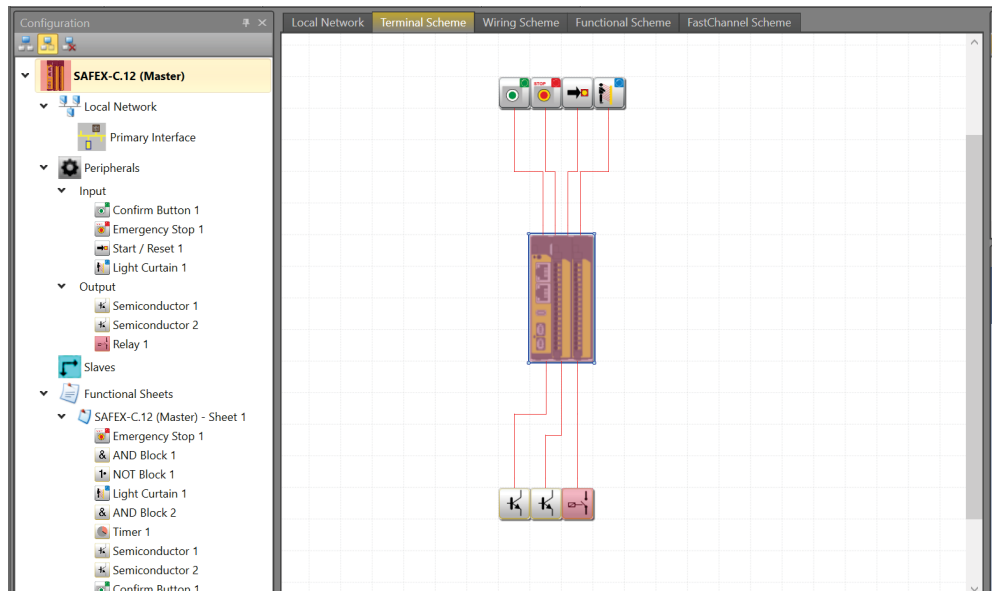


Fig. 79 Terminal scheme with elements

The connections of the elements are also adopted and displayed in the terminal scheme:



Devices marked in red still have elements that have not been used yet.

The elements marked in red in the left configuration window have not been used yet.



All available elements (marked in red) in the configuration window (configuration) must be used/ incorporated. If elements are unused, the compilation in ctrlX SAFETY Engineering creates an error with a corresponding error message.

The other Slaves are assigned accordingly:

- In our example:  
**Slave2: 2 buttons (Start) + 4 x Emergency-Stop + 2 switches (barrier + lamp)**  
**Slave3: 1 button (Start) + 2 x Emergency-Stop + 2 switches (relays to interrupt other functions)**

For devices with an encoder connection, also these encoder connections must also be given. For this purpose, an encoder version can be selected from the library in the "Encoder" folder.



Further application examples are located in the Application description for the integration of the ctrlX SAFETY SAFEX-C.1\* devices in ctrlX AUTOMATION DOK-XSAFE\*-SAFEX-C.1XC-APxx-EN-P<sup>4)</sup>

### 6.5.7.2 Configuration of Slaves in FSoE master (Master device)

After the slave profile has been created, the FSoE outputs and inputs of the slave profile can now be adapted in the FSoE master configuration. For this purpose, connection points are added to inputs and outputs of the profile. The naming of the connection points is composed of the block names of the profile. Optionally the name can be changed in the properties of the connectors.

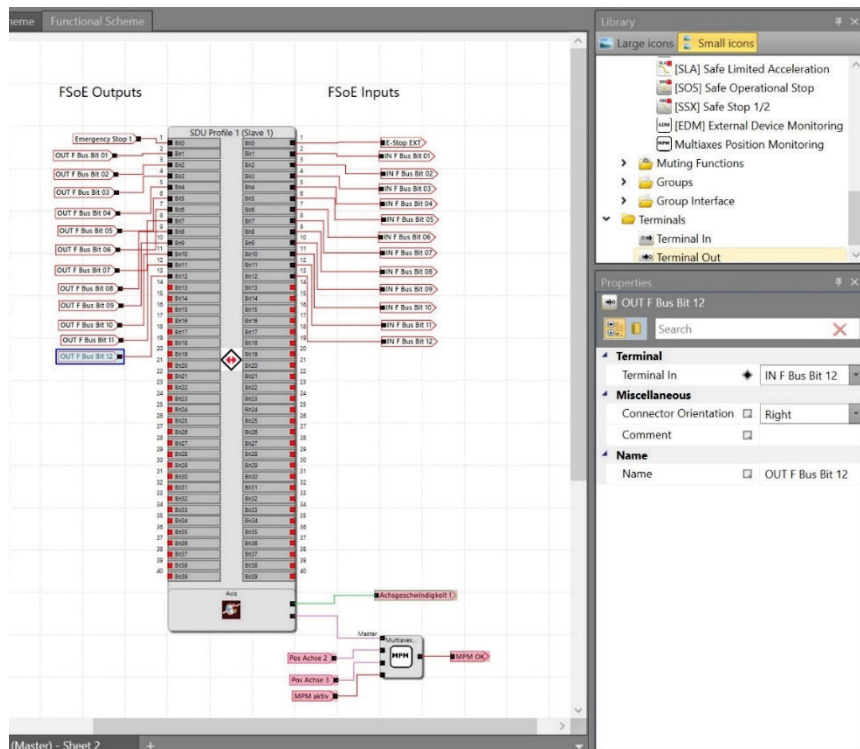


Fig. 80 View of a slave profile in a FSoE Master configuration

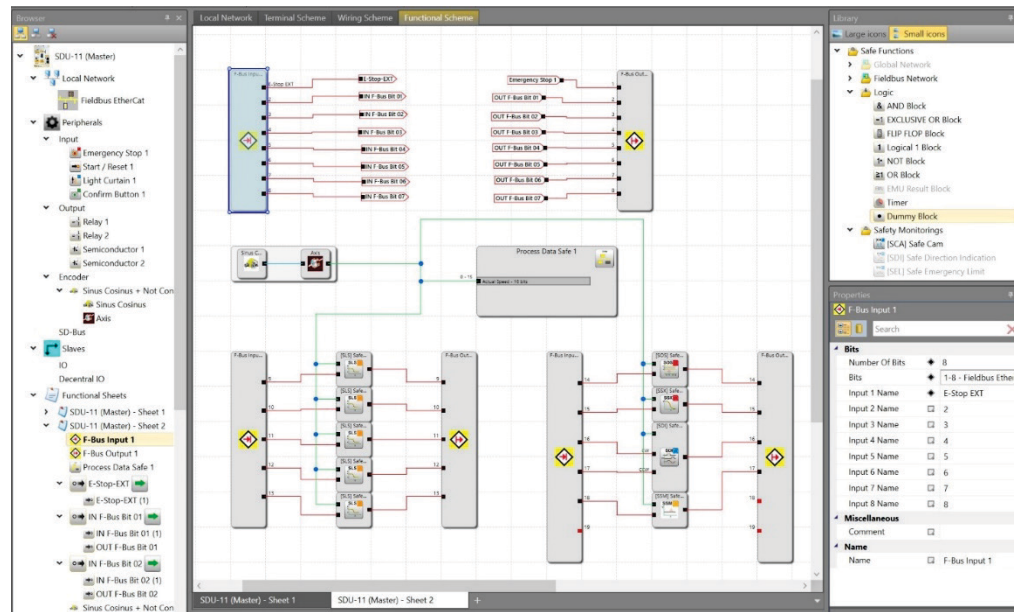


Fig. 81 Finished profile creation of FSoE inputs and outputs in FSoE slave document (Slave 1)

### 6.5.7.3 Slave profile types

The slave profiles are configurable and depend on the structure of the respective application to be parameterized.

40 FSoE inputs and outputs are freely available in the profiles.

Depending on the profile, the SDU profile contains additional connections for axis position and speed.



Fig. 82 Slave profiles (f.l.t.r.): SAFEX-C Slave profile, SDU profile, 40 Bit In/Out profile, 2 Byte Binary-Coded SMM

### 6.5.8 Determining the functions

The elements inserted in the wiring scheme are shown in the left configuration window (configuration) which also can be used in the functional scheme.

In the tab “Functional scheme“ the (safety) functions can be determined.

These functions can be entered according to chapter 6.10.4. Function blocks and 6.10.5 Safety functions.

For entering the functions, all inputs and outputs of all devices are available for selection in the “configuration” window (left)– the safety and logic functions can be taken from window “library” (top right).

The attributes of the selected (clicked) element can be determined in the properties window (bottom right).

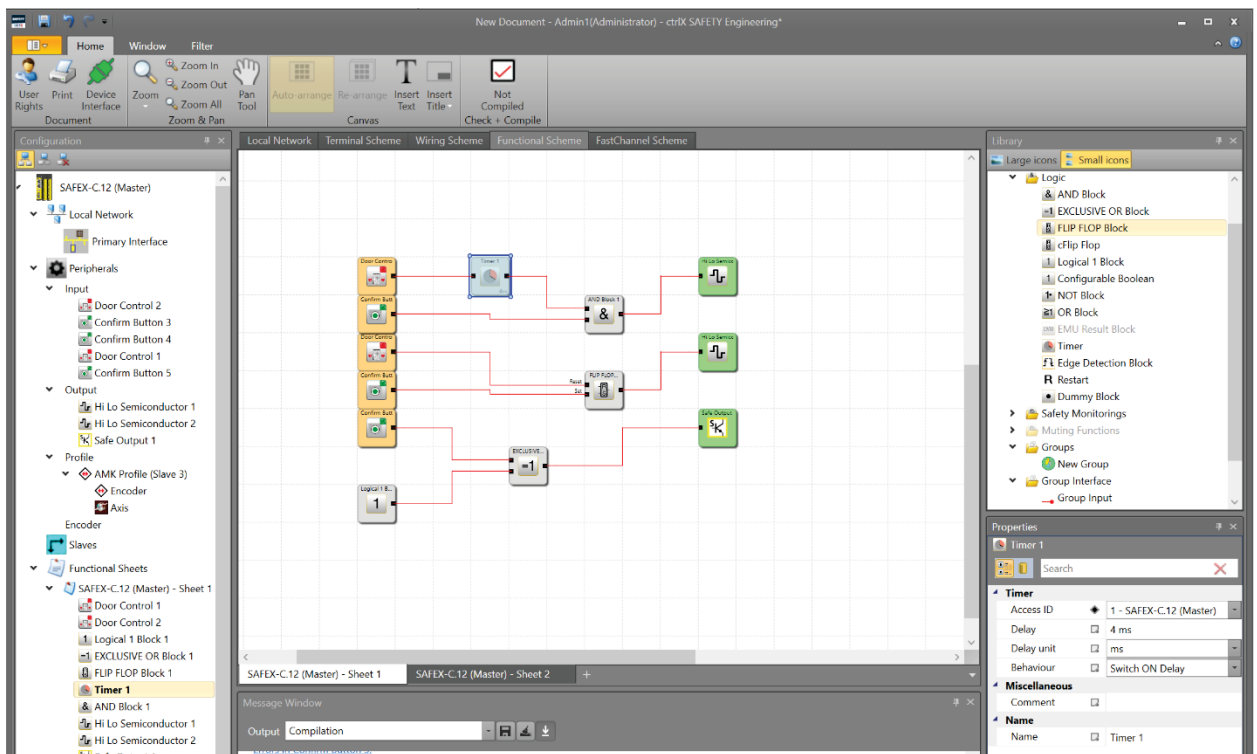


Fig. 83 Safety functions

After all functions have been entered, and all elements are used, the program can be compiled, and it can be transferred into the Master device.

Afterwards, the ctrlX SAFETY device SAFEX-C.1x can be started.

## 6.5.9 Embedding of existing Slaves

### 6.5.9.1 General information

Slaves already included in the program ctrlX SAFETY Engineering are incorporated according to the following simplified procedure. These slave devices are included in the library and can be integrated in the same way as the ctrlX SAFETY controllers according to chapter „Selection of ctrlX SAFETY controller / network components“. Via drag & drop, the devices are drawn from the “Library” in the window “Terminal Scheme”.

Together with the corresponding picture, the selected units are shown in “Local Network” and in the “Terminal Scheme”.



Fig. 84 Slaves: SAFEX-C.1x-Slave, IndraDrive Cx, Mx, SCU Slave, AMK ic5, AKD2G, SDC Slave (f.l. to right), view of terminal scheme

### 6.5.9.2 Adjusting the Slaves

The Slave devices are selected and integrated according to the chapter „Selection of ctrlX SAFETY controller / network components“.

#### 6.5.9.2.1 Example: SAFEX-C.1X-Slave

The wiring scheme shows the SAFEX-C.1x-Slave without contact points for inputs and outputs.

The order („Slave“ + logical device address) is shown in the brackets.

The axes of the axis slave devices can only be parameterized in the “properties” window. If a profile has been selected via the properties of the device and the profile has then been clicked on in the configuration tree. Up to 3 axes can be selected.:

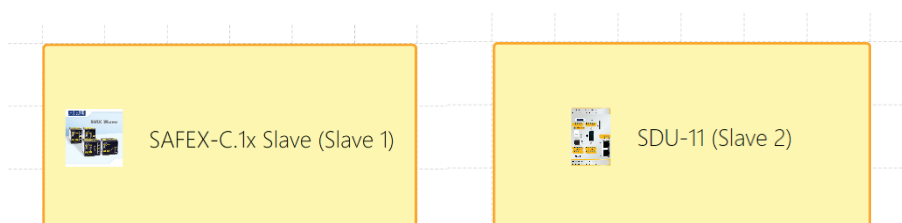


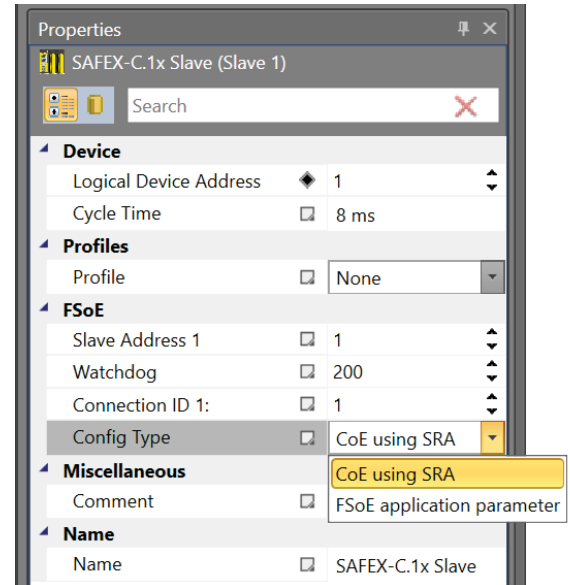
Fig. 85 Representation of the slaves in the wiring diagram

1. A logical device address must be specified for the SAFEX-C.1x slave device. Please refer to the FSoE network plan for these.

For other slaves, the number of axes can be specified in the „number of axes“ field. – if available at device

Then the profiles of the slave can be selected in the "Profiles" area.

The profiles to be selected can be imported before.



**Fig. 86 Properties window of a slave device- SAFEX-C.1x Slave**

Following parameters can be determined:

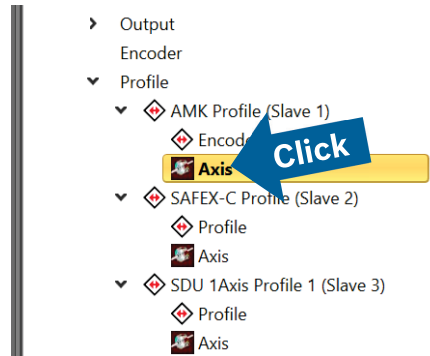
- FSoE address via the field „Slave address x“
- The Watchdog time in the FSoE-network can only be determined equally for all axes– this applies per device in the network.
- Connection-ID via field „Connection ID x“
- CoE/FSoE via the field „configuration type“

## NOTE

Currently, I/O slave devices are available to the user for project realization. For the coming release, slave devices with encoder settings can also be integrated.

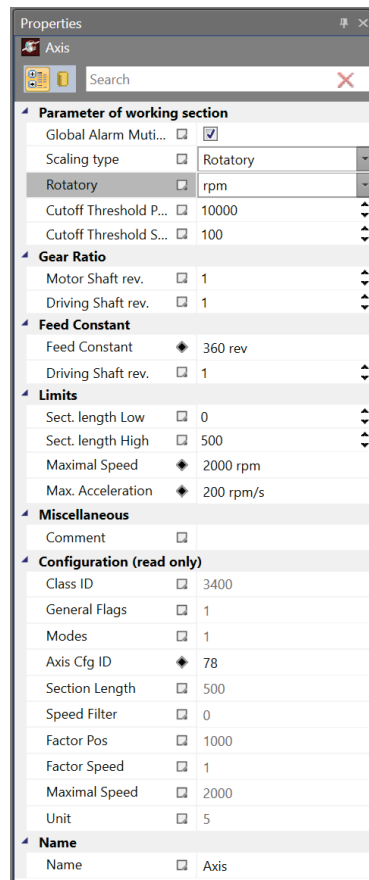
The following steps are required for slaves with axis monitoring (in preparation):

2. The encoder settings for the respective/ selected axes must be set as follows:
  - By clicking on the desired axis symbol, the properties can be shown in the window “Properties”.



**Fig. 87 Axis profile in configuration**

- The attributes of the selected axis can be changed via the window “Properties” (bottom right):
    - The settings must be set according to the data sheet of the encoder. These are e.g. type, scaling, direction, transmission ratio, position and speed limits, switch-off thresholds, acceleration, etc..
3. After all encoder parameters and all network parameters have been set, the slave device is integrated.



**Fig. 88 Axis properties**

After one or more Slave-devices, type SAFEX-C.1x-Slave, IndraDrive Cx/ Mx, SCU Slave, AMK iC5, AKD2G, SDC Slave (f.l.t.r) have been integrated, these Slave devices are shown in the Windows “Local Network” and “Terminal Scheme”.



Fig. 89 Slaves in the terminal scheme

In the wiring scheme, one sheet per inserted device is created. According to the inserted Slave device, the wiring scheme offers contact points for inputs or outputs.

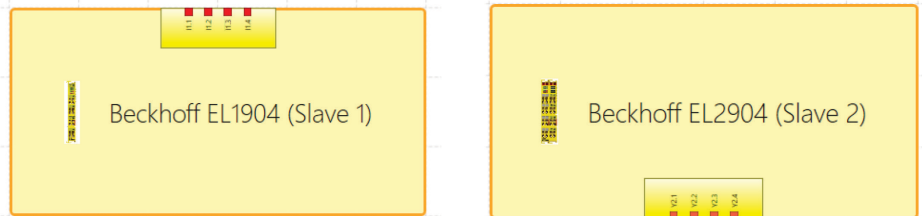


Fig. 90 IO slave devices EL x904 in the wiring scheme

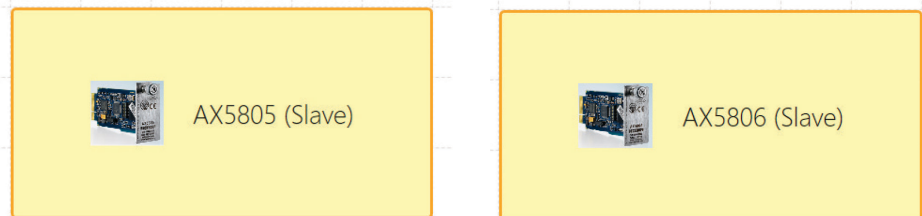


Fig. 91 Axis slave devices AX580x in the wiring scheme

In the wiring scheme the inputs and the outputs of the Slave devices EL x904 can be wired accordingly.

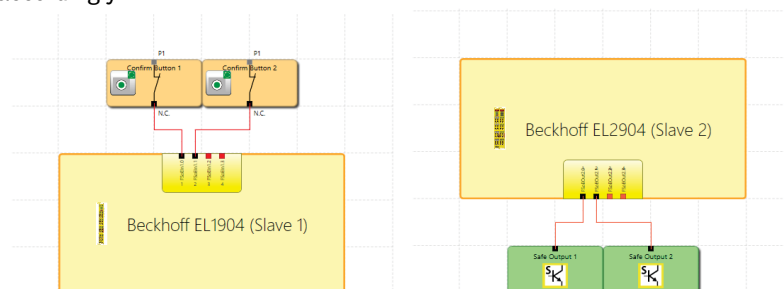


Fig. 92 IO-Slave device ELx904 with terminal assignment

The attributes of the respective devices can be selected in the window „ Properties “. Example of properties: Logical device address (according to network map), cycle time (longest period of all devices in the network), unit address (according to local network), Slave address (according to local network plan – indicates the order in the network), Watchdog time (max. telegram duration per device), connection ID (ID for the sequence of the messages) etc.

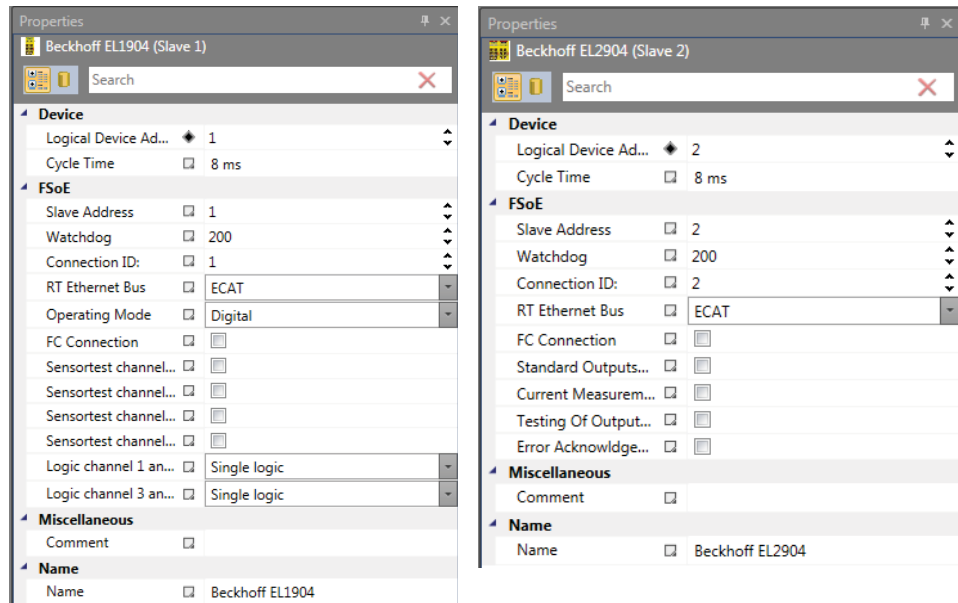
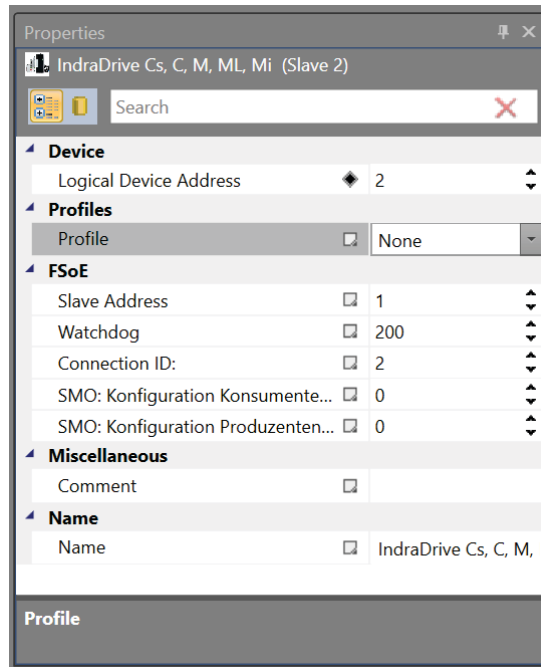


Fig. 93 Properties of the IO-Slave devices EL x904

The axis of the Slave device IndraDrive Cx/Mx can only be parameterized via „Properties“. It directly evaluates the information coming from the inverter.

The properties of the axis-Slave devices are identical, and are more manageable because the connected axis is selected automatically:



**Fig. 94 Properties of the Slave device IndraDrive Cx/Mx**

After inserting and parameterizing the slave device, they are available in the network.

#### 6.5.10 Embedding not predefined Slaves

- ▶ This option will be available in the later versions of the manual.
- ▶ To embed not predefined slaves, please contact the manufacturer.

#### 6.5.11 Adding input elements

The input elements (Input blocks) create the digital connection between one or more connected sensors or further subordinate switching devices in the **system**. Except the selection switch to select the operating mode, every input element provides one logic output signal "0" or "1" for further processing in the PLC.

The input elements are automatically placed to the terminal scheme or wiring scheme and connected to the next free terminal/connector/input/output connector. In the functional scheme, the input elements are inserted from the configuration.

The resource management of the function block elements of the ctrlX SAFETY system manages the available elements whose number can be restricted.

If no further elements are available during the programming of the terminal scheme, no blocks are available to add the corresponding modules or function blocks. The available blocks are displayed in the library. These resources can be released again by deleting the corresponding function blocks. To delete a block, select the block from the configuration or from the work surface. Click on it with the right mouse button, and select "Delete" or press "Del".

#### 6.5.12 Inserting output elements

The output elements (Output blocks) create the digital connection between one or more external circuit in the ctrlX SAFETY system. This element of the functional scheme has direct influence on the drive to be monitored, Furthermore, it can be determined, how external switching devices shall be monitored. The safe outputs switch actuators on or off.

For example, these can be drives with STO functions, contactors that switch simple asynchronous drives, or a valve that switches off the dangerous variable in the case of compressed air or hydraulic medium. Every output element is controlled by a logic input signal "0" or "1" via the functional scheme.

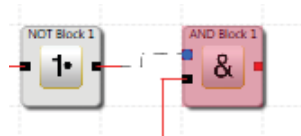
The output elements are added in the terminal scheme or in the wiring scheme. The output elements are edited in the functional scheme. In the terminal scheme, the output blocks are dragged from the configuration and dropped.

By the automatic monitoring of the resources of the function blocks of the ctrlX SAFETY safety controller only the available elements are enabled in the program. If no resources for the monitoring program are available in the safety controller the commands to insert the corresponding components or function blocks is deactivated (The library functions are not available.). This is the case if p. ex. all digital outputs of ctrlX SAFETY safety controller are occupied. These resources can be released again by deleting the respective function blocks.

### 6.5.13 Logic block elements

These function blocks are the basis for the creation of a program for the safety application. They enable the logical connection of the inputs with monitoring functions to the outputs. Only in the functional scheme view, it is possible to insert logic blocks. Otherwise, the logic blocks are disabled. This applies if the resources for a device are already exhausted, e. g. after all timer modules have been inserted. You find a description of the logic blocks in the chapter „Logical functions (Logic)“.

### 6.5.14 Circuit



The assignments in the functional scheme are achieved by linking the input connectors and the output connectors of the function blocks. If necessary, an output of a function block can be connected several times with inputs of other function blocks, but an input may be assigned only once. Furthermore, for technical reasons certain block groups cannot be interconnected. In case of an invalid connection, the program displays a corresponding warning.

Only rectangular control points can be created, i. e., the connecting lines always run horizontally or vertically.

#### Creating the connection:

1. Press the left mouse key to select a start connector.
2. The user can define the root and breakpoints by clicking in the free range.
3. With a second click the target connector is selected.
4. If “automatic arrange” has been enabled, the connection and the blocks are arranged automatically.

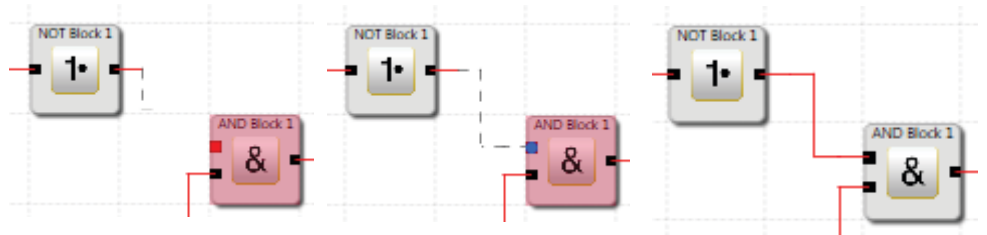





Fig. 95 Step-by-step illustration for creating a connection between function blocks

 Connections can only be selected with the mouse and they can be deleted with the „Del“- button.

 If all connections of a function block shall be deleted, the corresponding function block can be deleted. In this case, the connected terminals are automatically deleted.

The program automatically creates a new connection in the terminal scheme and in the wiring scheme. The program draws the connection by inserting additional control points (break points).

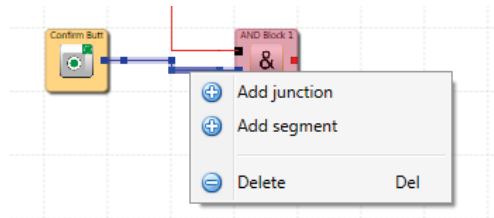
The graphical representation can be adjusted and the general representation can be optimized by moving the function blocks (if automatic arrange has been disabled). In complex diagrams, it may occur that a connecting line crosses a function block. This has no effects on the internal function of the connection.

 Only in the terminal scheme and the wiring scheme the connection is created automatically.

The drawing of user-defined connecting lines is also supported. User-defined connecting lines remain unchanged until the shifting of a connected function block forces the recalculation of the controls points (see Button „Auto arrange/re-arrange“).

### Add junction / segment

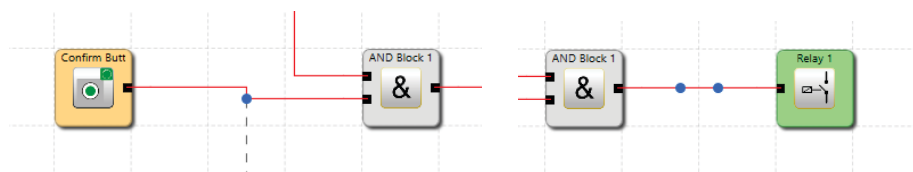
To add a segment to the connecting line, press the right mouse button and select “Add segment”.



**Fig. 96 Possibilities of adding junctions**

To add a node, double click on the connecting line, or press the right mouse button and select “Add junction”.

By selecting the connection, the user can define the connection and change every segment“.




**Fig. 97 Added junction in the functional scheme**

**Fig. 98 Added segment in the functional scheme**

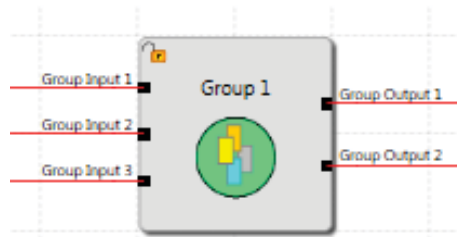
## NOTE

Junctions can only be entered with rectangular connecting lines, i. e., the connecting lines always run horizontally and vertically. The program connects the entered points until the drawing command is completed.

 Visual corrections of the logic diagram should be carried out shortly before the blocking of the functional scheme. Then, the layout is complete, and the blocks no longer need to be moved.

### 6.5.15 Using of groups

Groups connected several function/logic blocks parameterized by the user to form an encapsulated function.

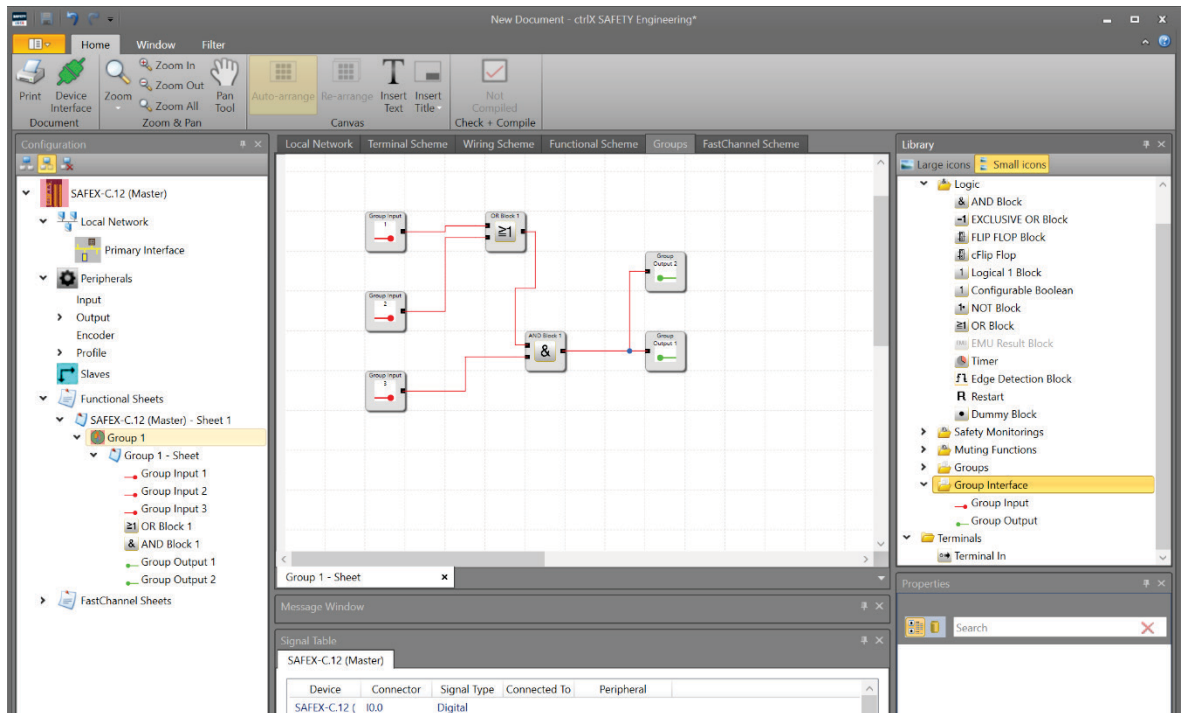


**Fig. 99** View of a “Group” block

By this grouping, the functional scheme obtains a clear structure. Via the Export function or the Import function, it allows the creation of an individual function library.

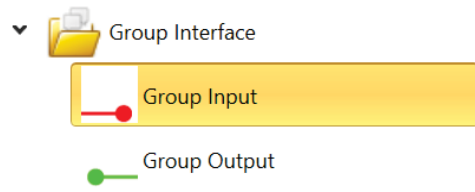
Groups contain the functionalities parameterized by the user.

By clicking on the group or the “Group” block, another "Groups" tab appears, in which function blocks can be inserted.




**Fig. 100** Function blocks in Tab „groups“

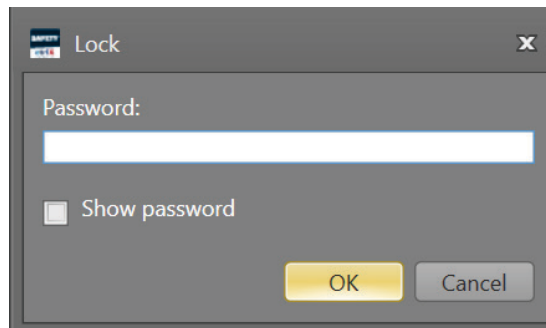
The connection between „functional scheme“ and „Groups“ is established via "Group input or Group output".



**Fig. 101** Folder „groups interface“ in the library

 For further information on function groups, refer to chapter 6.10.10 “Groups”.

After that, a window appears that requests a password entry. With this password the function group can be locked/unlocked.



### 6.5.16 Creating a program

After the program has been completed, compiling can be started by activating the compiler .

The results are shown in the message window which automatically appears during compilation. After the compiler has been called, the compilation undergoes the following steps.

#### Verifying open connections

**ctrlX SAFETY Engineering** ensures that all connections between function blocks can be opened. Connectors that are not connected are detected as errors.

#### Verifying of non-referenced “connection on” and “connection off”

**ctrlX SAFETY Engineering** ensures that all terminal blocks entered in the functional scheme are used. Open references are recognized as errors.

#### Verifying the value ranges of the monitoring functions

Before creating the instruction list, the **ctrlX SAFETY Engineering** checks if the parameters of the monitoring function lie within the range of the current encoder configuration. Otherwise, an unnoticed overflow of the range may occur if the encoder settings are changed with a monitoring function.

### Creating an instruction list (IL [AWL])


The IL code that has been created on the basis of the function groups is displayed in the message window where it also can be verified. Code segments of the corresponding function blocks are identified via the corresponding block ID.

### Creating the OP code

Generating of a machine-readable code for the system. Afterwards, this code is transmitted together with the parameters.

### Message window

All results of the compilation are displayed in the message window. If errors are detected, the message window appears automatically.

 Use the "Quick Jump" to jump directly to the respective block in the diagram by double clicking on the displayed block ID in the message window. Thereby, the corresponding function block can be easily identified in case of an error message.

### CRC backup

After a successful compiler accomplishment, a total of three CRC signatures is created:

- **CRC** for equipment configuration:  
signature for the program and for the parameter data

## NOTE

If an existing ctrlX SAFETY Engineering program is opened with a later version of ctrlX SAFETY Engineering, this program is ported.


- ▶ To grant the complete porting, an additional step is absolutely necessary.  
For this, the SAFEX-C safety controller must be dragged into the terminal scheme again. All settings are reset to standard.

 **Important: This display only serves for information purposes and must not be used for safety relevant documentation!**

### 6.5.17 Transferring the program to the device

This section describes the transfer of data and of the program to a safety device. If the



interface has been started (via the device's button , the device's interface toolbar appears. The toolbar contains connection tools and transmission tools. You find a description of the device in the chapter „6.8 Device interface“.

With “Connection Settings“ the window for document administration opened where the tabs “Document“ and “Document“ and “Master Device“ are situated.

## NOTE

In case of several devices, each device is stored in a different tab. In the “Document“ tab, the user can add the developer's and enter a comment. The tab “Master Device“ consists of device information and connection settings. This menu can also be called via the button “Document Properties“ in the menu ribbon menu.

More detailed current transmission statuses or errors that may have occurred are displayed in the message window. Due to restricted space, this window is not enabled automatically with every message. Thus, as much of the functional scheme as possible can be displayed in the diagnosis.

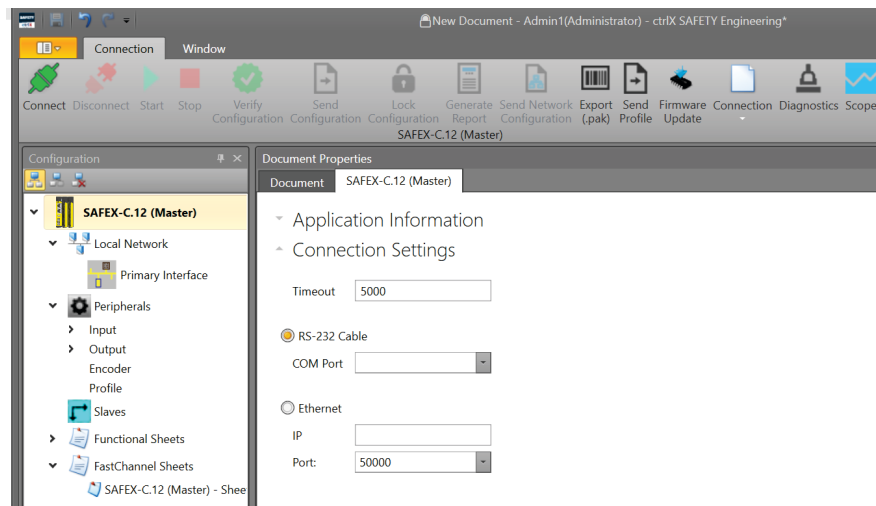


Fig. 102 “Document properties“ window with open tab „Master device“, here SAFEX-C.12

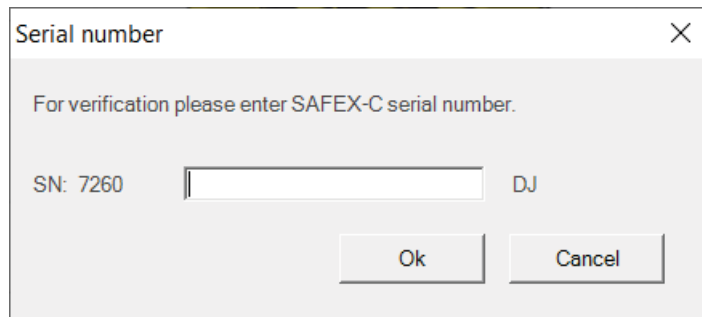
## NOTE

The standard connection between PC and ctrlX SAFETY system is based on an USB/RS485 interface. The corresponding driver is automatically installed with the installation of the CtrlX SAFETY.

- ▶ If the driver is not installed automatically, it must be installed manually. You find the driver in the installation directory of the **ctrlX SAFETY Engineering** programming surface (directory RS485\_USB\_Treiber).

When establishing a connection, the serial number of the safety device must be entered.

The following dialog appears:



**Fig. 103 serial number, Dialog**

A connection can only be established after the correct serial number has been entered (see nameplate safety device).

### 6.5.18 Connection settings

#### Timeout

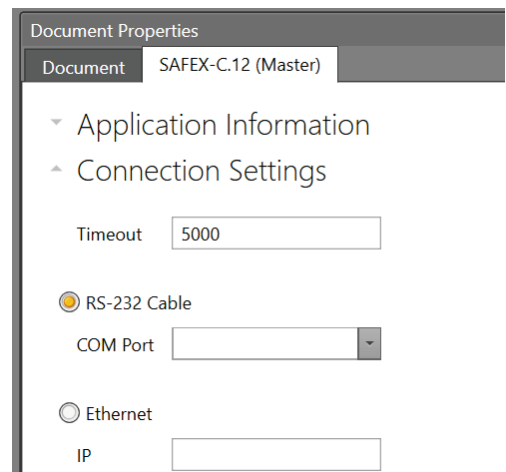
Communication timeout can be set in milliseconds.

#### RS-232 Cable

The COM interface used by the Windows driver must be configured.

#### Ethernet (TCP/IP)

Can be Ethernet over EtherCAT including routing via controller or Standard Ethernet directly to Ethernet interfaces.



The IP address must be configured.

#### *PC-sided separation:*

After 5 s at least, the system detects that the connection no longer exists and cannot be restored automatically if the connection shall be re-established.

#### *ctrlX SAFETY-sided separation:*

After 10 s at the latest, the system detects that the connection no longer exists. However, the connection is re-established automatically if the physical connection is re-established.

### 6.5.19 System and logic diagnostics



After the device interface has been enabled, the “Diagnostics” button is available. If you click on the „Diagnostics“ button, the diagnosis window appears. The diagnostic function cannot be performed at the same time as a configuration update, download or firmware update.

## NOTE

A correct diagnosis requires an adaption of data between functional scheme and equipment configuration. A missing functional scheme or inconsistencies between the existing functional scheme and the equipment configuration only allow a restricted diagnosis. In this case, the tab “Function Block” is not available.

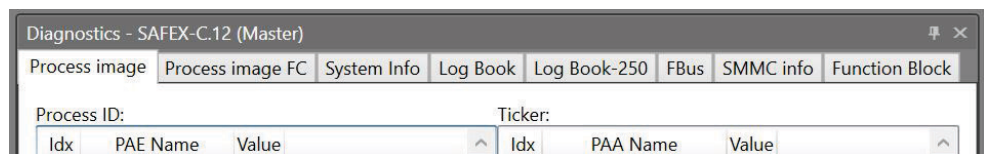


Fig. 104 Diagnostics window with its tabs

Depending on the device status, the data is updated in the diagnostics.

No data is generally updated in Stop mode. Notes of the individual tabs must be observed.

The diagnostics window consists of the following tabs:

**Process image:** Shows the status of all addresses of the input image and the output image in the ctrlX SAFETY device. The CRC of the active configuration is displayed together with the status of the internal transmission meter. The meter reading increases with every transmission to the ctrlX SAFETY device and, can serve as reference for documentation purposes.

The process image is only updated in the "Run" and "RunIntern" device states.

**Process image FC:** Displays the states of all addresses of the input and output image of the FastChannel in the ctrlX SAFETY control.

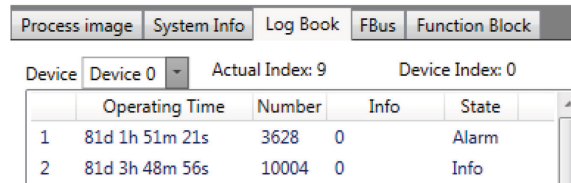
The process image FC is only updated in the "Run" and "RunIntern" device states.

**System info:** System information about ctrlX SAFETY control:

Parameter	Description
Device Configuration – CRC	CRC signature for the parameters
AWL CRC	CRC signature for the user program
Transfer Counter	Status of the internal transmission meter. The meter reading increases with every transmission to the ctrlX SAFETY device and can serve as reference for documentation purposes.
Serial number	Current serial number of the equipment
FW version	Version number of the firmware
HW version	Version number of the hardware
FPGA version	Version number of the FPGA
Lifetime [s]	Operating hour counter
License info PROFINET	Indicates if license for PROFINET is available
Temperature MPU B [deg]	Temperature CPU (Max. ca. 100°C) Note: No device or ambient temperature

**Log Book:** Displays the general information about the state of ctrlX controller and readout off ctrlX SAFETY<sup>link</sup> errors and diagnostics. Size 50 entries

**Logbook 250:** Displays general information of the status of the ctrlX controller as well as reading out the ctrlX SAFETY<sup>link</sup> errors and diagnostics. Logbook with 250 entries must be supported by the device firmware. *See release notes of the device versions.*



**Fig. 105** Diagnostics window, Log Book: parameter

Parameter	Description
Operating Time	Operating hours counter in h
Number	Error/info number [display in decimal] Error/info number see error list
Info	Additional display [value in decimal].
State	Status 1 – Fatal Error 2 – Alarm 3 – Info

**FBus:** Currently not supported

**SMMC Info:**


Parameter	Description
*Provider Device	Index SMMC-Provider
Consumer x state	Status of Consumer connection *)
Consumer x diag	Diagnostic info of Consumer connection **)

X: Index of Consumer


\*)

Status	Description
INVALID	Not configured
WAITFORTELEGRAM	SMMC connection setup
RECEIVEUID	SMMC configuration
PREPROCESS	SMMC in failsafe
PROCESS	SMMC in data exchange

\*\*) Diagnostic info see Error list / Diagnostic messages for ctrlX SAFETY SAFEX-C.1\* devices DOK-XSAFE\*-SAFEX-C.1XC-RExx-EN-P<sup>3)</sup>

 SMMC Info is only updated in the device state "Run", "RunIntern" and "Alarm".

**Function Block:** allows the selective monitoring of previously selected function blocks. To select function blocks from the work surface (canvas) for diagnosis, use the button „Block Diagnosis” or “Add FB I/O”. Ü This tab can be used to display the logical state "0" or "1" in the functional scheme.

 Only updated in the "Run" and "RunIntern" device states.

### 6.5.19.1 Diagnosis process in the function block diagram

Start the program with the "Start" button. If this is grayed out or the display in the status bar is on RUN, then the program has started. The button is located in the "Connection" tab in the ribbon menu.

Diagnosis in the work surface (Canvas)

The diagnosis in the work surface is only possible if the user has selected the tab „Function blocks“ in the dialogue window. After the tab “Function blocks “ has been selected, diagnosis starts automatically.

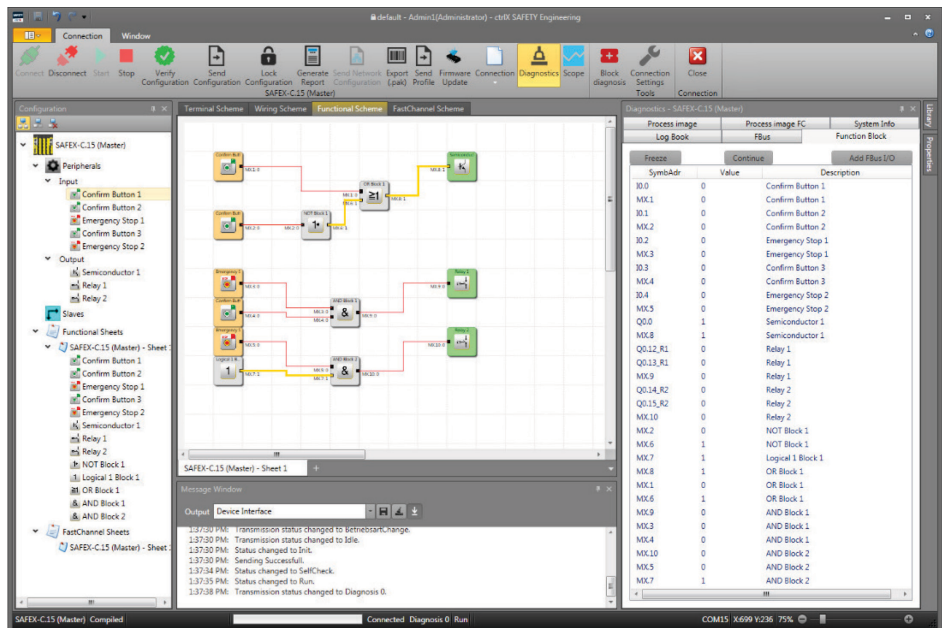



Fig. 106 Diagnostics procedure in the work surface (canvas)

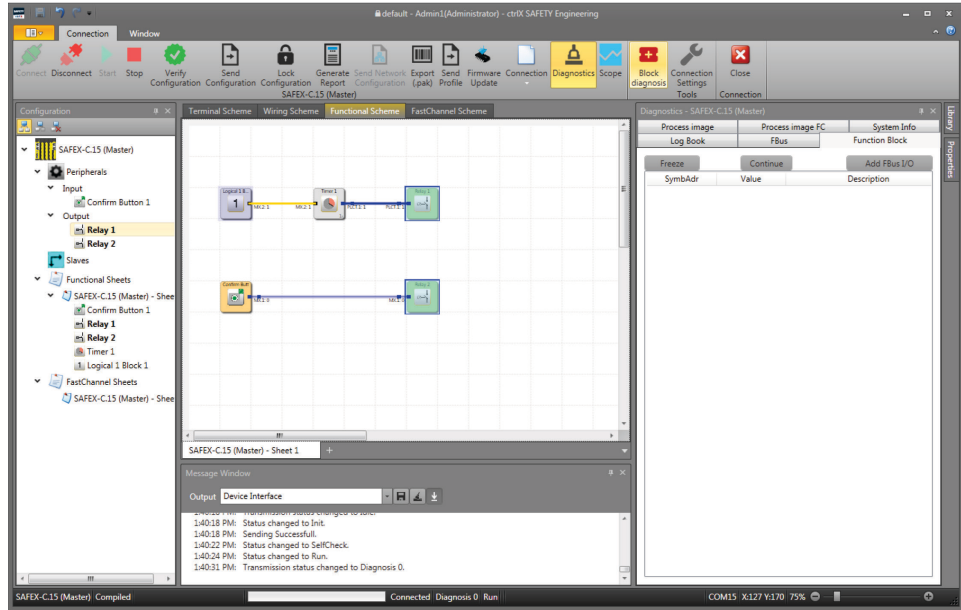
When doing a diagnosis in the work surface, the current input statuses and the current output statuses are shown in the plan according to their logic state “0” (red line) or “1” (yellow line). The logic state is indicated in the work surface beside the connection ID. When the tab “Function Block“ in the diagnosis window is left, and another diagnosis type is opened, i. e., another tab (e. g. “Encoder Position“) is opened, the diagnosis information is hidden from the work surface.

Diagnosis in the „Function Block“ tab

It is possible to do a diagnosis for selected blocks.

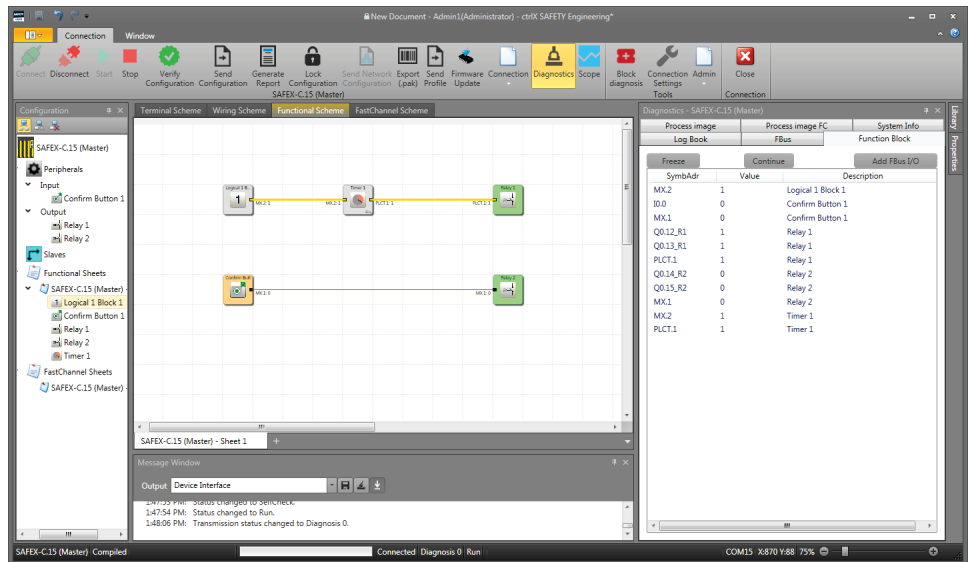
#### Selection of the data to be displayed

In the “Function Block“ tab it is possible to select function blocks whose status shall be monitored. Function blocks can be selected in the work surface. After the selection, click on the “block Diagnosis“ button . After a click on the button, the blocks are transferred into the monitoring list.




**Fig. 107 Selected blocks on the work surface**

The monitoring list shows the symbol address, the logic value and the description of every added block. If the diagnosis of a function block is carried out, the current input status and the current output statuses are shown in the selected block according to their logic status “0” or “1”.




**Fig. 108 Diagnosis, Display of the logical state of inputs and outputs in the selected block**

A block can be removed from the monitoring list by marking it and pressing the “Del” button. By double clicking on a list entry, the corresponding function block is shown in the plan.

 With the command “Select all” in the context menu (right mouse button) all files in the functional scheme can be selected.

Now, the selected files can be diagnosed if the information in the functional scheme matches with the functions in the actively connected ctrlX SAFETY-System.

 The symbol addresses shown in the list are also used for compilation and in the validation report.



## CAUTION

### No update of the process display after alarm or fatal error

- ▶ If the ctrlX SAFETY control is set into alarm mode, the process representation is no longer updated. The change of input levels is no longer valid and is also no longer displayed in the diagnostics.

## NOTE

- ▶ The integrated error recovery function requires intensive data transfer between the ctrlX SAFETY system and **ctrlX SAFETY Engineering**. This may cause a temporary delay in the display of data. Short-term status changes at module outputs may not be detected as a result.



### 6.5.20 Scope diagnostics

The parameterization of drive monitoring requires sound knowledge of process data from the perspective of the ctrlX SAFETY system. Knowledge of the temporal course of speed, acceleration, and position is crucial. This is the only possible way in which to set the correct threshold values and limiting parameters.

The scope monitor function is available in the dialog box on the device interface. To select this function, choose the “Scope” button. The “Diagnostics” and “Scope” buttons cannot be used at the same time; while one button is in use, the other is disabled.

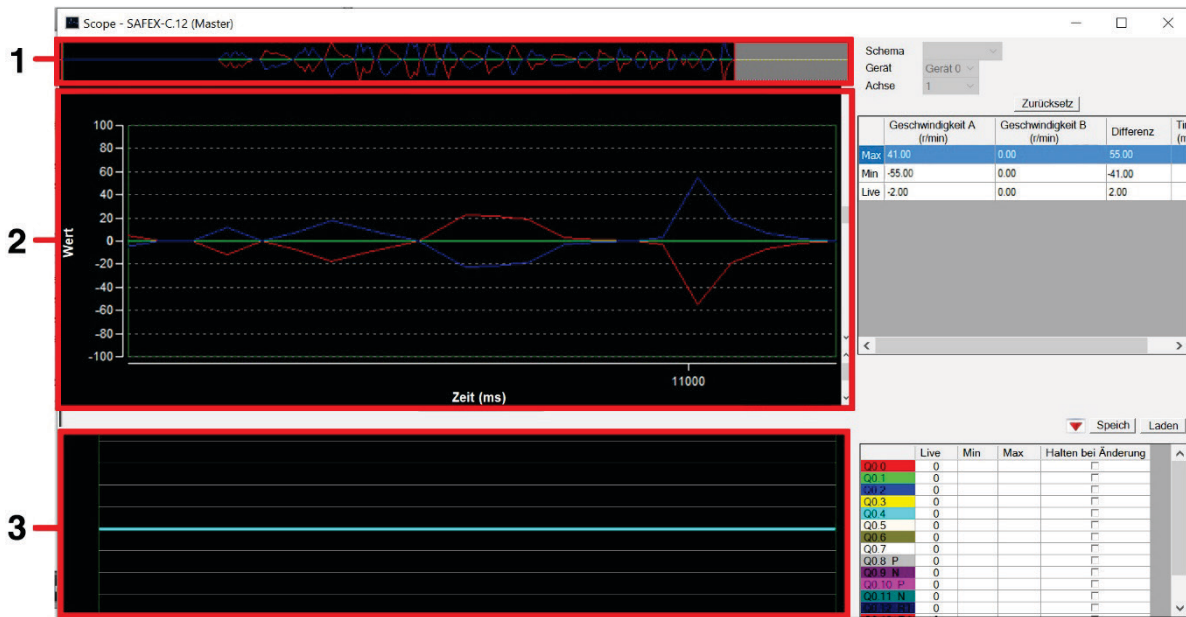


Fig. 109 Scope monitor areas

1. Overview scrollbar
2. Main diagram window
3. Signal output window

All available graphics functions read the required process data ONLINE from the active ctrlX SAFETY system via the communication interface for time-based display. Current values appear on the right of the scope monitor and move toward the left during recording, until they finally disappear. Although the data disappears from the visible area, it is stored in a buffer and can be moved back into the visible area by sliding the scrollbar above the main diagram window.

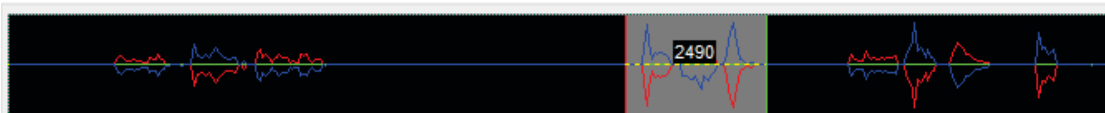


Fig. 110 Overview of the scrollbar for the main diagram

**Scheme:** The “Scheme” dropdown list can be used to select the current context for the desired visualization. The context of the graphs displayed changes depending on the

scheme selected from the dropdown list. The graphs are assigned a color based on the legend.

The following schemes are available:

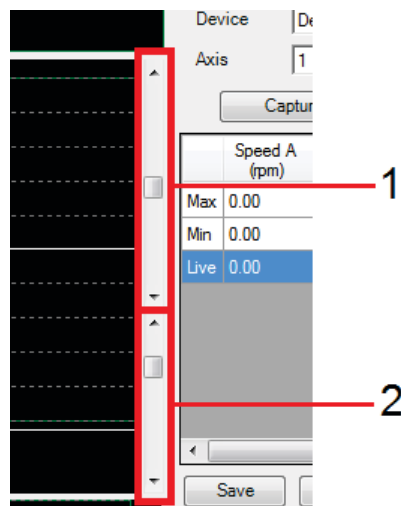
- Encoder data
- Speed encoder
- Speed position
- Data SSX1 block
- Data SSX2 block
- Data SSX3 block
- Data SSX4 block
- SEL (time based)
- SLS filter (Safe Limited Speed)
- SCA filter (Safe Cam)

Depending on whether the scheme shows time or position-dependent values, the X-axis will show the elapsed measurement time or the measurement length configured in the encoder. The Y-values relate to the selected scheme.

It is not possible to change the scheme while a measurement is running.

**Device:** Selection of device.

**Axis:** When using several identical functions, these can be selected and displayed separately via this dropdown list. The values of this measurement data are displayed for each relevant cursor position.



Scaling the displayed diagram function enables adjustment of the Y-values in the individual graphs via sliders 1/2.

**Slider 1:** Change the visible range of the Y-values in the diagram.


**Slider 2:** Change the maximum range of the Y-values displayed in the diagram.

**Fig. 111** Scaling the diagram via the slide bars

**Start / Stop:** Start or stop recording.

**Pause:** Choose the “Pause” button to pause the values displayed in the main diagram. The data is still available in the buffer.

**Reset:** Reset the diagram values and process data.

 Double-click in the main diagram window to insert a pointer at this position. This displays the cursor in the value table for optional measurements.

**Hold on change:**

If the “Hold on change” button is chosen, recording will stop 2 seconds after an edge change of the specified output (see above). This function allows for long-term recording and error analysis in the absence of an operator.

**Save:**

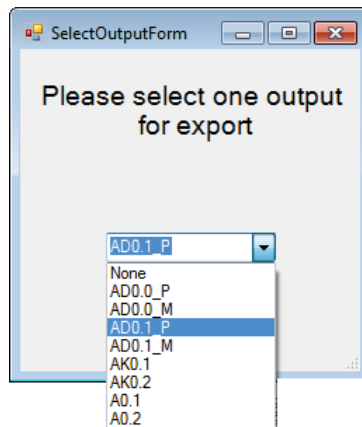
In stopped condition, the current recording can be saved to a file. The scope data is imported to the file as ASCII values. The individual values are assigned XML tags, so that the recording can be used for documentation purposes or for the analysis associated with the encoder configuration. The data can also be viewed with the current Microsoft Explorer or any other XML viewer.

**Load:**

This button can be chosen to reload to the scope monitor a measurement saved in a scope XML file. The scope dialog will then change to view mode. Due to possible differences between the encoder configuration of the measurement displayed and the current program, as well as the resulting deviations when it comes to scaling the position and speed values, the “Start” button and “Scheme” dropdown list will be disabled once the data has been loaded for display. Measurements will remain disabled until the scope monitor is restarted.

**Import:** Import a measurement from .ScpXml files.

**Export:** Export the measurement of one selected output to a .ScpXml-file.



**Fig. 112 Selection of an output for export**

### 6.5.20.1 Scope schemes (measuring schemes)

**Table 6: Encoder data**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>Recording of scaled position values from system A and system B over the course of time.</li> <li>Recording of process values and acceleration over the course of time.</li> </ul> <p><b>Note:</b> After reciprocal comparison of the two channel values, the process value for the position will be generated from one channel.</p>
<b>Application</b>	<ul style="list-style-type: none"> <li>Scaling of encoder systems A and B during position monitoring. If the encoder system is scaled correctly, there should be no significant deviation between positions A and B, and the actual deviation should not exceed the permitted deviation set in the encoder dialog.</li> <li>Analysis and history of the encoder signal for diagnostic purposes (e.g. troubleshooting).</li> <li>Acceleration and speed behavior of the drive.</li> <li>Detection of thresholds.</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>Acceleration in [rpm/s] in red</li> <li>Position A in [revs] in green</li> <li>Position B in [revs] in yellow</li> <li>Speed in [rpm] in blue</li> <li>Selectable output of ctrlX SAFETY in gray</li> <li>Two cursor values – can be positioned</li> </ul> <p><b>Note:</b> The assigned colors can be adjusted.</p>

**Table 7: Speed encoder**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>Recording of the current speed from system A and system B over the course of time.</li> <li>Recording of the differences in the speed signals from system A and system B over the course of time.</li> </ul> <p><b>Note:</b> After reciprocal comparison of the two channel values, the process value for the position will be generated internally from one channel.</p>
<b>Application</b>	<ul style="list-style-type: none"> <li>Scaling of encoder systems A and B during speed monitoring. If the encoder system is scaled correctly, there should be no significant deviation between speeds A and B, and the actual deviation should not exceed the speed threshold set in the encoder dialog.</li> <li>Analysis and history of the encoder signal for diagnostic purposes (e.g. troubleshooting).</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>Speed A in [rpm] in red</li> <li>Speed B in [rpm] in green</li> <li>Speed difference in [rpm] in yellow</li> <li>Selectable output of ctrlX SAFETY in gray</li> <li>Two cursor values – can be positioned</li> </ul> <p><b>Note:</b> The assigned colors can be adjusted.</p>

**Table 8: Data block SSX1 – SSX4**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>Recording of process data for speed and acceleration over the course of time.</li> <li>Recording of maximum and minimum speed limits for the monitoring function over the course of time.</li> </ul>
<b>Application</b>	<ul style="list-style-type: none"> <li>The diagram shows the dynamic behavior of the drive via the visualization of speed and acceleration.</li> <li>If SSX is not activated, the speed limit remains zero.</li> <li>When the SSX function is activated, the speed limits and current speed will be recorded and displayed over the course of time.</li> <li>If the drive maintains its current speed below the speed limit, the system will not shut down.</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>Acceleration in [rpm/s] in red</li> <li>Minimum speed limit in [rpm] in green</li> <li>Maximum speed limit in [rpm] in yellow</li> <li>Current speed in [rpm] in blue</li> <li>Selectable output of ctrlX SAFETY in gray</li> <li>Two cursor values – can be positioned</li> </ul> <p><b>Note:</b> The assigned colors can be adjusted.</p>

**Table 9: SEL (time based)**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>Recording of process data for speed and acceleration over the position or over the course of time.</li> <li>Visualization of the current position in form of a live cursor.</li> <li>Visualization of the current stopping distance in the form of a drag pointer.</li> </ul>
<b>Application</b>	<ul style="list-style-type: none"> <li>The diagram shows the value of the dynamic stopping distance as a minimum value for the braking distance.</li> <li>Verification of the parameter values set in the SEL function; verification of the available reserve for shutdown.</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>Current position in [revs] in red</li> <li>Speed in [rpm] in green</li> <li>Acceleration in [rpm/s] in yellow</li> <li>Stopping distance in [revs] in blue</li> <li>Selectable output of ctrlX SAFETY in gray</li> <li>Two cursor values – can be positioned</li> </ul> <p><b>Note:</b> The assigned colors can be adjusted.</p>

**Table 10: SLS filter**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>• Monitoring of the maximum velocity or speed of a drive.</li> <li>• Recording of process data for speed over the position or over the course of time.</li> <li>• Visualization of the current position in form of a live cursor.</li> <li>• Visualization of the integrated measured values over the speed as a position value approximation.</li> </ul>
<b>Application</b>	<ul style="list-style-type: none"> <li>• The graph shows the current speed in relation to the speed limit set.</li> <li>• Verification of shutdown when the speed limit is exceeded.</li> <li>• Display of the integrated speed.</li> <li>• Control of the functions that operate in dependency of the speed limit.</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>• Speed limit in [rpm] in red</li> <li>• Limit in [rpm] in green</li> <li>• Integral in yellow</li> <li>• Status of the function in blue</li> <li>• Selectable output of ctrlX SAFETY in gray</li> <li>• Two cursor values – can be positioned</li> </ul>

(The limit indicates the speed limit.)

**Table 11: SCA filter**

<b>Functionality</b>	<ul style="list-style-type: none"> <li>• Monitoring of a parameterizable position range with assigned minimum and maximum values and maximum speed/velocity.</li> <li>• Recording of process data for speed over the position or over the course of time.</li> <li>• Visualization of the current position in form of a live cursor.</li> </ul>
<b>Application</b>	<ul style="list-style-type: none"> <li>• The graph shows the current speed in relation to the speed limit set – as well as the position determined by integrating the speed.</li> <li>• Verification of shutdown when the speed limit is exceeded or when the permitted range between minimum and maximum values is left.</li> <li>• Control of the functions that operate in dependency of the position range and speed limit.</li> </ul>
<b>Output</b>	<ul style="list-style-type: none"> <li>• Speed limit in [rpm] in red</li> <li>• Limit in [rpm] in green</li> <li>• Integral in yellow</li> <li>• Status of the function in blue</li> <li>• Selectable output of ctrlX SAFETY in gray</li> <li>• Two cursor values – can be positioned</li> </ul>

**6.5.20.2 Procedure of a measuring in the range**

After the range window has been opened, it still stands on “Stop”, i.e., no cyclical process data from the ctrlX SAFETY system are read. To carry out a measurement that is faultless to the greatest extent, you should proceed as described below.

**NOTE****Overload during measurement**

All Internet based and all LAN based programs (e.g. E-mail programs) running in the background should be closed before the measuring.

**6.5.20.3 Preparing the measurement**

Select the desired scheme. During a speed-oriented measurement, the running control-time of the ctrlX SAFETY controller is shown on the X-axis. The running control-time is a continuously rising meter for the system control signs of the ctrlX SAFETY controller. The measurement data are constantly updated and are stored in the cache. The recording memory is approx. 15 minutes.

Measurement automatically stops when the cache is full. The preceding measurement is automatically saved as “ScopeTempData.ScpXml”.

During position-oriented measurement, the configured measuring range of the set axis is shown on the X-axis.

**NOTE****Plan changes**

When the scheme is changed, recorded data from the preceding measurements get lost. When the window size is changed, the displayed data must be newly scaled. This requires position-oriented measurement and the reset of the data buffer (SSX).



The list of the different measurement plans (schemes) can be found in chapter 6.5.20.1.

**6.5.20.4 Starting measurement**

The button “Capture” to start measurement is only available with an active connection to the ctrlX SAFETY system. After this button has been clicked on, the data are transferred cyclically into the cache, and are shown in the diagram from left to right. An active recording can be stopped with the “Stop” button.

**6.5.20.5 Stopping a measurement and indicating data**

After measurement is finished, the data can be analyzed by appropriately moving the slider bars accordingly.

## 6.6 Validation report

**ctrlX SAFETY Engineering** uses the validation function („Device interface -> Generate Report“) to produce a validation report for equipment configuration. This function is only available with an active connection to an ctrlX SAFETY system. This function can also be enabled by selecting the symbol „Generate Report“ in ribbon menu.

In the "Document properties" window under Application information in the “SAFEX-C.1x (Master)” tab information and description can be entered or edited. After generation, these are shown in the validation report.

Every field has a blocking function.

The screenshot shows a window titled "Document Properties" with two tabs: "SAFEX-C.12 (Master 0)" and "SAFEX-C.15 (Master 1)". The "Application Information" section is expanded, showing two columns of input fields. The left column is titled "Descriptions" and includes fields for End Customer, Labelling, Location, Installer, Configuration, Create Date, Functional Characteristics, Hardware, and Comments. The right column is titled "Contact Details" and includes fields for Installation Name, Installation Phone, Installation Fax, Customer Name, Customer Phone, Customer Fax, Supplier Name, Supplier Phone, Supplier Fax, Installer Name, Installer\_Phone, Installer Fax, Version, and AKZ. Below the "Application Information" section, there is a collapsed section for "Connection Settings".

**Fig. 113 Application information for validation report**

The report is created as a PDF file.  
The report is saved in a file and can be edited afterwards.

## NOTE

**The printed file serves as template for the safety-relevant check!**

- ▶ The report can be created only after saving the configuration file.

The created file (\*.pdf) has the same name and is situated in the same list as the corresponding configuration file.

### 1. Step: Editing the report's header

In the header, the following fields can be edited.

<u>End customer:</u>	customer's name
<u>Installation name:</u>	project name
<u>Comments:</u>	Helpful information
<u>Configuration:</u>	Configuration name
<u>Acceptance:</u>	Indication of the project's inspectors
<u>Create date:</u>	Date when the report was created

**2. Step: fill in contact partner and plant description**

<u>AKZ:</u>	plant identification
<u>Version :</u>	document version
<u>Installer (Manufacturer):</u>	Commissioning of the equipment
<u>Installer (Manufacturer) Phone:</u>	phone number
<u>Installer (Manufacturer) Fax:</u>	fax number
<u>Installation (plant) Phone:</u>	phone number
<u>Installation (plant) Fax:</u>	fax number
<u>Installation (plant) Name:</u>	xxx
<u>Customer Phone:</u>	phone number
<u>Customer Fax:</u>	fax number
<u>Customer Name:</u>	operator of the equipment
<u>supplier Phone:</u>	phone number
<u>Supplier Fax:</u>	fax number
<u>Supplier Name:</u>	manufacturer of the device / the equipment
<u>End customer:</u>	customer's name
<u>(Installation) Labelling:</u>	project manager
<u>Location:</u>	project location
<u>Installer:</u>	Commissioning of the equipment
<u>Configuration:</u>	configuration name
<u>Create date:</u>	Date when the report was created
<u>Functional characteristics:</u>	application description
<u>Comments:</u>	helpful comments, e.g. file name of functional scheme/configurations
<u>Hardware:</u>	Code designation of the equipment

### 3. Step: individual check of the system components

This section contains control boxes that should be marked if the given information is correct.

Visual check for mechanical damage and correct fastening:

Component documentation is available:

Visual check for deviations from the installation guideline:

<u>Device type:</u>	Enter device type, e.g. SAFEX-C.12, SAFEX-C.15 etc.
<u>Serial number:</u>	Serial number of safety controller (label)
<u>CRC device configuration:</u>	Signature for the program and parameter data
<u>Extension device:</u>	Description of extended devices
<u>Transmission meter:</u>	This field can also be edited.
<u>Number of axles:</u>	Total number of axles


### 4. Function test:

**To create the validation report, the correct program data and the correct parameter data must be loaded!**

The test engineer must revalidate all configured data in the printed report by verifying the programmed functions on the equipment/the device.

All set limit values of the monitoring function used must be checked for correctness. The system reaction times mentioned in the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>) must be observed.


**A successfully completed validation should be completed by clicking on the button “Lock configuration”.**

 If a new configuration is loaded into the ctrlX SAFETY system, the system LED lights **YELLOW** if the system is operated correctly. This signals an unvalidated application. If the button “Lock configuration” is activated during an active connection with the device, the LED is permanently **GREEN**.

## 6.7 User management (in preparation)

Via the user management, functional schemes can be locked against unintentional or unauthorized changes. The access to function blocks in the current functional scheme can be disabled or enabled. This means, that in a disabled functional scheme all menu ribbon options and configuration tree for adding function blocks are grey (= disabled). Furthermore, in function blocks that have already been added, the parameters can't be changed any more.

For unlocking, a password is necessary. In this case, the configured values and the functional modules of a disabled plan can be displayed but they cannot be modified. This function ensures that unauthorized persons can't modify the functional scheme.

 Functional schemes can only be unlocked with the password that has also been used to deactivate the plan. A disabled functional scheme can no longer be compiled. However, access to ctrlX SAFETY SAFEC-C.1x is still possible.

## 6.8 Device interface

The device interface is displayed in the menu ribbon. This menu ribbon contains advanced communication options, e. g., program transmission, diagnosis and range monitoring by connected ctrlX SAFETY devices. If the device interface is opened, the program automatically starts the compilation. The window contains the instruments of the device interface.

### 6.8.1 Symbols in the device interface

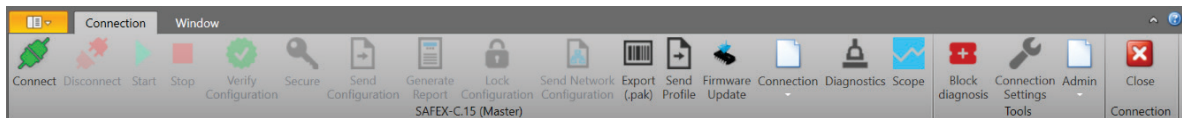


Fig. 116 Symbols in the device interface – not connected

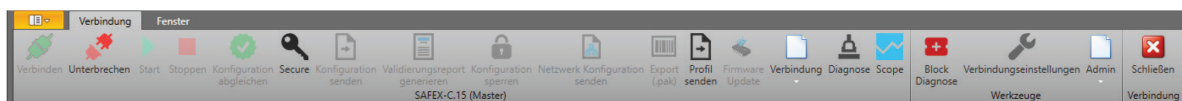


Fig. 115 Symbols in the device interface – connected

**Connect:** starts the connection with ctrlX SAFETY system.


**Disconnect:** disconnects an active connection.

**Start:** starts a program sequence in the “connection” mode.

**Stop:** stops the program sequence in the “connection” mode

**Verify configuration:** Compares the application of the ctrlX SAFETY Engineering to that on the ctrlX SAFETY system by means of CRC.

**Secure:** In the Security System Interface the password can be entered to unlock the device. After connecting or reconnecting with the serial number to the SAFEX-C.xx device, the secure mode must be enabled. This is done via this "Secure" icon.

 For more information see chapter 7.8

**Send configuration:** Transmits the configuration of the function block diagram to the ctrlX SAFETY system. This is only possible in the “Stop” mode.

**Lock configuration:** After every configuration data transfer to an ctrlX SAFETY system, these data are marked “Not validated “. The base group signals this by the status LED flashing green. With the “Lock configuration” command access to the configuration data can be disabled in the basis block. This is indicated by the status LED flashing permanent green.

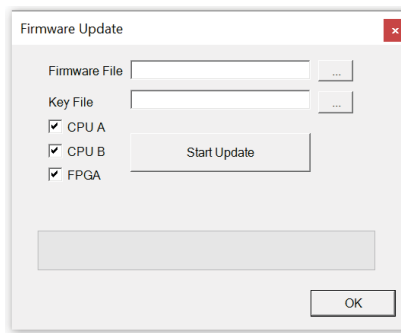
**Generate report:** Creates a PDF file of the current ctrlX SAFETY configuration for the connected device. The text file lists the parameters of the configured devices and of the IL [AWL] program. The printout must be confirmed and released in accordance with the required standards and guidelines.


**Send network configuration:** Transmits the set network parameters. (Only when using a further bus interface on the secondary port/Ethernet 2 interface with the SAFEX-C.15 device)

**Export (.pak) profile:** Creates a profile from an FSoE Slave.

**Send profile:** Transmits a profile to an FSoE Slave.

**Firmware Update:** Opens a dialog window „Firmware Update “. Selection of Firmware File /Key File. Check marks can be set for CPU A/B and FPGA.



 For further information see chapter 7.6 “Firmware update“

**Connection:** A selected binary configuration file can be sent to the assembly or loaded/read from the assembly to a file. This is required for device exchange. This function is disabled if the diagnostics window or the range window is open.

The password for security can also be changed or reset in this menu. In addition, the project file or configuration file can be written to or read from the  $\mu$ SD memory card.

**Diagnostics:** Opens a dialog window. See chapter „System and logic diagnostics“.

**Scope:** Opens the scope window. This enables online diagnosis of various process data.

**Block Diagnostics:** With this button selected elements in the device diagnostics window can be added the “Function Block” tab. This tab is only activated if the device window is displayed.

**Connection settings:** Opens the document properties with the connection settings to create a connection with an ctrlX SAFETY system, the transmission parameters must be set accordingly.

**Close:** Closes the device interface.

### 6.8.2 Status bar of device interface



1. **Compilation display**  
**Compiled** – Current file has been compiled  
**Not compiled** – Current file has not been compiled
2. **Progress**  
**None** – Grey background indicates that no configuration process is available  
**Send configuration** – Transmission of the configuration of the functional scheme to ctrlX SAFETY-controller. (To find under „Connection“ icon > Send>...)  
**Read configuration** – Reading out the current ctrlX SAFETY device configuration (To be found under "Connection" icon > Read >...)
3. **Connection status with display**  
**Connected** – Active connection to the COM interface of an ctrlX SAFETY monitoring unit  
**Disconnected**– No active connection
4. **Program status**  
**Idle** – Program has completed all task of the controller  
**Upload** – Program uploads into the ctrlX SAFETY system  
**Binary download** – Program downloads the configuration from the device  
**Diagnostics** – Program uses diagnostics instruments in the “diagnostics” tab “.  
**Scope** – Program monitors the time-dependent process of speed, acceleration and position in the “range” tab
5. **Device status**  
**Stop** – stops the transmitted program  
**Carry out** – starts the transmitted program  
**Initialize** – Program initializes the device  
**None** – no connected device (only status „disconnected “)  
**Alarm status** – Alarm type and additional information in alarm status
6. **Alarm status: only in case of an alarm**  
**Alarm** – additional information in alarm state, alarm case with number of errors
7. **Connected COM-Port**

## NOTE

- The diagnostic functions is described in chapter 6.5.19 “System and logic diagnostics “

## 6.9 Networks

### 6.9.1 Master to Master (SMMC)

#### 6.9.1.1 Description

Global network with an SMMC Safe-Master-Master-Communication.

SMMC Safe Master-Master Communication is available up to

- FW-Version 1.0.1.19 and
- ctrlX SAFETY Engineering Version 1.7.1.8215

For the network

- Minimum are 2 master
- Maximum depending on interface
  - Primary (EtherCAT) XF28/29: 4 master
  - Secondary (TCP/IP) XF30/31: 8 master

#### 6.9.1.2 Creation

The user must connect a ctrlX SAFETY controller (Master) in the terminal scheme, that supports SMMC.

If the user connects a second ctrlX SAFETY controller (Master), that supports SMMC, the following window appears:

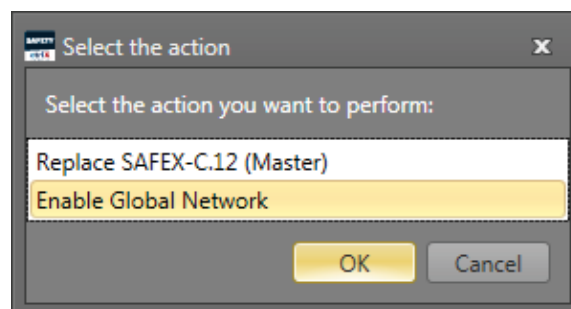

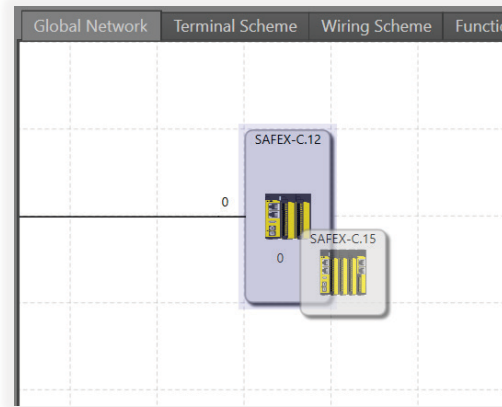


Fig. 117 Window „Select the action“

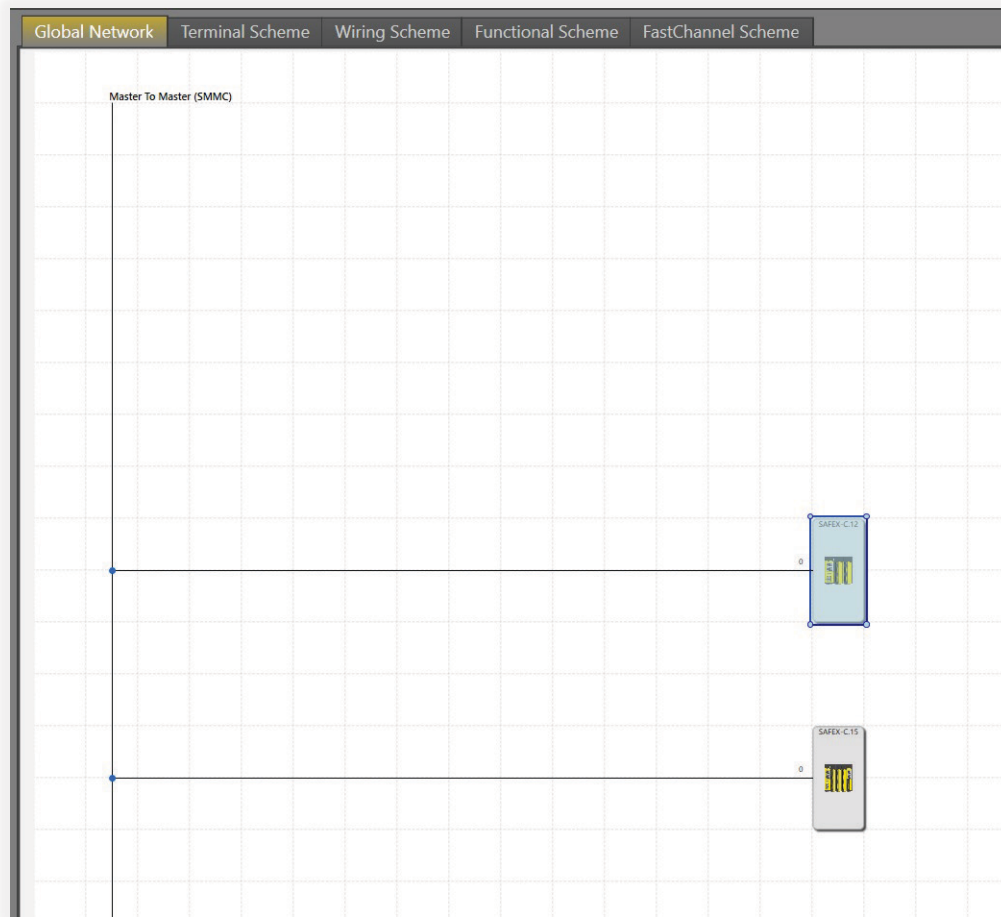
Select “Enable Global Network”, and confirm with “OK“. The second Master is added, and the tab “Global Network” appears.

After an SMMC network with at least 2 Master devices has been created, the window does not appear any more when the next Master device with SMMC support is added, and the device is automatically added to the global network (up to 4 devices).

 If you want to replace a Master device by another device, you must drag the new device from the library exactly over the symbol of the device you want to replace. The mouse pointer must point to the symbol of the device you want to replace (cf. illustration below).



**Fig. 118** Replace an SMMC master by dragging it from the library and overlaying it, deactivate automatically when a master is deleted and only one master is left.

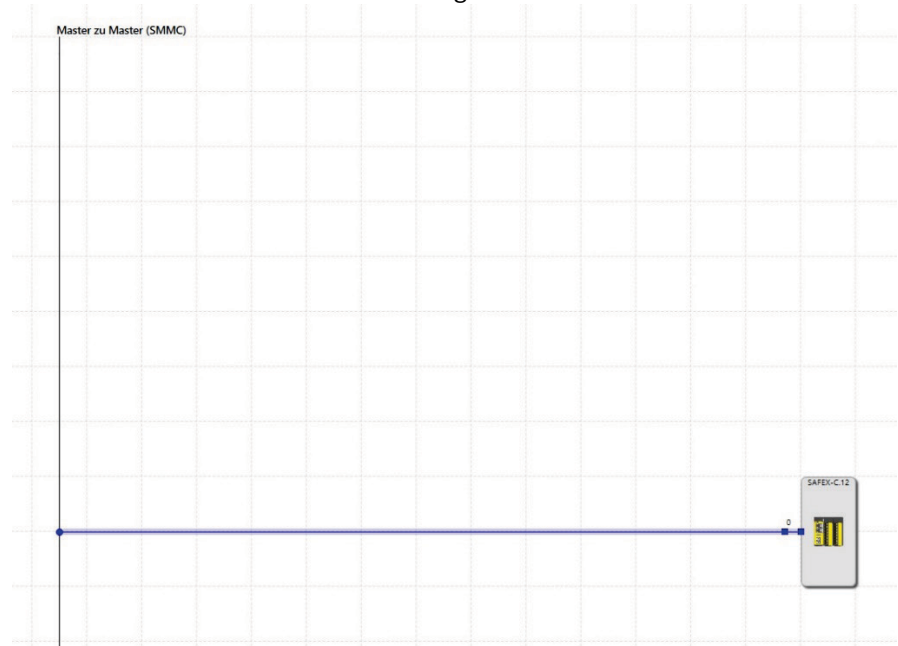


**Fig. 119** View „Global network“, SMMC.SMMC network configuration

Joint configuration

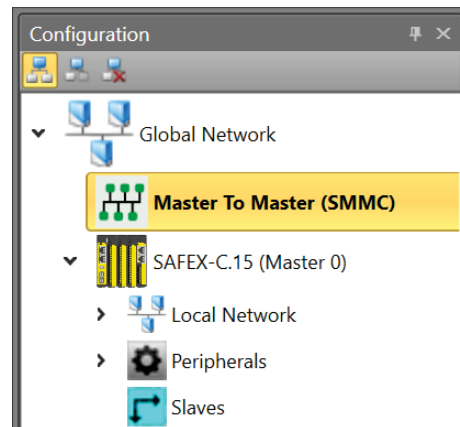
### 6.9.1.3 Configuration of SMMC Network

If the user clicks on the SMMC line in the global network



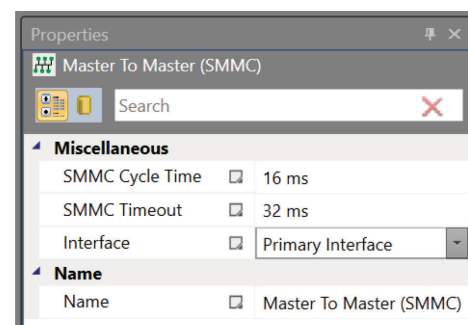
**Fig. 120 Global network, SMMC line**

or if the selects SMMC in Browser (configuration),



**Fig. 121 SMMC in Configuration (Browser)**

appears the properties of SMMC in the properties window.



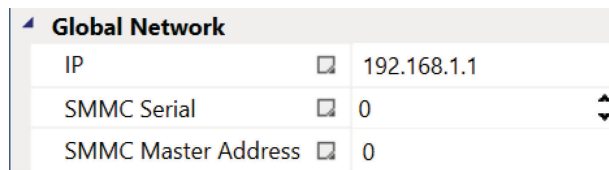
**Fig. 122 Properties window, Master to Master (SMMC)**

**Table 12: SMMC times**

<b>SMMC cycle time</b>	Cycle time of the SMMC communication in [ms] [8ms...128ms]
<b>SMMC Timeout</b>	Timeout time of SMMC communication in [ms] [12ms...256ms]
<b>Interface</b>	Selectable between Primary interface Secondary interface
<b>Name</b>	Free input possible for users

Individual configuration  
of SMMC masters

After a click on each Master device in the SMMC network, the properties window appears, with which these devices can be configured individually.



**Fig. 123 Tab „Global Network“**

**IP address** — When using SMMC at the secondary Ethernet interface, an IP address can be set.

- This address is only used/needed at the secondary Ethernet interface.
- If a PROFINET master/controller is used at the secondary Ethernet port, the assigned IP address from the PROFINET controller must be set here.



This address must be transferred manually to the configuration, since ctrlX SAFETY Engineering has no access to the runtime system data.

**SMMC serial number** — entry field. Here, the serial number of the selected device must be entered.

**SMMC-Master address** — This is the address of the device in the SMMC network. The SMMC Master device has the address 0. The ranking in the plan and the Master address are interconnected. The first device (from top to bottom) is the Master, and has the address 0. The second device has the address 1, the third device has the address 2, and the last device has the address 3. If the user changes the ranking of the devices in the global network via Drag & Drop, the Master address changes according to the above principle (first device = Master address 0, etc).

By clicking on the Master device in the configuration window (browser) with the right mouse button, this device can be selected as SMMC Master via “Set as SMMC master”.

After this device has been selected as Master, it appears in first position in the global network, and the other devices are pushed downward, and the addresses of the Masters change.

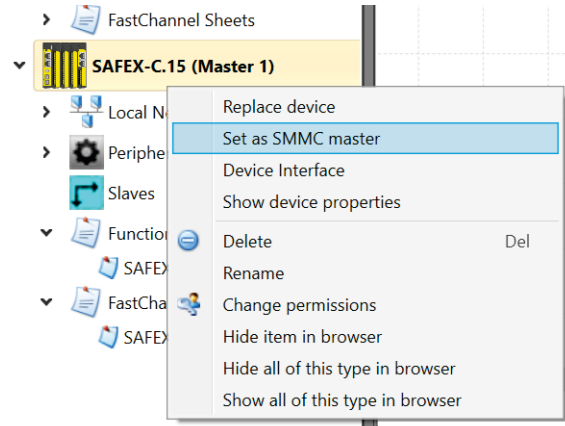


Fig. 124 Configuration, Exchange of SMMC master device

#### 6.9.1.4 Use

##### SMMC Terminal Out „SMMC Output Connection“

Every device can write 32 bit as output on SMMC. By the connection with SMMC, these bits are defined as “SMMC Terminal Out” [SMMC output connection].

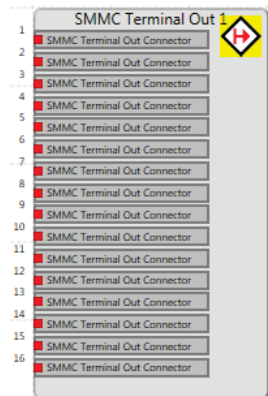


Fig. 125 SMMC Terminal Out

##### SMMC Terminal In „SMMC Input Connection“

Every device can read bits from other devices, and it can read its own Bits. These bits are defined as „SMMC Terminal In“ [SMMC input connection].

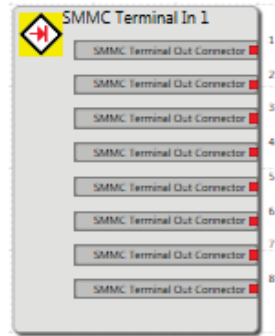


Fig. 126 SMMC Terminal in

A restricted number of configurable common bits for every device and this Master can be assigned to logic as SMMC “Terminal Out”, and can later on be used in the functional layouts of other Masters in these Masters ‘logic.

These elements of the bit group SMMC “Terminal Out” connection are available in the library as elements that can be used individually for every Master for input configuration in the functional scheme. Afterwards, an instance can be generated as SMMC “Terminal In” connection. This instance can be used as bridge in the functional scheme of other devices.

The connection behaves like a normal output – with the exception that the corresponding output must be inserted into every Master’s functional scheme, and that it can be assigned to the logic of the respective functional scheme. The SMMC “Terminal In” connection is available after the user has configured the corresponding SMMC “Terminal Out” connection in the library of the functional scheme.

### SMMC „Status“

This Block can display the status of each SMMC connection as a logical value. Two bits per connection are displayed.

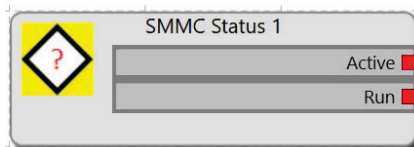


Fig. 127 SMMC Status

**Active** – indicates the status of the SMMC connection to this device.

- 0: connection could not be established.
- 1: device successfully connected

**Run** – indicates the status of the connected device

- 0: Device not in RUN or not connected
- 1: Device successfully connected and in RUN status

## NOTE

**If SMMC device is not connected or not in "RUN" status**

- ▶ SMMC input data is set to „0“

## NOTE


- ▶ Malfunctions of the SMMC network can lead to loss or impairment of safety functions!

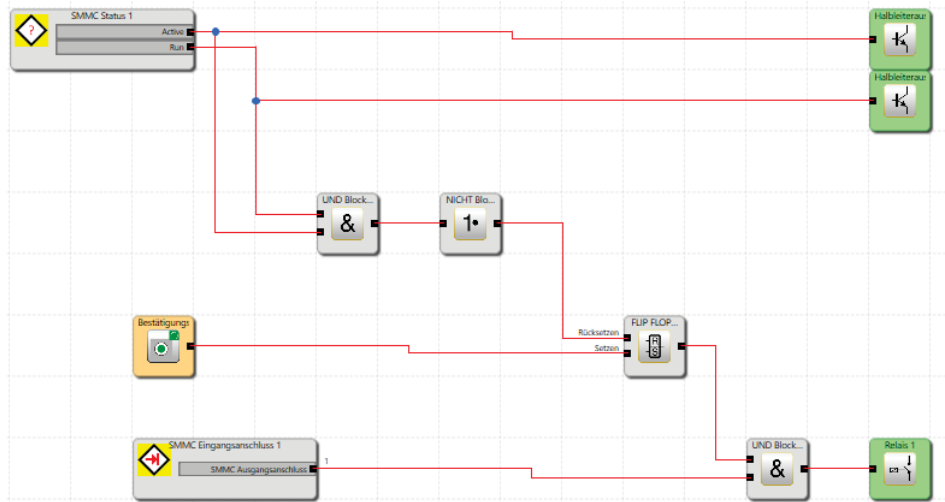
## ! WARNING

**After start-up of the SMMC master connection, the data is automatically released.**


A restart of the bus communication must be parameterized/programmed in the function block diagram of the module configuration.

- ▶ The "Restart" or "FlipFlop" function block can be used for this purpose.

 Example of restart via FlipFlop function block. Enable via confirmation button.



**Fig. 128 SMMC network - startup via "FlipFlop" block**

 Example of Restart via “Restart” block. Enable via “confirmation button”.

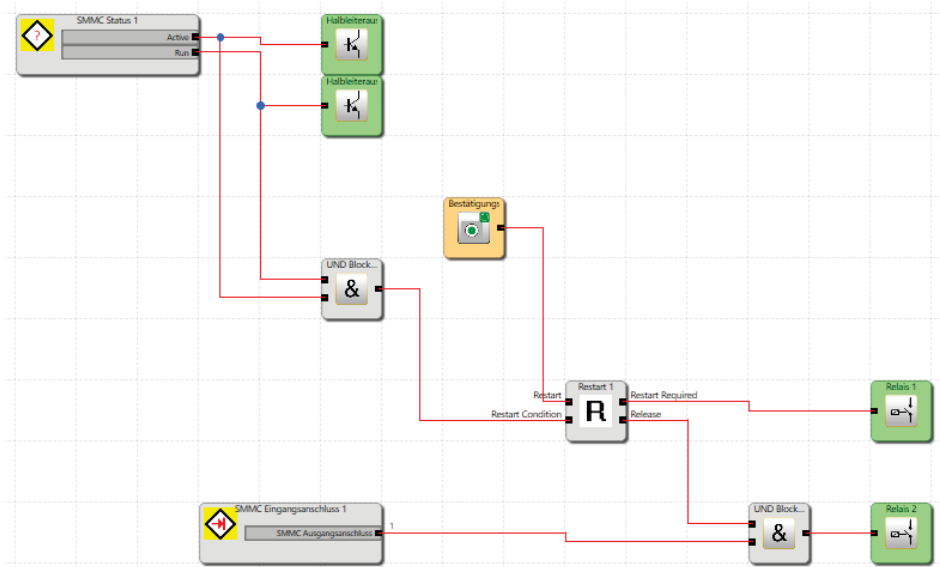


Fig. 129 SMMC network - Startup via „Restart“ block

## 6.9.2 Fieldbus

### 6.9.2.1 Description

Fieldbus is the name of a group of industrial computer network protocols for real-time transmission control. Fieldbus is standardized in the IEC 61158 standard.

#### Fieldbus network protocols:

##### Non-safe networks

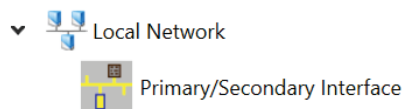
- EtherCAT
- PROFINET (only possible with Ethernet 2- interface)

##### Safe networks

- FSoE-Master/ Slave
- PROFIsafe

### 6.9.2.2 Creation

If the device supports fieldbus, a "FSoE Slave" field is shown in the property window of the device. By marking the corresponding check box, the fieldbus can be switched on or off.

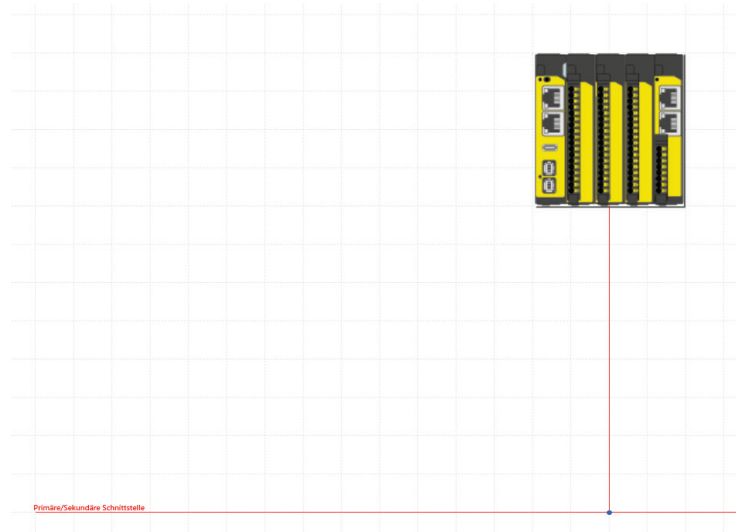


**Fig. 130 Configuration (Configuration window) „Local network “ after activation of „Slave Network Interface“**

If a fieldbus is enabled for a device, a network line is created for this purpose. The fieldbus network communicates with the subordinate PLC via individual connections. Furthermore, the "Fieldbus EtherCAT" or "primary/secondary interface" object appears in the configuration tree.

## View

### In local Network:



**Fig. 131 view in local network**

This view shows a connection of the device with the superordinate safety controller. In the local network, the fieldbus is activated separately for each device. The use of the fieldbus can be safe, non-safe or both. The use can be selected in the properties window. The design of line for the fieldbus changes according to the selected use.

Safe use is indicated by a solid red line:



Non-safe use is indicated by a dashed red line:

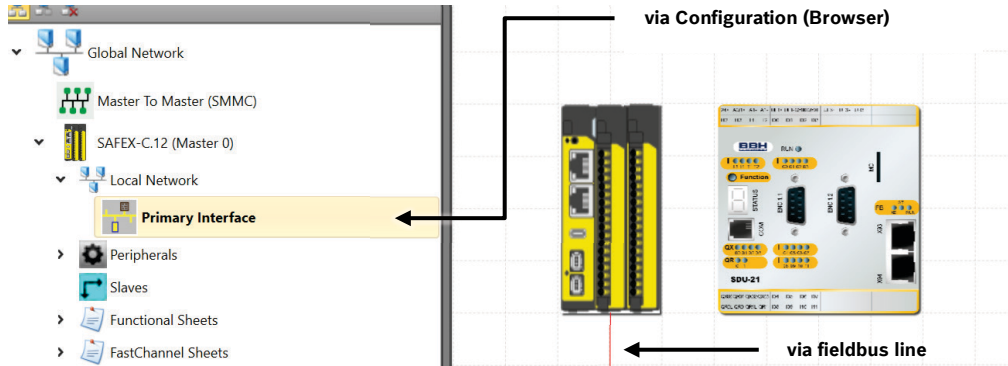


If both possibilities are used, this is indicated by a double orange-blue line:



### 6.9.2.3 Configuration of Fieldbuses

The properties of this network are configurable when user clicks on the fieldbus line or selecting the fieldbus object in the configuration tree through the Properties window with defined properties in library.



**Fig. 132 Fieldbus configuration in the project**

The information over this bus has a fixed size for transmission (e. g. 96 bit). This information is shared between “process data” like speed, position which each one can be defined as byte, int16, int24 or int32 or even brand defined types. The other part can also be used for the transmission of the logic information. The way that this network is configures is depend on the pre-defined profiles.

The properties window for the different protocols is shown below.

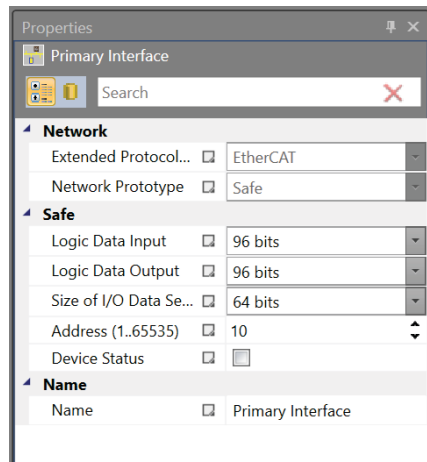


Fig. 133 Network protocol type „EtherCAT“, set properties

Network use – is **safe** with ctrlX SAFETY controllers.

Parameter	Description
Ethernet 1- Interface (primary interface)	EtherCAT/FSoE slave
Ethernet 2 -Interface (secondary interface)	PROFINET/PROFIsafe

Safe use

Currently, FSoE master/slave can be selected for safe use.

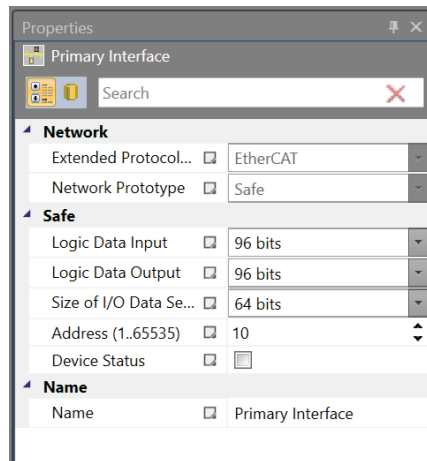


Fig. 134 Primary interface properties, network protocol type- EtherCAT – FSoE (safe), by SAFEX-C.12

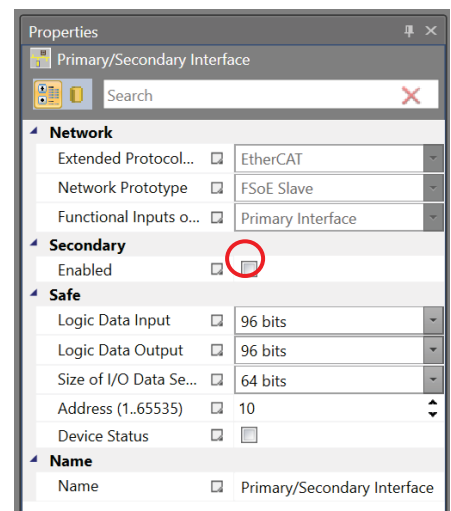

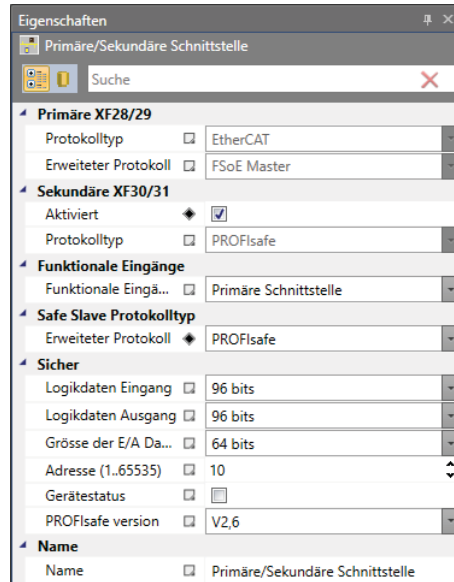


Fig. 135 Primary/ secondary interface properties, network -protocol type EtherCAT - FSoE (safe) by SAFEX-C.15

 For ctrlX SAFETY SAFEX-C.15, the "Secondary enabled" checkbox must be activated in the properties window to be able to use the secondary interface. (see Fig. 135 Primary/ secondary interface properties, network -protocol type EtherCAT - FSoE (safe) by SAFEX-C.15)

PROFIsafe can be used for the secondary interface.



The following settings are possible:

**Logical data input** – setting range from 8 Bit to 96 Bit.

**Logical data output** – same range as logical data input (8 to 96 Bit).

**Size of I/O data segments**– same range as logical data input (8 to 96 Bit).

The values indicate the number of bits used by safe connections.

**Address** – Safe bus address (FSoE slave address or F-Destination address for PROFIsafe).

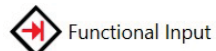
**PROFIsafe Version** – PROFIsafe Stack Version selectable for 2.4 and 2.6

*Comments: PROFIsafe Stack:*

 „F\_iPar\_CRC“ is not supported

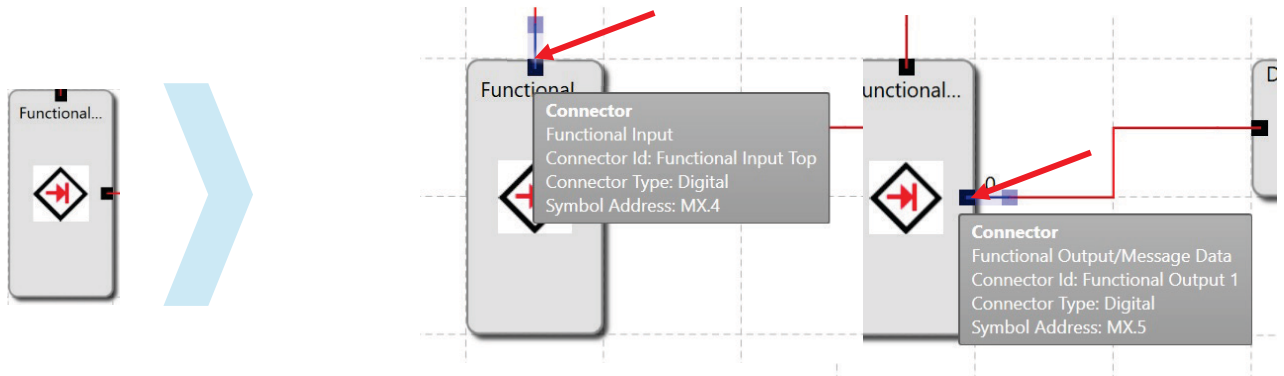
Logical data inputs and outputs with fixed bits are available.

**Functional input**– a bit can be used only once. Each block can configure the number of inputs from 1-32. It is possible to set the range of inputs. The non-safe input is possible via the functional input, but it is not allowed to use a non-safe input directly. It is possible to activate a non-safe input via another safe input. Therefore, a functional input has an additional input connector for each non-safe input, which ensures the use of the non-safe input. This checks that this additional input connector is connected to a safe input module. The connection with a non-safe block is not permitted.



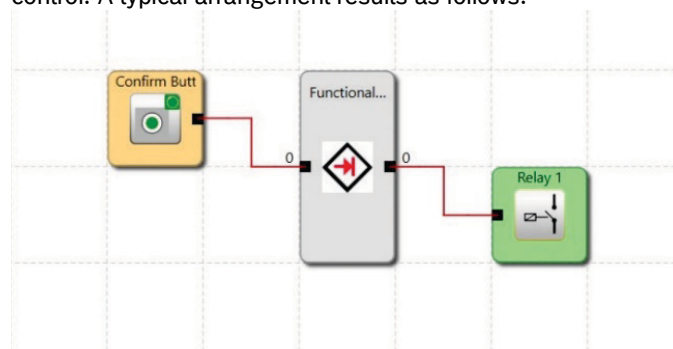
**Fig. 136** Function block "Functional input", View in library

This Function block has one input and one output. The input is to be connected with a signal of the safety control. The input signal of the function block is linked with a logical AND to the functional input signal.



**Fig. 137** Function Block "Functional input", view Functional scheme

The structure of the block ensures a forced AND-operation with a signal of the safety control. A typical arrangement results as follows:



**Fig. 138** Example of a connected „functional input“

A maximum of 143 functional inputs can be used.

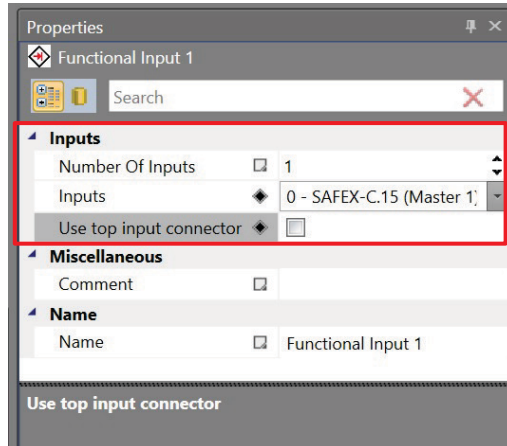


Fig. 139 “functional input“ properties window

The following settings are possible:

- Inputs – Input selection on the master device
- \*Use input connector – visual setting of the input and output connection of the functional input. In this configuration, a collective enable input is used for all functional inputs used in the block.

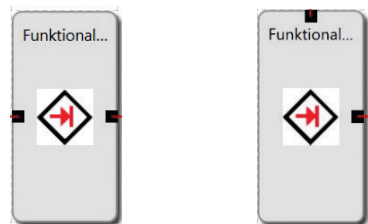


Fig. 140 Functional input: \*Use top input connector-function inactive / active

Diagnostics data are only transmitted via the EtherCAT connection (FSoE Master).

The data can be parametrized via the functional outputs.

A maximum of 143 functional outputs can be configured. Binary information is transmitted.

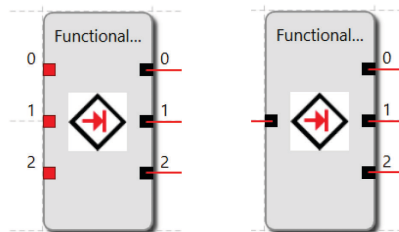
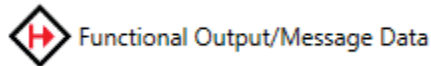


Fig. 141 Functional input: \*use top input connector from version 1.7.1.8179

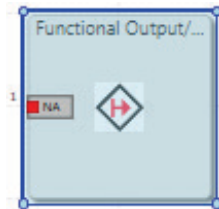
## NOTE

- ▶ Starting with version 1.7.1.8179, any safe signal can be used to activate the functional input.
- ▶ From version 1.7.1.8179, the connector is also displayed on the left when "Use top input connector" is configured.

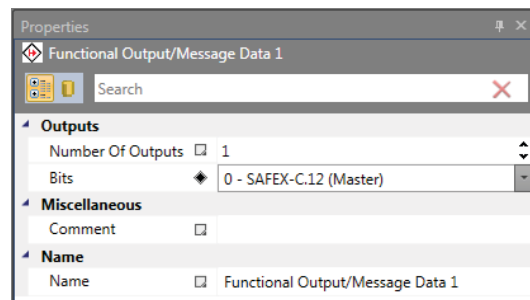
**Functional Output** – a bit can be used only once. Each block can configure the number of outputs from 1 – 143.



**Fig. 142** Function Block „Functional output“ , view library

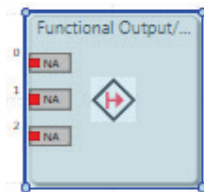


**Fig. 143** Function Block "Functional output"



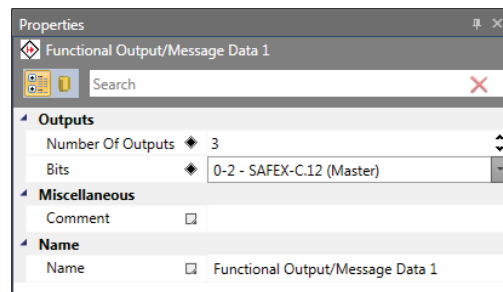
**Fig. 144** Properties window- Functional Output

In one block also more than one functional output can be configured. The illustration shows a functional output with 3 outputs. Each connector can be configured.



**Fig. 145** Functional output with 3 outputs

Properties window for functional output with 3 outputs.



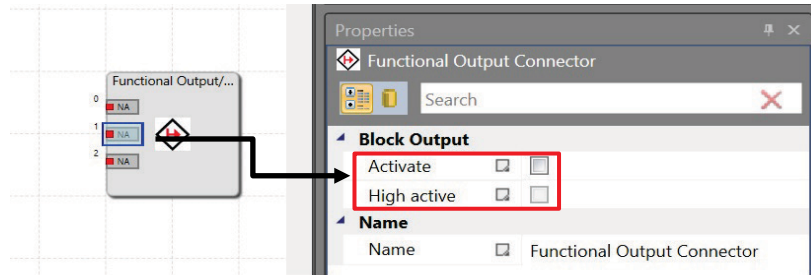
**Fig. 146** Properties window for functional output, example with 3 outputs.

After selecting the functional output connector, the properties of the selected connector appear in the properties grid. The connector output can be set as follows:

**NA** – not activated (both boxes are unchecked)

**A** – activated

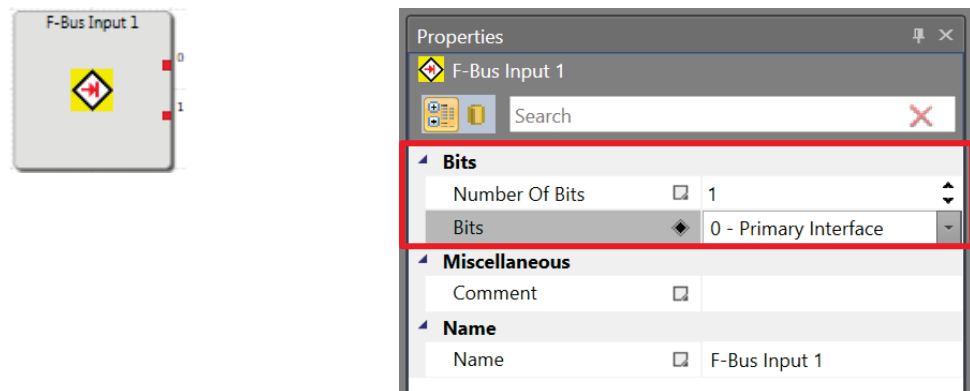
**A/H** – activated with „High active“



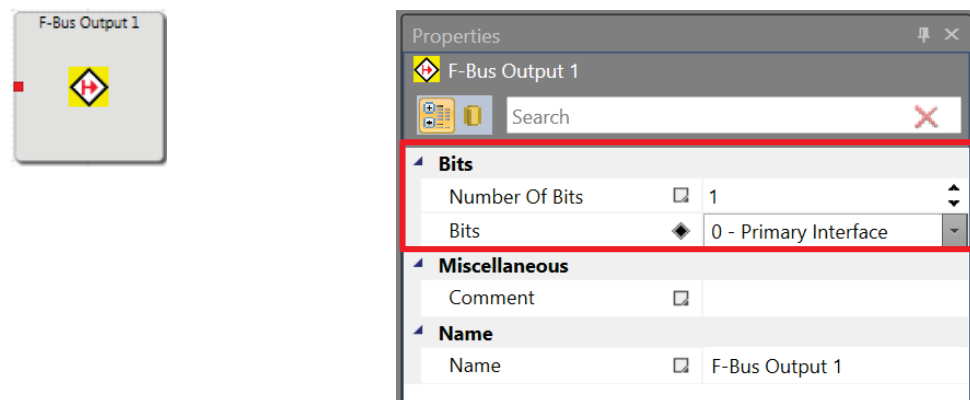
**Fig. 147 Functional output, Block output settings**

**F-Bus-Input and F-Bus-output**

Safe connections “F-Bus Input” and “F-Bus Output” – each bit can only be used once. For every block, the number of bits can be set within the range of 1-96. The bits used can also be set.



**Fig. 148 F-Bus Input: function block and properties window**



**Fig. 149 F-Bus Output: function block and properties window**

## Process data output for ctrlX SAFETY controller

Currently, only device status can be transmitted.

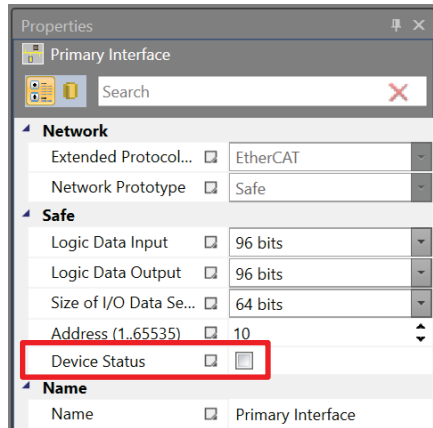


Fig. 150 properties "primary interface", device status

### 6.9.3 Reset via network

If safe communication is used, a device reset (alarm messages) can be configured via safe communication.

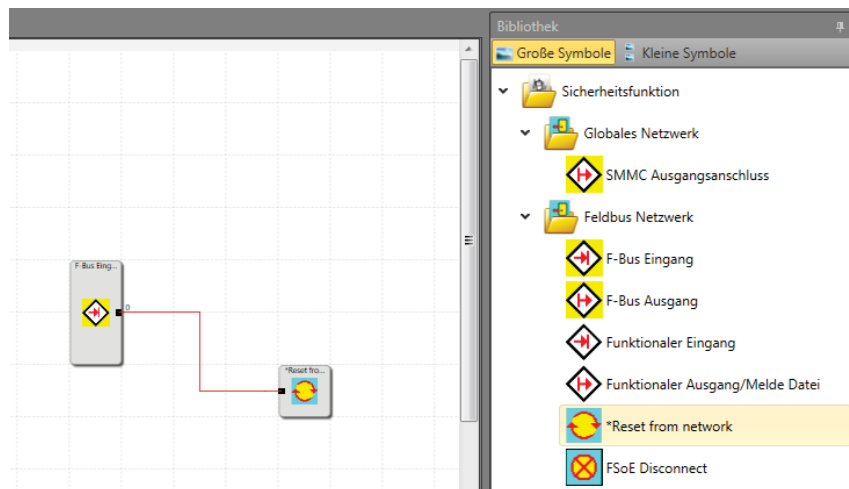




Fig. 151 Use of an device reset, example Reset from network

-  Bit "0" cannot be configured/used for reset via network.
-  A maximum of 1 reset block is available.



**(FDB) FSoE Disconnect Block** – safe disconnection of an FSoE connection

#### Function:

The "FSoE Disconnect" block is used to temporarily disable the FSoE connection. The recognition of which device must be deactivated is set via the FSoE address. This function avoids an error state in the master at defined switch off / disconnect of a slave device.

Find more information in the chapter 6.10.5.3 FDB (FSoE Disconnect-Block).

## 6.9.4 Fast-Channel

### 6.9.4.1 Description

In the ctrlX SAFETY Engineering, maximum 16 ctrlX SAFETY<sup>link</sup> slave groups can be operated in the Fast-Channel mode.

The processing time of a Fast-Channel connection is indicated in the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>).

### 6.9.4.2 Creation

In the Master device, a Fast-Channel connection can be activated.

After the activation of the Fast-Channel connection, a FastChannel scheme is displayed (FastChannel), where Fast-Channel data can be concatenated via IL.

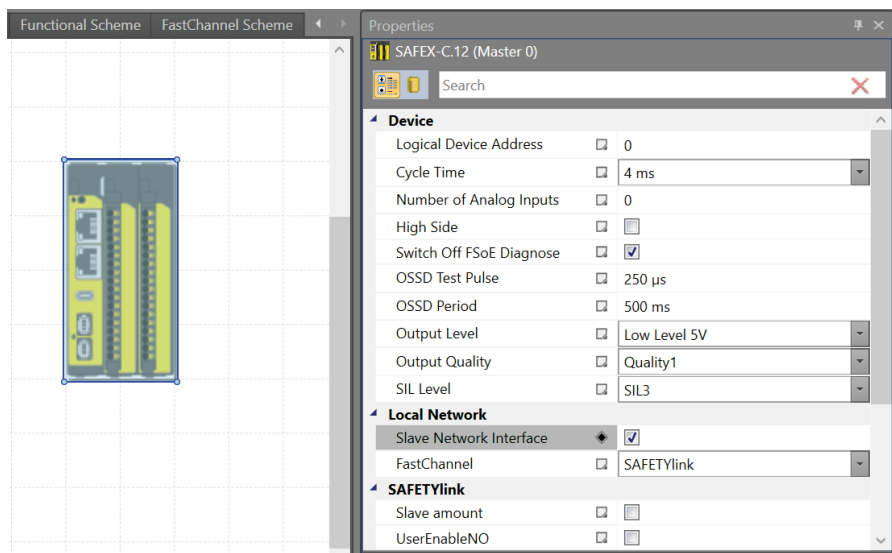


Fig. 152 Fast-Channel scheme

### 6.9.4.3 User program

The processing in the Fast-Channel scheme is similar to the „Standard“ functional scheme. There are restrictions with respect to program size and with respect to the library.

Logical program concatenation between “Standard functional scheme” and the FastChannel functional scheme takes place via the function blocks Fast-Channel Merker Input und Fast-Channel Merker Output. This data is exchanged between the two functional schemes once per device cycle.

## **⚠ WARNING**

**Program concatenations must consider the reaction time of the “Standard” functional scheme .**

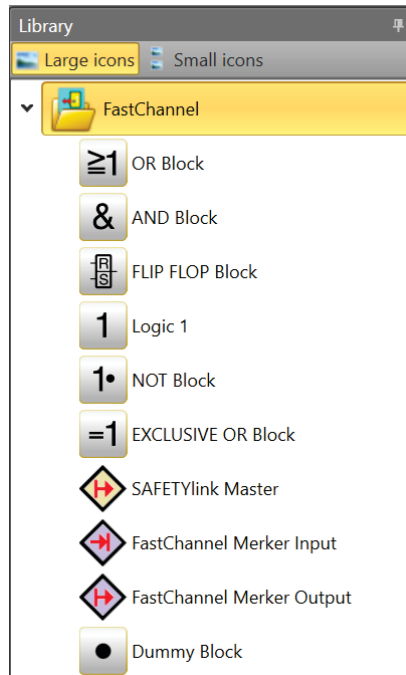


Fig. 153 library window "FastChannel"

### ctrlX SAFETY<sup>link</sup> master

Input/output information for ctrlX SAFETY<sup>link</sup> communication.

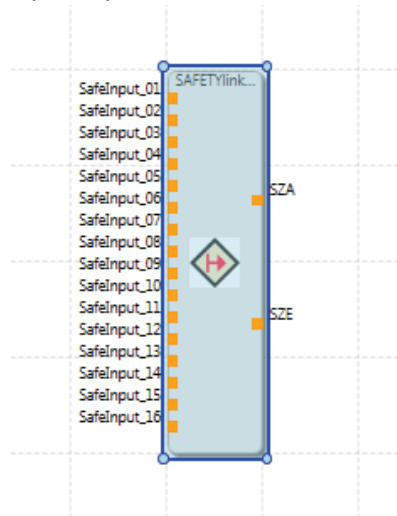


Fig.154 ctrlX SAFETY<sup>link</sup> Block

## FastChannel Merker Output

Marker bit for use in the "standard" functional scheme

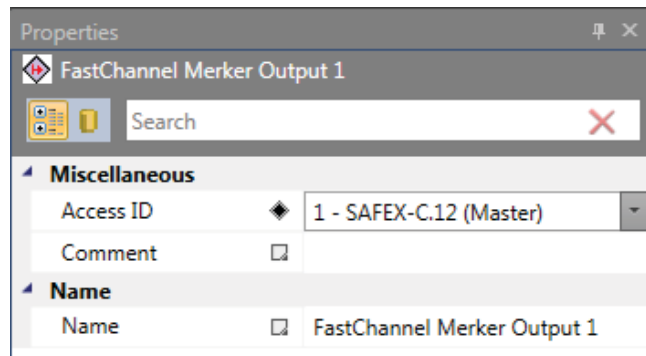


Fig. 155 Access ID: Selection bit number marker

## FastChannel Merker Input

Reading of marker bit from "Standard" functional scheme in Fast-Channel- functional scheme.

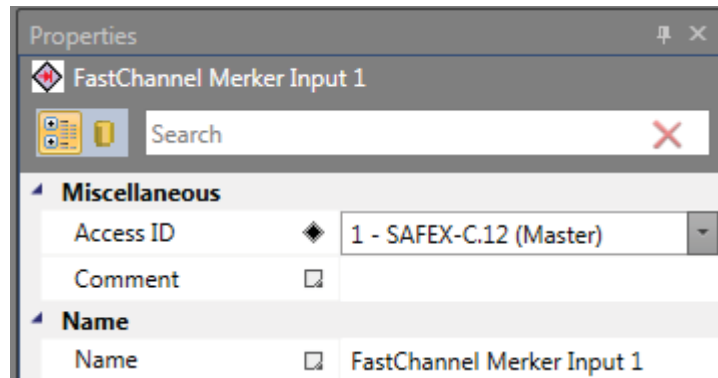
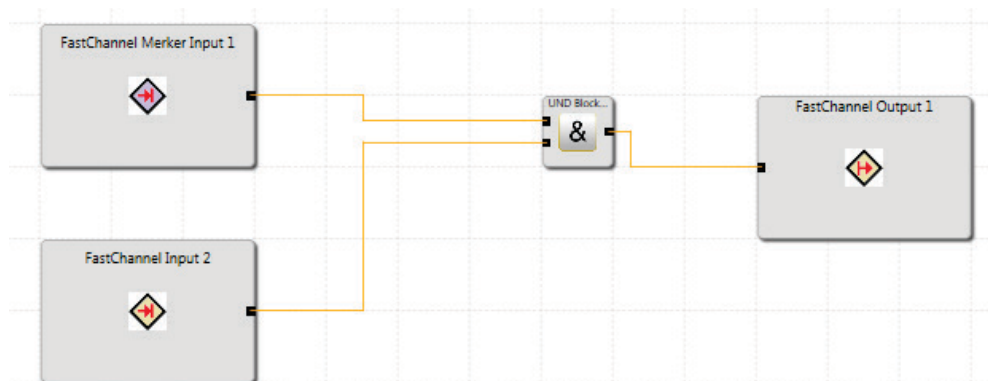


Fig. 156 Access ID: Selection bit number marker

### Program example:

Enabling of output on Slave device via "Standard" functional scheme (standard reaction time) and disabling via FastChannel processing (FastChannel response time)



## Digital inputs/outputs

The digital inputs and outputs used in ctrlX SAFETY compact safety control can also be used in the FastChannel. Usage can be configured in the individual elements. The following restrictions apply:

### Digital inputs:

- Input elements cannot be used with time monitoring.
- Input elements cannot be used with startup test.

### Digital outputs:

- Relay cannot be used.
- The outputs can be used only in the FastChannel or standard function plan.

### Program example:

Output activation on slave device via “standard” function plan (standard response time) and shutdown via FastChannel processing (response time FastChannel)

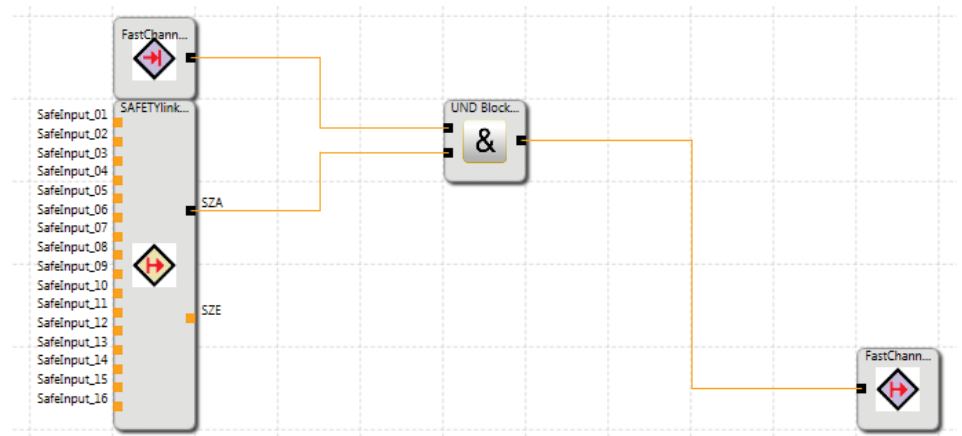


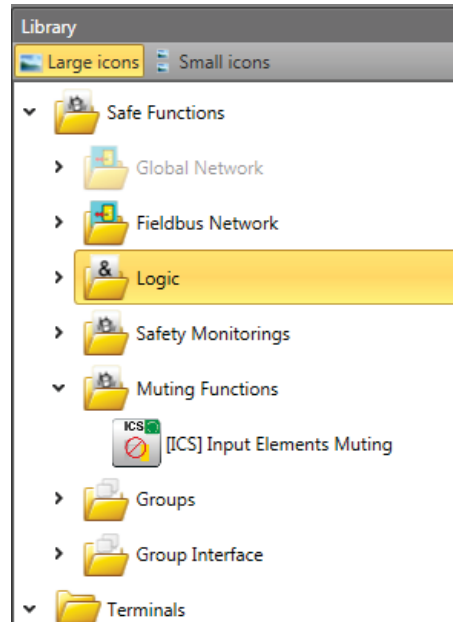
Fig. 157 FastChannel function blocks in the function plan

## 6.10 Content of library

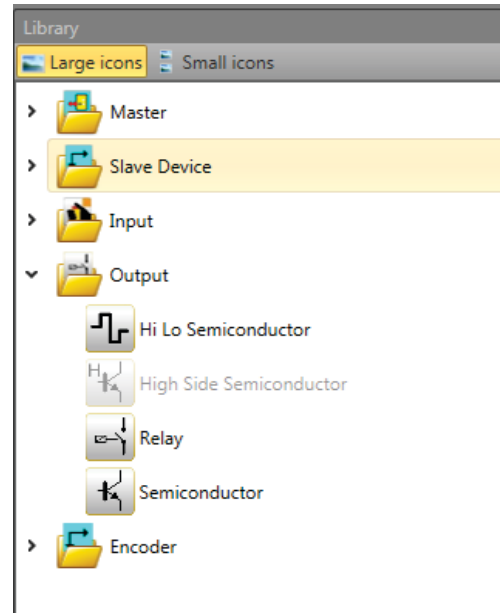
The library offers all available blocks to create the desired function block diagrams in the functional scheme.

Only the elements that can be used in the selected plan are displayed.

The blocks can be added with Drag&Drop in the plan view, and they can be edited in the properties window.



**Fig. 158 View of the library – functional scheme selected**



**Fig. 159 View of the library – Terminal scheme selected**

The resource control of the block elements of the ctrlX SAFETY systems manages the available elements. The number of available elements can be restricted.

Through the automatic monitoring of resources of the block elements of the ctrlX SAFETY device, only available elements are enabled in the program. Above all, this concerns the time-monitored peripheral devices. Some blocks depend on other blocks and are available only if these blocks are already present in the plan.

If no resources (memory) for the monitoring program are available in ctrlX SAFETY device, the components or function blocks are displayed grayed out in the library view. This is the case if, e. g., all digital connections of an ctrlX SAFETY device are occupied, or if all timer modules have been used.

By deleting the corresponding function blocks, these resources can be released again.

## 6.10.1 Devices



### 6.10.1.1 Master devices

The Master device is the basic module for programming.

For the ctrlX SAFETY there are two variants of the base devices (ctrlX SAFETY-C.12/ ctrlX SAFETY-C.15).

A ctrlX SAFETY Engineering document can contain programs for several Master different Master devices. The Master devices with this capability can communicate with each other via the SMMC network.



### 6.10.1.2 Slave devices

A Slave device is an extension module offering more I/O connections or allowing the control of more axles. There are two types of Slave devices:

I/O extensions enlarge the number of inputs and outputs.

Axis extension modules can be used to monitor additional axes. The axis extension modules optionally provide additional inputs and additional outputs.

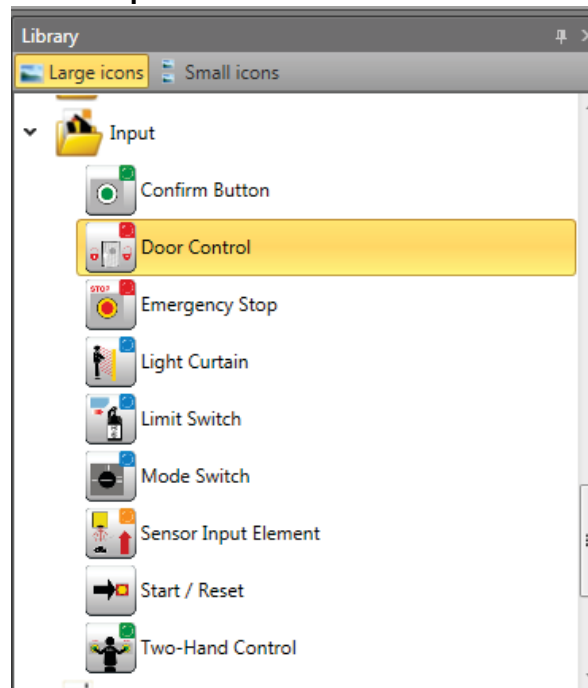
### 6.10.1.3 Peripheral devices

Peripheral devices are external blocks which are connected to the inputs / outputs of the ctrlX SAFETY controller and provide inputs signals / output signals

They can be inserted in the terminal scheme or wiring scheme, where they are automatically connected with the corresponding connections of the ctrlX SAFETY devices.

After the peripheral devices have been inserted, the corresponding function block is created. (In the functional scheme) Together with other function blocks, this function block can be used to configure the desired function of the system.

### 6.10.2 Input blocks



**Fig. 160 List of input elements**

Input blocks create the digital connection between one or more connected sensors or other subordinate switching devices in the ctrlX SAFETY system. They provide data about the operating status of the plant that is monitored by the ctrlX SAFETY device. These components, which, from the point of view of the ctrlX SAFETY device, are situated outside the device, can be added or configured only in the terminal scheme or in the wiring scheme. Except the operation mode switch, every input block provides a logic output signal “0” or “1” for further processing in the PLC.

The blocks are structured according to use and type of input signal, so that targeted resource monitoring of the ctrlX SAFETY device is possible.

The input blocks are structured according to their application (e.g. Button „confirm button“).

The following paragraphs contain details about this type (e.g. Button „confirm button“).

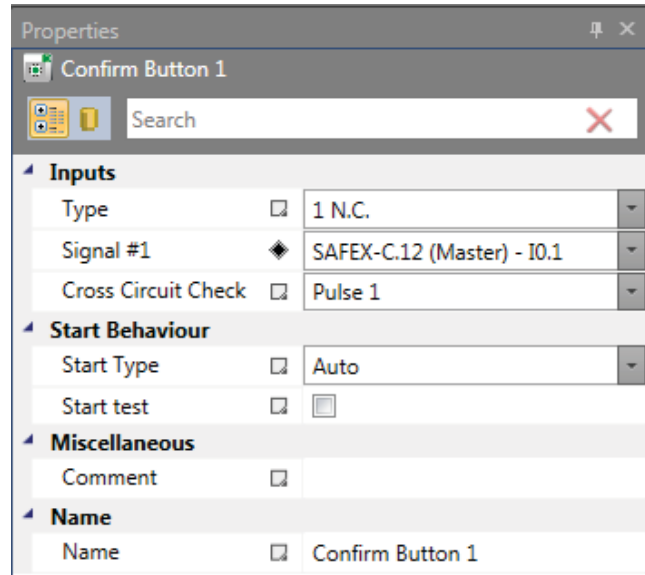


Fig. 161 Example properties of button „Confirm Button 1“

## NOTE

### The configuration of the input block

The configuration of the input block has significant effects on the performance level. The report can be created only after saving the functional scheme..

- ▶ See Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>

The configuration of the digital inputs is always based on the same process:

### „Can be used“ in FastChannel

When enabled, the input element can be used in the FastChannel functional scheme .

### Switch type

Switch type of the component that is connected to the ctrlX SAFETY device. The number of corresponding input signals and the monitoring behaviour of the ctrlX SAFETY device vary with the selection.

In case of time-monitored switching elements, another signal change must take place at  $t = 3$  s after the first signal. If this does not happen, a malfunction is detected.

**Signal no.**

Assigned number of the external signal to the digital input of the ctrlX SAFETY device. This selection list shows the identifiers of the input signal (e.g. „I0.1“) of the ctrlX SAFETY device, that have not yet been used. The identifiers are assigned by the user. A double allocation of the input signals is prohibited. If the resources of the ctrlX SAFETY device are nearly exhausted, and if the selection of the switch type required too many input signals, the selection list remains empty. In this case, a switch type with fewer connections must be used.

**Cross-connection test/ Pulse assignment**

Source of the input signal used. Two signal impulses, Pulse 1 (P1) and Pulse 2 (P2) are available. As an alternative, the option “OFF” can be selected.

To grant the reliable monitoring of short-circuits and line breaks, in the ctrlX SAFETY device, neighboring inputs must have different pulse numbers (P1 and P2). Otherwise, a warning is emitted.

**Start behavior**

This setting determines the behavior of the peripheral devices during a start or a reset of the system.

Start type:

- *Automatic system [Auto]*  
Due to this preset startup type, the des ctrlX SAFETY device can be booted without a user feedback.

**Table 13:**

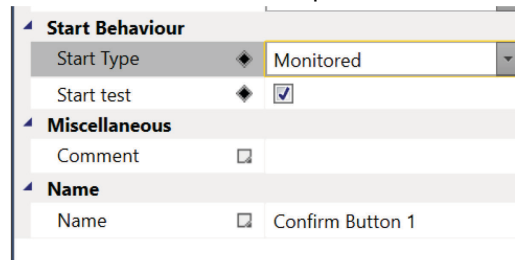
Start type	Function	Plan
Automatic	Automatic start after reset of equipment. The output of the input element switches to “1” if the safety circuit is closed / active according to the definition of the switch type.	<p>Start type Auto</p> <p>The diagram shows three signals over time. The 'Element input' signal starts at a low level, then transitions to a high level. The 'Start button' signal starts at a low level, transitions to a high level, and then returns to a low level. The 'Element output' signal starts at a low level, transitions to a high level, and then returns to a low level. Vertical dashed lines indicate the timing relationships between these signals.</p>

- *Monitoring (Monitored)*  
Release of the monitored input element with a falling edge of the corresponding monitoring input. This is always necessary if the monitored input element is to be switched.

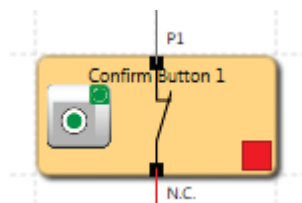
Example: start of a drive only after confirmation by the operating personnel. With a monitored startup type, an additional connector is provided to connect the startup element. Here, continuous behavior for the monitoring of the input element during the start-up phase can be configured.

Start-up test / Start test:

Manual start after equipment reset or after interruption of the preset safety circuit, including the test of the connected monitoring equipment. The monitoring equipment must trigger once in monitoring direction, and it must switch on again afterwards. Afterwards, normal operation follows. This one-time triggering of the input element during the start (or during reset) of monitored equipment warrants the functioning of the input element at the time of start. A start test can be carried out for all elements except the selection switch for the operation mode.



An activated start test is indicated by a red rectangle around an inserted function block.



**Fig. 162** Function block with active Start test

Every input block can carry out an automatic function test (= start test). In total, two switch elements can be configured for the start test.

**Table 14:**

Start type	Function	IL [AWL]	Plan
Start test	The startup test must be fulfilled independently of the startup modes to ensure startup. This means that the subsequent start type can only be run through when the input element has completed a full change of state.	LD E1 ST MX.y1 LD NOT MX.y1 ST MEAA_EN.1 LD MX.y1 ST MEAA_EN.2 LD MEA.1 AND MX.y1 ST MX.2	<p>Start type start test</p> <p>Device RUN/start-up</p> <p>Switching function</p> <p>Output (depended of start type)</p>

*Comment*

Text to be shown on the block. You can enter your own comment.

### 6.10.2.1 List of Input elements



#### The „Confirm button“

Table 15:

Switch type	Description	Comment
1 (1 N.C.)	1 opening contact	Activation switch (standard)
2 (1 N.O.)	1 closing contact	Activation switch (standard)
3 (1 N.O.; 1 N.C.)	1 closing contact, 1 opening contact	
4 (2 N.O.)	2 closing contacts	
5 (2 N.C.)	2 opening contacts	Activation switch with larger number of requests
6 (2 N.C. time monitored)	2 opening contacts (time monitored)	Activation switch (monitored)



#### Emergency stop

Table 16:

Switch type	Description	Comment
1 (1 N.C.)	1 opening contact	Emergency stop (standard)
3 (2 N.C.)	2 opening contacts	Emergency stop with higher requirements
4 (2 N.C. time monitored)	2 opening contacts (time monitored)	Emergency stop (monitored)



#### Door control

Table 17:


Switch type	Description	Comment
3 (2 N.C.)	2 opening contacts	Door monitoring with higher requirements
4 (2 N.C. time monitored)	2 opening contacts (time monitored)	Door monitoring (monitored)
5 (1 N.O. 1 N.C.)	1 closing contact + 1 opening contact	Door monitoring with higher requirements
6 (1 N.O. 1 N.C. time monitored)	1 closing contact + 1 opening contact time monitored	Door monitor (monitored)
7 (2 N.O. 2 N.C.)	2 closing contacts + 2 opening contacts	Door monitoring with higher requirements
8 (2 N.O. 2 N.C. time monitored)	2 closing contacts + 2 opening contacts time monitored	Door monitor (monitored)
9 (3 N.C.)	3 opening contacts	Door monitoring with higher requirements
10 (3 N.C. time monitored)	3 opening contacts (time monitored)	Door monitoring (monitored)



## Two-hand-control

Table 18:

Switch type	Description	Comment
11 (2 toggles)	2 closing contacts + 2 opening contacts	Two hand switch with higher requirements; type III C
12 (2 N.O.)	2 closing contacts	Two hand switch (monitored)); type III A

 These input elements cause a fixed impulse assignment which the user cannot influence. No fault evaluation! No time monitoring when changing to the inactive state!



## Limit switch

Table 19:

Switch type	Description	Comment
1 (1 N.C.)	1 opening contact	Activation switch (standard)rd
2 (1 N.O)	1 closing contact	
3 (2 N.C.)	2 opening contacts	Activation switch with higher requirements
4 (2 N.C. time monitored)	2 opening contacts time monitored	Activation switch (monitored)



## Master switch

Switch type is not supported with this device type



## Light curtain

Table 20:


Switch type	Description	Comment
3 (2 N.C.)	2 opening contacts	Light barrier with higher requirements
4 (2 N.C. time monitored)	2 opening contacts time monitored	Light barrier (monitored)
5 (1 N.O. 1 N.C.)	1 closing contact + 1 opening contact	Light barrier with higher requirements
6 (1 N.O. 1 N.C. time monitored)	1 closing contact + 1 opening contact time monitored	Light barrier (monitored)



## Mode switch

Table 21:

Switch type	Description	Comment
13 (N.C. N.O.)	Selection with opening contact / closing contact	Selection switch (monitored)
14 (3 Phases)	Selection switch 3 steps	Selection switch (monitored)
15 (4 Phases)	Selection switch 4 steps	Selection switch (monitored)

 If the status of the switch is changed, the ctrlX SAFETY Engineering program warrants that the outputs of the module are disabled. (Attention: standard 60204-Part1-Section 9.2.3).



## Sensor Input element

Table 22:

Switch type	Description	Comment
1 (1 N.C.)	1 opening contact	Sensor input (standard)
2 (1 N.O.)	1 closing contact	Sensor input (standard)
3 (2 N.C.)	2 opening contacts	Sensor input with higher requirements
4 (2 N.C. time monitored)	2 opening contacts time monitored	Sensor input monitored
5 (1 N.O. 1 N.C.)	1 closing contact + 1 opening contact time monitored	Sensor input monitored



## Start /Reset element

This input element offers an extended monitoring function and the possibility to reset an alarm that has occurred.

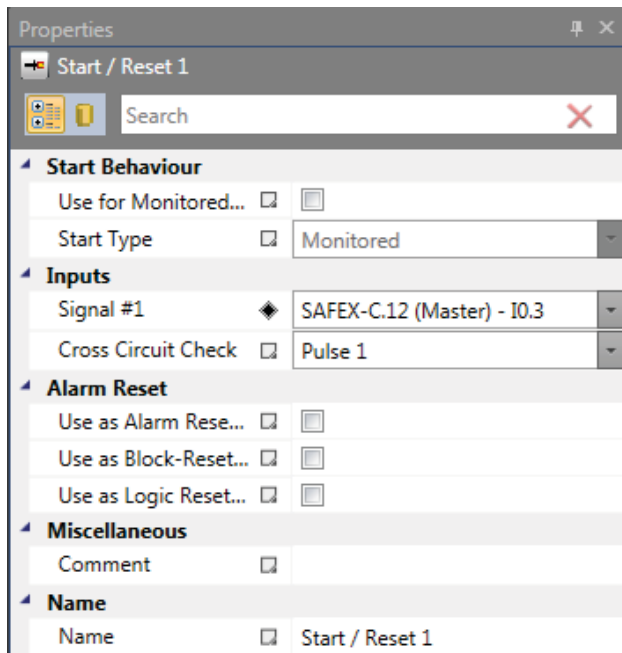


Fig. 163 Properties of the start/reset element

### Use of monitored start

With the start monitoring being enabled, automatically a special IL [AWL] code segment for the monitoring of an assigned input segment during a restart or during the reset of an alarm of the equipment to be monitored/ the alarm to be monitored is created.

This function relevant test of a peripheral element (e. g. triggering of an emergency stop) shall ensure the function during the start of the equipment.

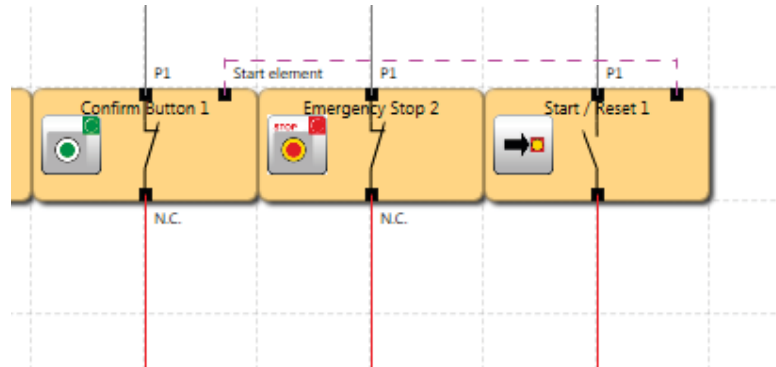
**Table 23:**

Start type	Function	IL [AWL]	Plan
Auto[matic]	<p>Automatic start after the reset of the equipment or after the input has been enabled.</p> <p>The output of the input element changes to "1" when the safety circuit is closed / active according to the definition of the switch type.</p>		<p>Start type automatic</p>
Monitored	<p>Monitored start after the reset of the equipment. This output of the input element changes to "1" when the safety circuit is closed / active according to the definition of this switch type, and the start button has been pressed once.</p> <p>The output changes to "0" after the safety circuit is open</p> <p>E1: switch function E2: start button M.(X1): auxiliary flag 1</p>	<p>LD I0.1 AND I0.2 S M.(X1) LD NOT I0.1 R M.(X1) LD M.(X1) AND I0.1 ST I0.x</p>	<p>Start type monitored</p>

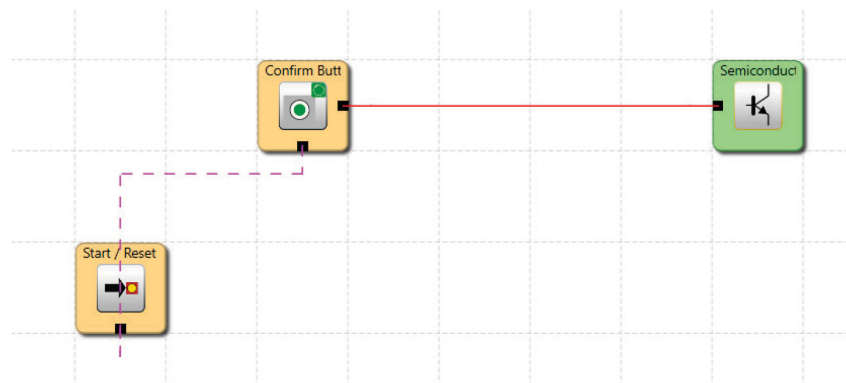
<p>Manual</p>	<p>Manual start after equipment reset with monitoring of start circuit for static 1 signal.</p> <p>The output of the input element changes to “1” if the safety circuit is closed according to the switch type, and the start button has been pressed and released once. The output changes to “0”, after the safety circuit is open.</p> <p>E1: switch function E2: start button M.(X1): auxiliary flag 1 M.(X2): auxiliary flag 2</p>	<pre> LD I0.1 AND I0.2 S M.(X1) LD NOT E.1 R M.(X1) LD M.(X1) AND I0.1 AND NOT I0.2 S M.(X2) LD NOT I0.1 R M.(X2) LD M.(X2) AND I0.1 ST I0.X                     </pre>	<p>Startart Manuell</p> <p>The diagram shows three digital signals over time. The top signal, 'eSwitch function', is high during the first pulse of the 'Start button' and low during the second pulse. The middle signal, 'Start button', has two pulses. The bottom signal, 'Output', is high during the first pulse and low during the second pulse. Vertical dashed lines indicate the timing of the pulses.</p>
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### Listing of the start-up types via “confirm button”

The input of the start element to be monitored must be connected with the output of the input element by the description “Start element”. Various elements can be monitored.



**Fig. 164 Example: Start/Reset-block (element) connected with confirm button(start monitored) in wiring scheme < Version 1.7.1.8154**



**Fig. 165 Example: Start/Reset-block (element) connected with confirm button (start monitored), in functional scheme >= Version 1.7.1.8154**


☞ When the corresponding input element is edited, in this case the confirm button, the connection to the start element is deleted, and cannot be restored any more. After the connection has been deleted, it must be manually completed.

- **Input: signal no. 1**

Like with the input elements, this selection list is used to determine the input in the ctrlX SAFETY device, with which the button for the start element shall be connected. Internally, this input is restricted to the assignment to a basic module (Ix0.0 bis Ix0.xx).

- **Use as „Alarm-Reset (normally open contact)“**

If this option is set, the corresponding button can be used to reset (to quit) a device alarm that can occur during operation. Thus, the user is not forced to reset an occurring error with the function button (SF40) on the ctrlX SAFETY device. No special programming code is created, but this input is directly processed by the ctrlX SAFETY device in case of an alarm. Only one alarm reset can be used.


 If a reset element is used, no monitoring of the cross connection can be processed for this input. In this case, the test of the cross connection is set to "AUS" ["OFF"].

<h2 style="margin: 0;">NOTE</h2>
<p><b>Error message</b></p> <ul style="list-style-type: none"> <li>▶ In case of error messages of the type "Fatal Error ", the ctrlX SAFETY Device must be restarted.</li> </ul>

The input of the alarm reset can be operated with 24 V continuous voltage and is triggered by the edge.

- **Use as Block Reset (normal contact)**

Up to 6 Block Reset elements can be inserted. The Block Reset elements are used to reset the monitoring functions (e. g. SLS, SOS, etc.)..

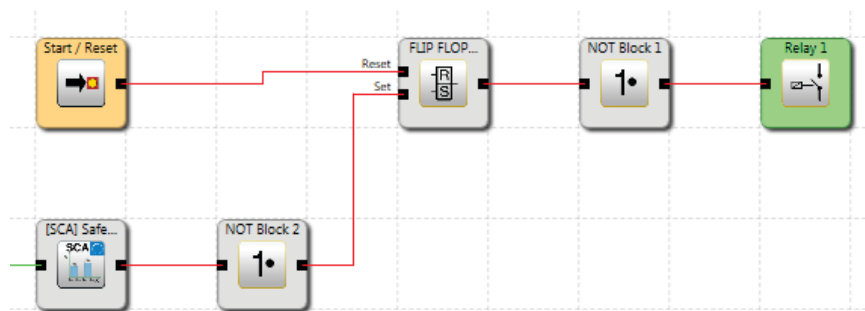
 The resetting capability of monitoring functions see Overview safety modules

- **Use as logic reset (normally open contact)**

With this option, the rest function / the confirmation is available in the functional scheme for further processing. In this case, the output of the function block is created automatically, and can be used to be processed with a logic function. With this option the reset function / the confirmation function in the functional scheme is available for further processing. In this case, the output of the function block is created automatically and can be used for the connection with a logic function. Normally, this logic reset signal is used to confirm FlipFlops.

This is intended for the case that an occurring SCA error is permanently present at the FlipFlop and can only be reset by pressing the RESET button.

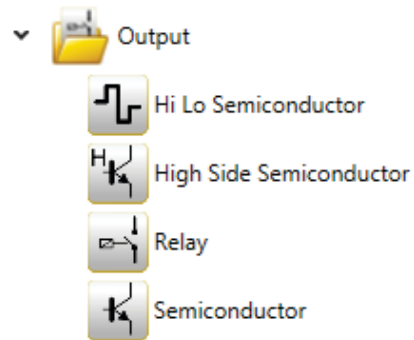
**Table 24:**



**Fig. 166 Start / Reset to save and reset errors of the SCA module via RS-FlipFlop**

Switch type	Comment	Classification category	classification SIL
1 closing contact	Alarm reset Standard (evaluation of the edge)	--	--
1 closing contact	Logic reset Standard	category 3	SIL 2
1 closing contact	Start monitoring Standard (optional function)	--	--

### 6.10.3 Output blocks



**Fig. 167** List of output blocks

The output blocks create the digital connection between one or several external switching circuits in the ctrlX SAFETY system. Every block is triggered by a logic input signal “0” or “1” via the functional scheme.

### 6.10.3.1 Configuration Output type

The output type can be configured in the device property.

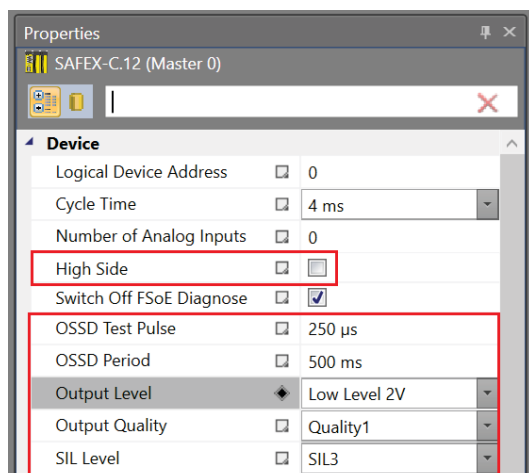


Fig. 168 Output type

- High side**  
 If activated, the HiLo semiconductor outputs are switched from P-N to only P-switching outputs at the device.  
 If this field is not activated, only HiLo semiconductor outputs can be used.. (see chapter 6.10.3.2)
- OSSD Test Pulse**  
 Test pulse width when using the semiconductor outputs configured as OSSD outputs.
- OSSD Period**  
 Test pulse repetition period of the semiconductor outputs configured as OSSD output.
- Output Level**  
 Configuration Switch-off threshold for "LOW" level of the digital outputs.  
 Supported levels are 2V and 5V.
- Output Quality**  
 Configuration Filter for static output testing.  
 Quality 1-> Default "no filter"  
 Quality 2 ...5-> Filter 2...5 x cycle time device

## ⚠ CAUTION

### Response time extension

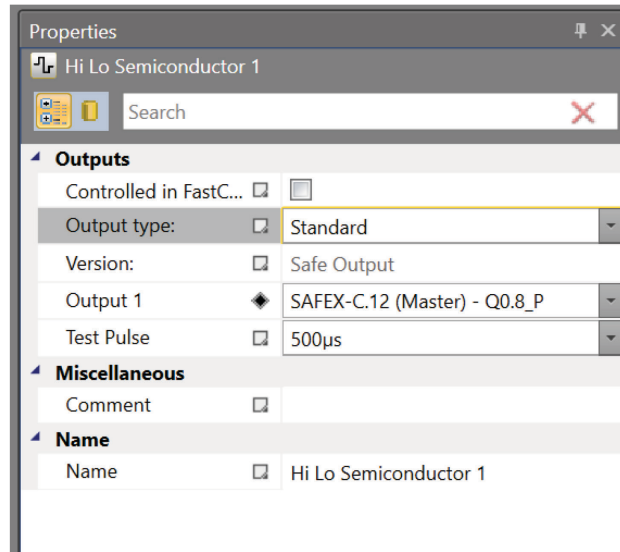
- ▶ When using quality 2...5 the reaction time of the device is extended (see Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>)

- SIL Level**  
 SIL 3: All digital outputs are designed as safety outputs.  
 SIL2: All digital outputs can only be used as auxiliary outputs.  
 The semiconductor outputs can be configured as OSSD outputs for SIL 2.

### 6.10.3.2 List of output elements



#### HiLo semiconductor



#### Controlled in FastChannel

When activated, output can only be used in FastChannel.

#### Output type

*Standard* : „HISIDE“ (= P-circuit) or “LOSIDE“ (= N-connection) can be selected as standard outputs. The use of simple standard outputs is not suitable for safety outputs.

*Redundant*: This option obliges a combination “HISIDE” outputs and “LOSIDE” outputs as auxiliary output or safety output.

#### Output as safety output

HiLo semiconductor outputs can be used grouped as safety outputs (for details, see document Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P2).

#### Test pulse

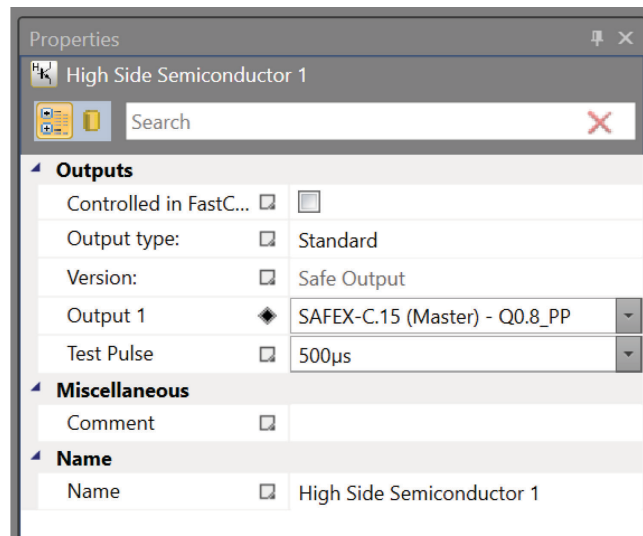
Configurable test pulse 500µs /750µs for dynamic switch-off test with SIL configuration of the digital outputs. Default setting is 500µs.

## NOTE

- ▶ With configuration 500µs a shutdown pulse < 600µs is achieved.
- ▶ With configuration 750µs a shutdown pulse < 850µs is achieved.



## High Side Semiconductor



### Controlled in FastChannel

When activated, output can only be used in FastChannel.

### Test pulse

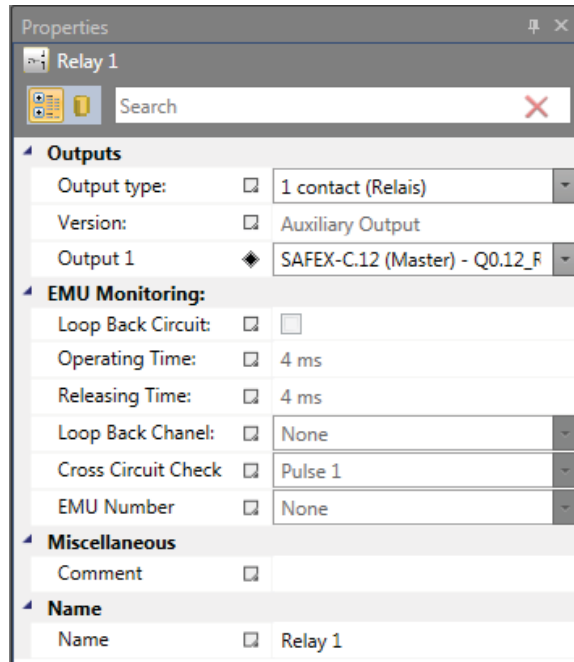
Configurable test pulse 500µs / 750µs for dynamic switch-off test with SIL configuration of the digital outputs. Default setting is 500µs.

## **NOTE**

- ▶ With configuration 500µs a shutdown pulse < 600µs is achieved.
- ▶ With configuration 750µs a shutdown pulse < 850µs is achieved.



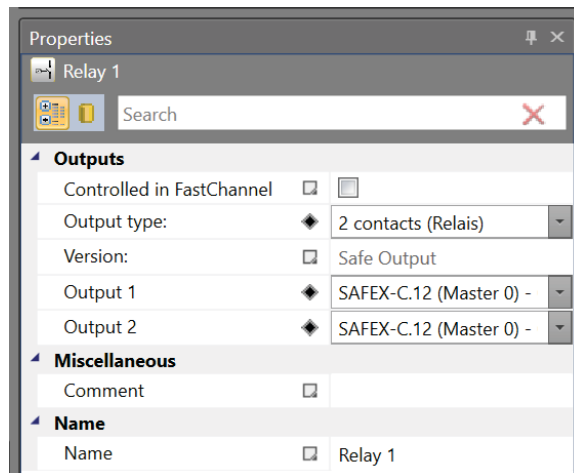
## Relay




### Output type

*Standard:* 2 simple relays (K1 to K2) can be evaluated independently.

*Redundant:* Two relay outputs are combined, and are always interconnected.

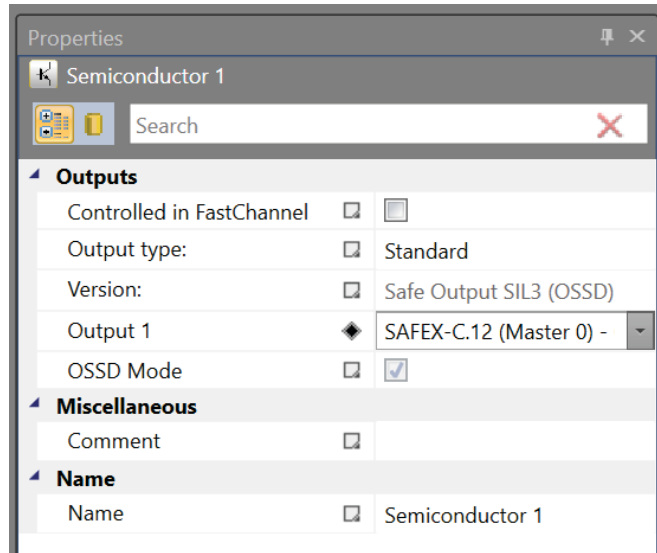


 Observe the explanations in Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>, if you use a relay in safety applications.



## Semiconductor

This semiconductor output can be used as OSSD output when using SIL2.



Certain semiconductor outputs can only be used as auxiliary outputs. Thus, they are not suitable for safety applications. (For details, see the Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>)

### Controlled in FastChannel

When activated, output can only be used in FastChannel.

### Test pulse

Configurable test pulse 500µs /750µs for dynamic switch-off test with SIL configuration of the digital outputs. Default setting is 500µs.

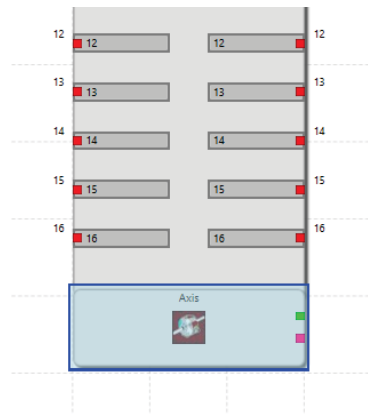
## NOTE

- ▶ With configuration 500µs a shutdown pulse < 600µs is achieved.
- ▶ With configuration 750µs a shutdown pulse < 850µs is achieved.

Certain semiconductor outputs can only be used as auxiliary outputs and are therefore not suitable for safety applications (see Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>) Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2</sup>) for details)

### 6.10.3.3 Setting the encoder's range

The setting of the two encoders for the detection of position and velocity can be set in "[Properties]" by clicking on the correspondent dependent encoder range in the functional scheme or in the configuration



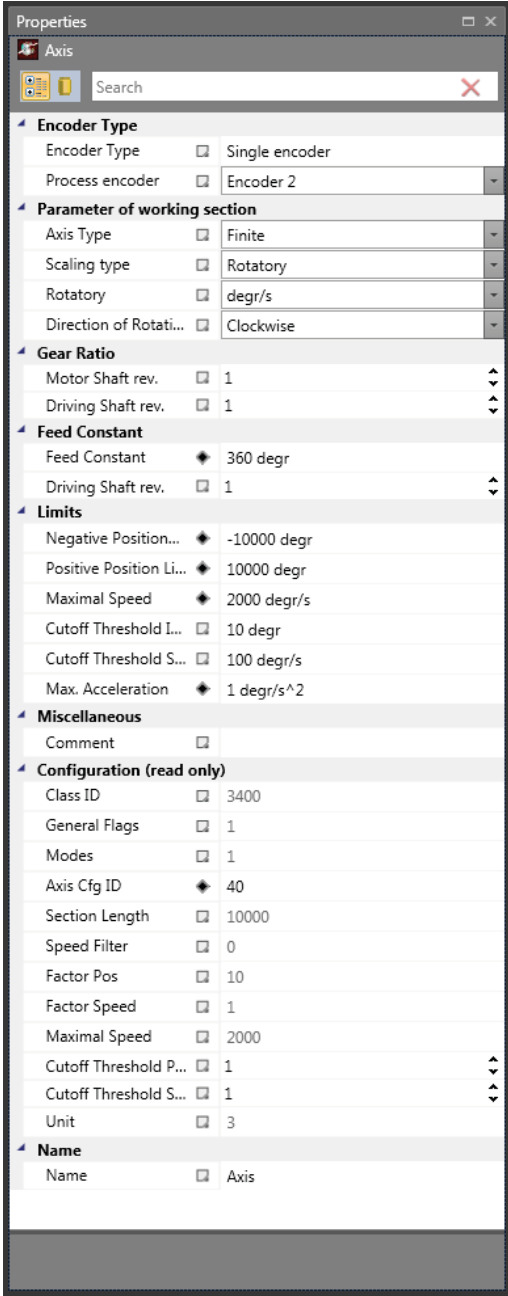
#### View of the encoder in the slave profile

Configuration only concerns the control software of the encoder. For correct functioning, an advanced hardware setting of the encoder interface. For details concerning this subject, c. f. the Installation manual of the ctrlX SAFETY device.

### 6.10.3.4 Setting the axle

To use the encoder for monitoring functions, the axis must be configured. The settings depend on the used profile of the axis slave:

Table 25: Parameters of axis properties



Parameter	Description	Value
Encoder type	Display encoder type	No input possible
Process encoder	Not supported.	Info only.
Axle type	Axle range	Finite modules
Scaling type	Linear or rotatory setting	Linear
Rotatory	Unit	Rotatory
Direction of Rotation	Direction of rotation	Clockwise Counter Clockwise
Motor Shaft rev.	Transmission ratio drive meter	
Driving Shaft rev.	Transmission ratio gear denominator	
Feed constant	Ratio distance / encoder revolution - meter	
Driving Shaft rev.	Ration distance / encoder revolution denominator	
Negative Position Limit	Minimum measuring length	
Positive Positions Limit	Maximum measuring length	
Maximum speed	Max. speed range	
Switch off threshold Position	Not used because of Safety Encoder	
Switch off threshold speed t	Not used because of Safety Encoder	
Max. acceleration	Max. acceleration application	

## 6.10.4 Function blocks

### 6.10.4.1 Logical functions (Logic)

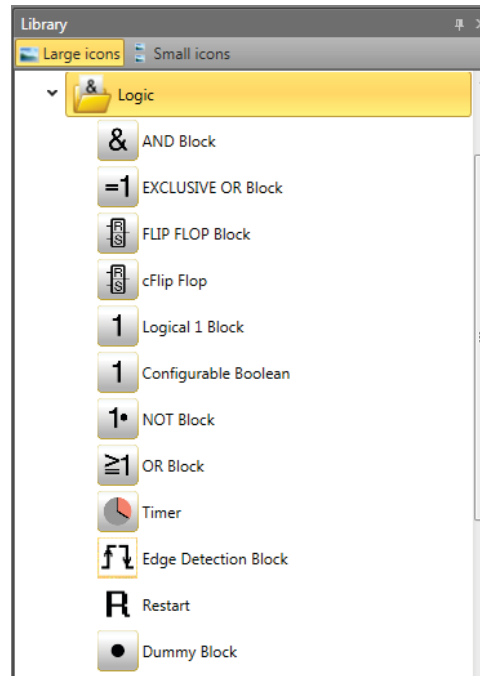


Fig. 169 Listening of function blocks in the library window

These blocks are the basis for the creation of a program for the safety application. They allow the logic connection of the inputs with monitoring functions with the outputs. The insert of function blocks is only possible in the “functional scheme” view. Otherwise, the corresponding menu options are deactivated. The menu options are deactivated if the resources for a device are already exhausted, e. g., after all timer modules have been inserted.

### 6.10.4.2 Listing of the logical function blocks



#### AND block

“AND” links of not more than 5 output signals of other function blocks. The AND-link provides the signal state “1” for all input signals “1” as logic result. Otherwise, it is “0”.

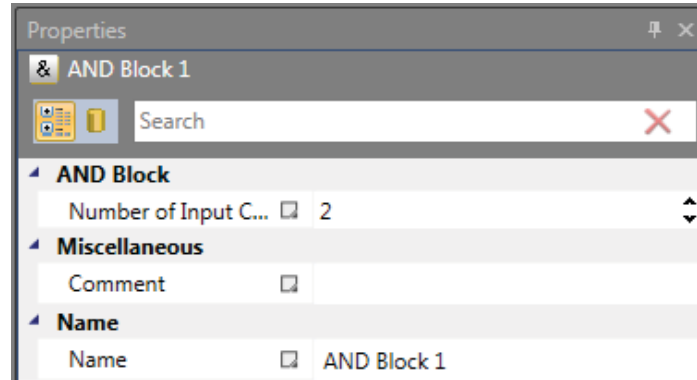


Fig. 170 properties window of “AND” block



The number of input connections can only be reduced in case of free connections. If all connectors are connected, these connections must be deleted before.



#### EXCLUSIVE OR block

„EXCLUSIVE OR“ connections of 2 output signals from other function blocks. The “EXCLUSIVE OR” module provides the logical result “1” if the input has the input signal “1”, and if the input has the input signal “0”. Otherwise, it is “0”.

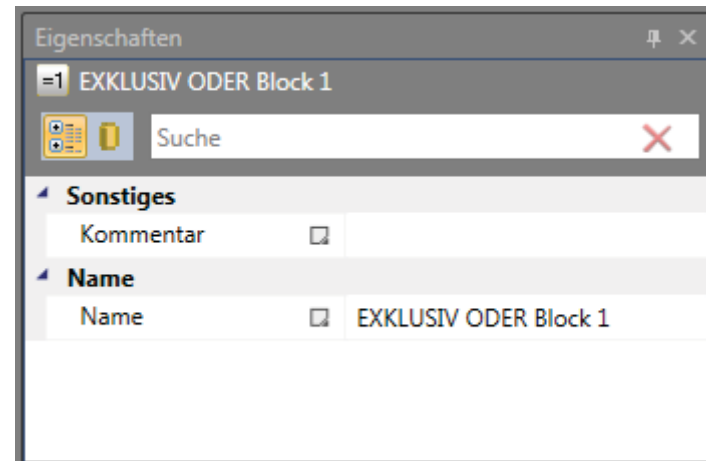


Fig. 171 Properties of “EXCLUSIVE OR” block



### FLIP FLOP block

Setting / reset of a contact element. The switch element has the following properties:

The logical result during the initialization of element is “0”.

The logical result changes to “1” if an edge change from “0” to “1” occurs in the “Setting” input. The output stays “1”, even if the state in the “Setting” switches to “0” again.

The logical result turns to "0" when a rising edge change from "0" to "1" occurs in the "Reset" input.

If both inputs are set to “1”, the result is “0”!

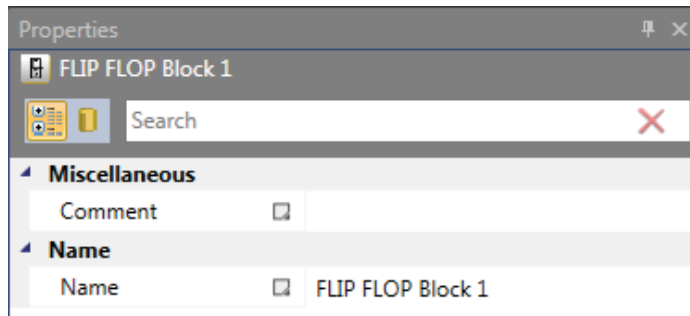


Fig. 172 Properties of “FLIP FLOP” block



The desired switching state in this element is achieved only according to the name (reset / setting).



### cFLIP FLOP block

Set / reset switching element. This switching element saves the state in a tension proof way. After a POR, the state saved last is restored.

Functioning like Flip Flop. If both inputs are set to “1”, the result is “0”!

“Save permanent” not active.

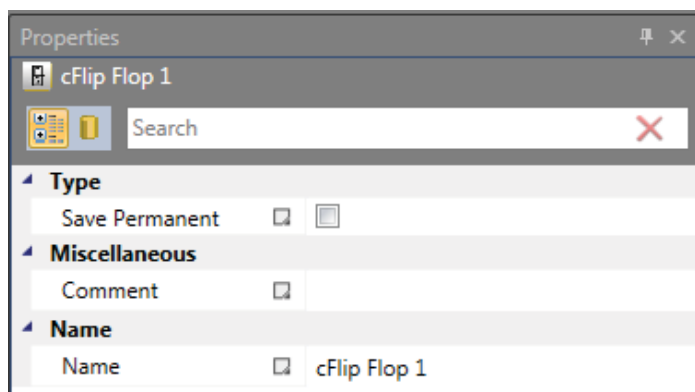


Fig. 173 Properties of “cFLIP FLOP” block



After configuration data have been loaded on the safety block, the result is reset.



Max. 64 cFlipFlops can be used.

1

### Logical 1 block

This module always provides the value "1". This function can be used for programming static states in the functional scheme.

Example: assignment of an input that is not used to a direction-dependent SDI

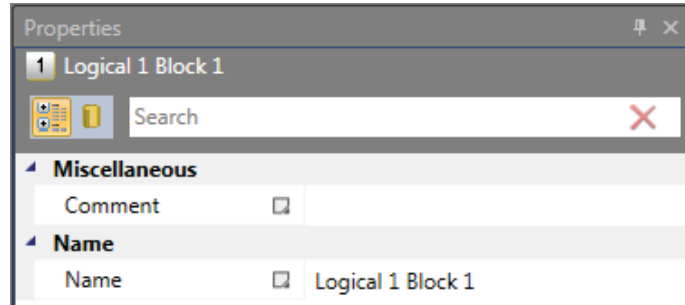


Fig. 174 Properties of "logical 1" block

1

### Configurable Boolean

This module always provides the parameterized Boolean value "TRUE / FALSE". This function can be used for programming static states in the functional scheme.

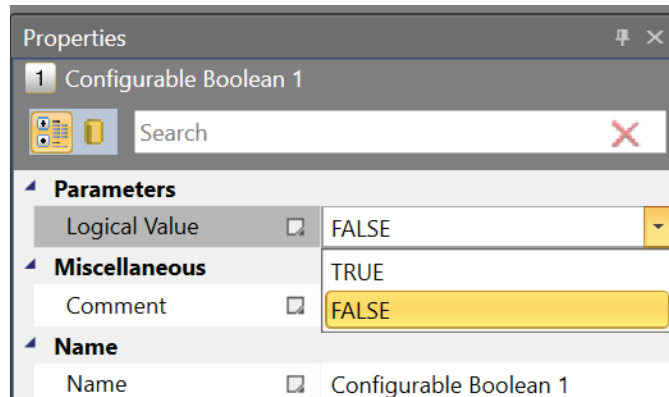


Fig. 175 Properties of "Configurable Boolean" block

Max. 64 modules can be used.

1.

### NOT Block

The logical result of this function block is the negation of the input signal. Here, the term "negation" signifies that the logical result is reversed (negated).

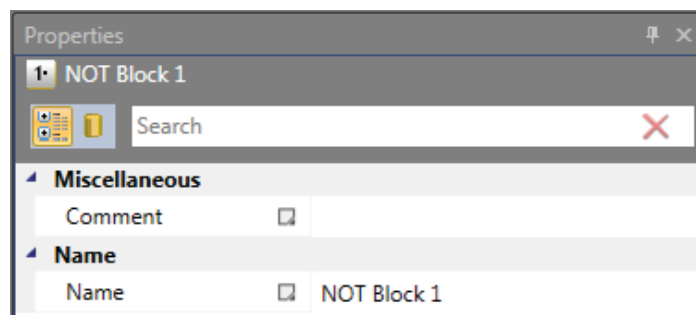


Fig. 176 Properties of "NOT" block



## OR block

“OR” connections of not more than 5 output signals from other function blocks. The OR connection provides the signal state “1” for at least one input with the signal state “1”. Otherwise, the signal state is “0”.

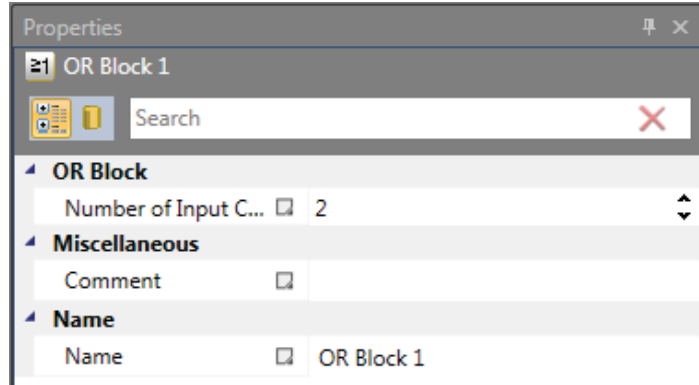


Fig. 177 Properties of "OR" block



## Timer

Function block that starts a meter in case of an edge change. After the fixed time lag, the result is “1” or “0”.

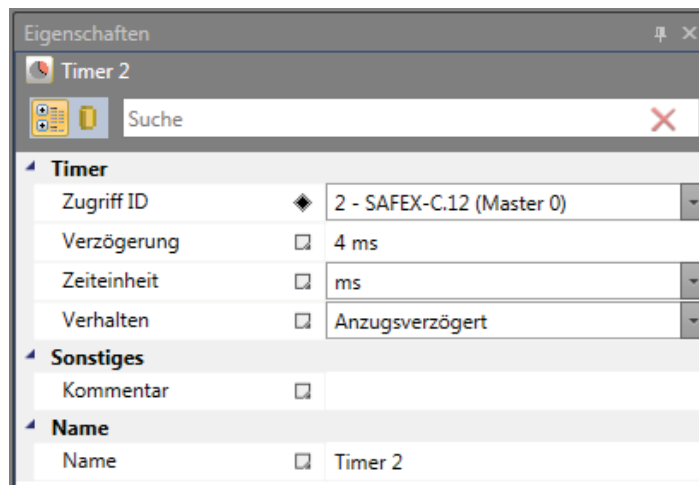


Fig. 178 properties of “Timers”

Block-ID: Timer number. The timer number can be set when the timer is plugged in. If all timers are used, the timer command in the menu is disabled.

Delay: desired period, during which the timer shall run.

T min = 16 ms

T max = 2592.000.000 ms

43.200 min

720 h



The programmable values equal an integral multiple of the cycle time!



Max. 64 timer blocks can be used.



The set timer values depend on the configured cycle time of the device. When switching the cycle time, the values must be checked accordingly.

Behavior

**Table 26: Timer behavior**

Function	Activation of Timers	Time diagram
Fall-delayed	Falling edge	
Delayed closing	Rising edge	
Impulse	Rising edge	
Fall-delayed	Falling edge	
Save permanent	According to function	<p>Voltage proof saving of timer value. After unit POR, the timer value saved last is loaded again. After loading of configuration data on the PLC unit, the saved timer value reset again ("0").</p>

Note:  $\Delta t$  = PLC Timer value



## Edge detection

Block for edge detection rising, falling or both.

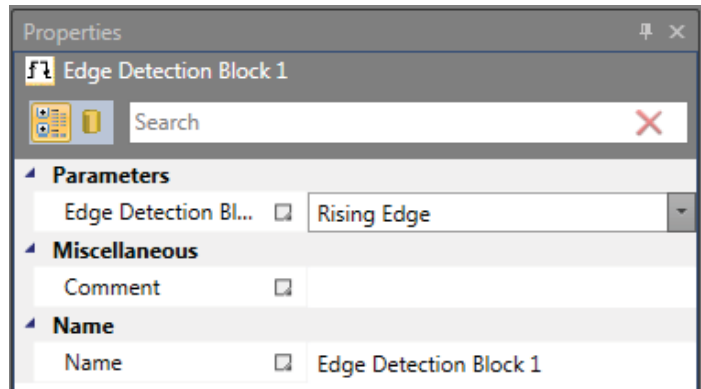


Fig. 179 Properties of „Edge detection“ block

### Edge detection parameter:

Positive:

Evaluation of rising edge. Signal at block output changes to “high”, if rising edge is detected at block input.

Output signal remains set for one cycle.

Negative:

Evaluation of falling edge. Signal at block output changes to “high”, if falling edge is detected at block input.

Output signal remains set for one cycle.

Positive and negative:

Evaluation of rising / falling edge. Signal at block output switches to “high” if rising / falling edge is detected at the block input.

Output signal remains set for one cycle.

# R

## Restart-Block

Block for confirmation signal for stopping and for the following request to restart the application.

The basic requests for the block are:

- Commissioning of the device (cold start after the Power Cycle)
- Restart of the device (warm start after program download, soft reset etc.)

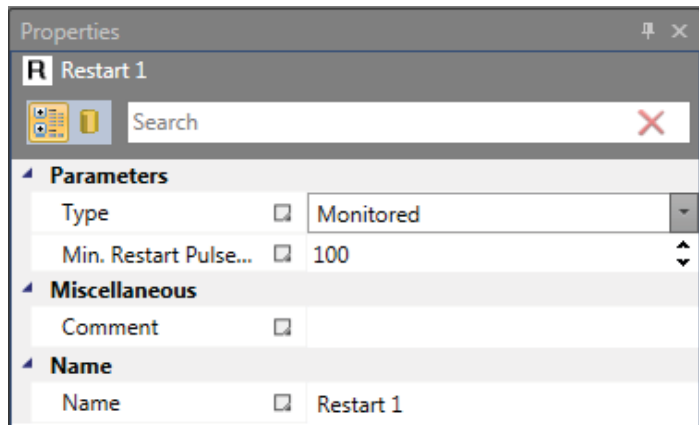


Fig. 180 Properties of "Restart"-Block

### Type of reset start "Monitored": ":

"Release" condition reacts to the falling Edge Restart signal.

The falling edge must occur > "Min. Restart Pulse" and < 15s after activation.

### Type of restart "Manually ":

"Release" condition reacts to the rising Edge Restart signal.

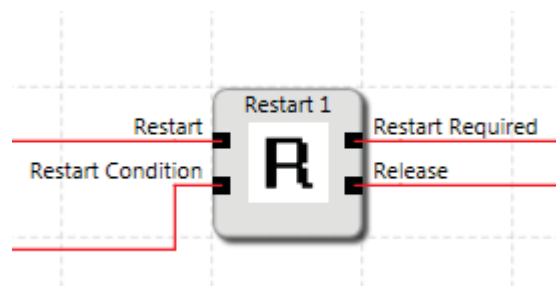


Fig. 181 view of "Restart" block in functional scheme

### Restart:

Evaluation of Restart signal after selection of type.

### Restart condition:

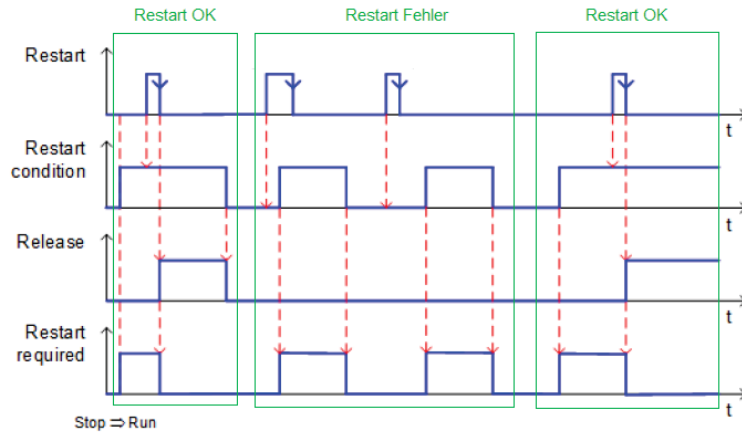
Restart condition. As condition, a "high" signal is expected.

**Restart required:**

The message “Restart required” that the function block expects a valid restart impulse at the “Restart” input that the “Release” output can switch to “high”.  
As a rule, this output is used to control a signal lamp.

**Release:**

The output switches to “high”, if the following conditions are fulfilled:



**Dummy-Block**

This block has no effect on the functionality of the device and the running program and should normally only be used temporarily for troubleshooting..

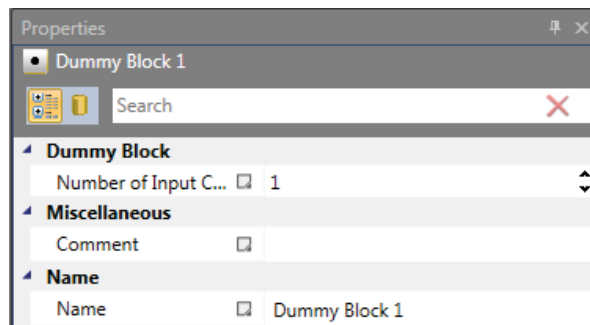
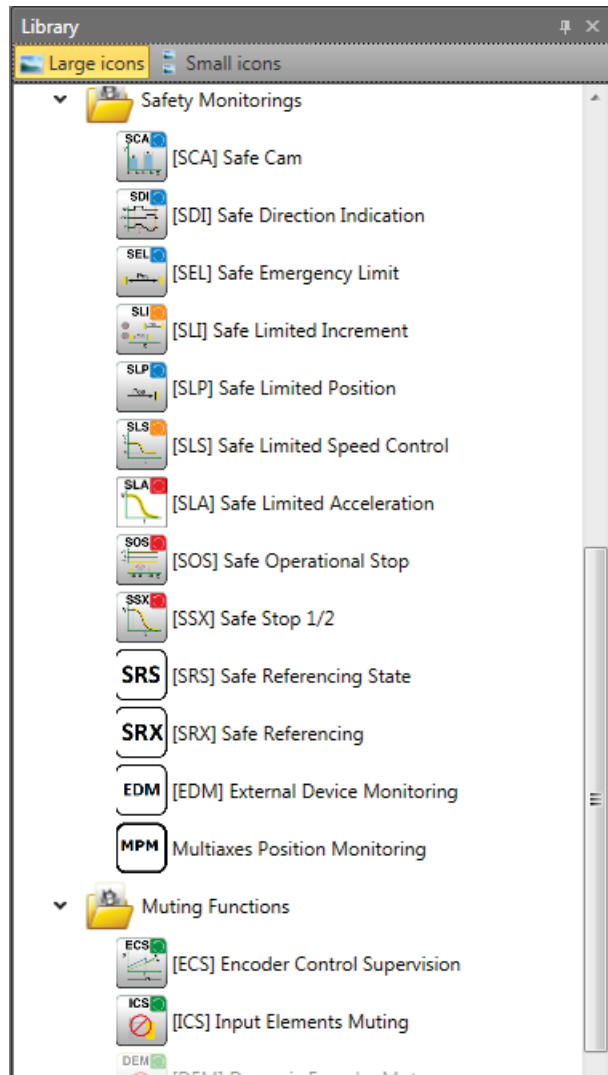


Fig. 182 Properties of "Dummy"-Block

### 6.10.5 Safety functions



**Fig. 183 List of Safety functions in the library**

The safety functions are an important function of the ctrlX SAFETY system. Preset functions are available for:

- Speed monitoring
- Position detection
- Monitoring of limits and target positions
- Functional emergency monitoring
- Standstill monitoring
- Direction monitoring
- Function monitoring of external shut off devices
- Reset functions
- Muting

The function for monitoring position, speed and shut-off is enabled only after the successful configuration of an encoder. After the encoder has been successfully configured, the respective functions can be inserted, if the ctrlX SAFETY-device has resources available for this purpose. After all resources have been used, the menu option for the corresponding function block is deactivated

### 6.10.5.1 Overview safety modules

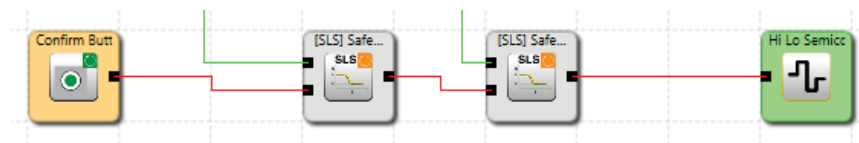
Table 27:

Module	Amount	Use	Single axis	Cascading	Reset
FDB	8	RUN, RUN intern	No	No	No
EDM	16	RUN, RUN intern	No	No	Yes
SBR	2	--	--	--	--
SRS	12	RUN, RUN intern	Yes	No	No
SRX	48	RUN	Yes	No	No
SEL	16	RUN	Yes	Yes	Yes
SLP	12	RUN	Yes	No	Yes
SCA	48	RUN	Yes	Yes	No
SSX	18	RUN	Yes	No	Yes
SLI	12	RUN	Yes	No	Yes
SDI	12	RUN	Yes	No	Yes
SLS	48	RUN	Yes	Yes	Yes
SOS	16	RUN	Yes	Yes	Yes
ECS	12	RUN only on Sensorbox SSB	Yes	No	Yes
MPM	2	RUN	Yes	No	Yes

If the shut-off shall be displayed externally by a monitoring function, e. g. a control unit, an auxiliary output can be used for this purpose. If “1” has been signaled to the outputs, while the monitoring functions are in the “OK” status, the result must be negated for feedback according to the following example.

### 6.10.5.2 Cascading

In case of safety modules with cascading, subsequently, another safety module can be triggered, without losing a system cycle.



With safety modules without cascading, 1 cycle must be added for response time.



### 6.10.5.3 FDB (FSoE Disconnect-Block)

Safe disconnection of an FSoE connection

**Number:** cf. chapter 6.10.5.1 „Overview safety modules“

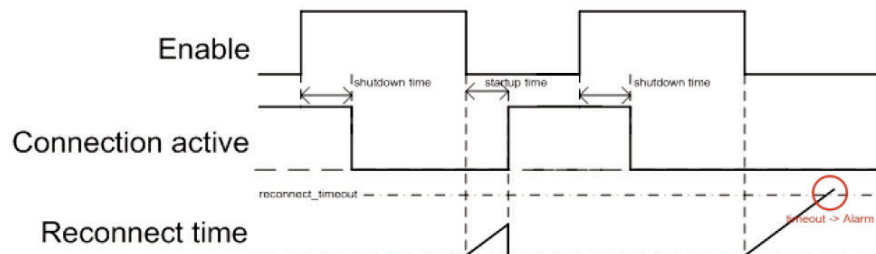
**Function:** “Disconnect Block“ is used to temporarily disable the FSoE connection- The detection, which device must be disabled, is set via the FSoE address. By the function, an error status in the Master in case of defined shut off / defined disconnection of a Slave device is avoided.

**Input:** FSoE connection active / inactive

**RESET function:** no reset necessary

**Description of function:**

- At the activation of Disconnect Block, the FSoE connection of the participant must be disabled, and the process data are disabled (“0”).
- At the deactivation of the Disconnect Block, the Master block tries to restore the FSoE connection to the Slave. If the connection has been successfully established, the FSoE Slave continues to work normally, and the input information / the output information work with a cyclical update of the input data / the output data. If the FSoE connection is not established within a determined, configurable time, an alarm is triggered.



When using SSB, automatically both FSoE connections are disconnected.

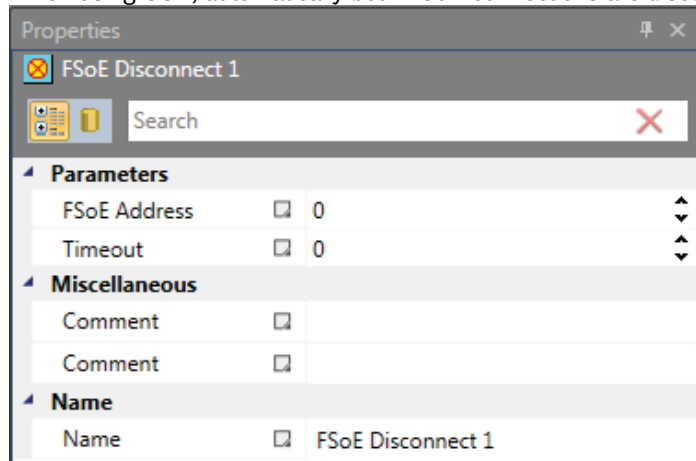


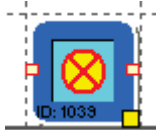
Fig. 184 Properties of "FSoE Disconnect" block

**FSoE address**

FSoE Slave address to shut down the FSoE connection of the Slave block on which the function shall act.

**Timeout**

Timeout in ms, until FSoE connection is actively expected after deactivation of the Disconnect block.



**Fig. 185 “FSoE Disconnect” function block in workspace (canvas)**

**Table 28:**

Signal	Description
Enable	0: FSoE connection is not interrupted 1: FSoE connection shall be shut down
Output	0: FSoE connection is inactive 1: FSoE connection is active



### 6.10.5.4 EDM (External Device Monitoring)

Monitoring of external switch contacts

Number: cf. chapter 6.10.5.1 „Overview safety modules“

Function: Normally, additional switch devices are necessary for contact multiplication and for power multiplication. These switching devices are triggered via the outputs of the safety control. The EDM monitoring device implements the “Safety relay” function by processing an external feedback circle. For applications according to category 4 of EN ISO 13849-1, for these switch devices, among others, functional monitoring is required. For functional monitoring, the switching devices must be equipped with positively driven auxiliary contacts.

Input: Activation signal external switch contact

RESET function: Up to 6 resets are configurable

Description of function:

- Test of external Feedback signal for state of external switch contact.
- State of Feedback signal must change within response time / release time.
- A faulty error signal or a status change larger than the response time / the release time is signaled at the “Error” output as “high”.

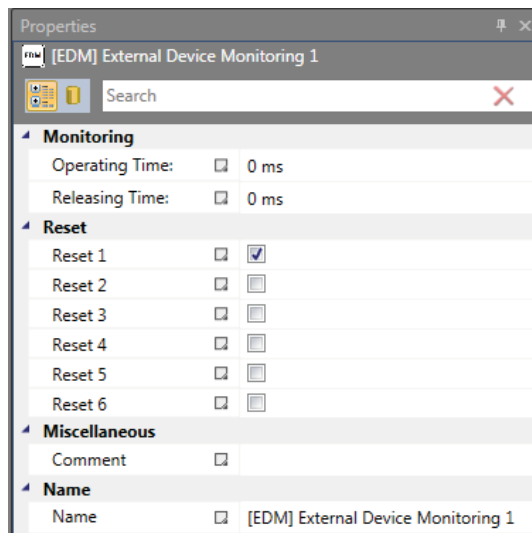


Fig. 186 Properties of EDM function

#### Response time

Variable time window (turn-on delay) for the test of the external switch contact

$$\text{Min}\{T_{\text{EDM}}\} = 4 \text{ msec}$$

$$\text{Max}\{T_{\text{EDM}}\} = 750 \text{ msec}$$

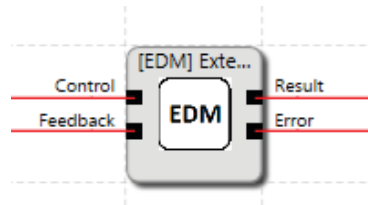
#### Release time

Variable time window (turn off delay) for test of the switch contact

Min{T<sub>EDM</sub>} = 4 msec  
 Max{T<sub>EDM</sub>} = 750 msec

**Reset**

Selection of Block-Reset



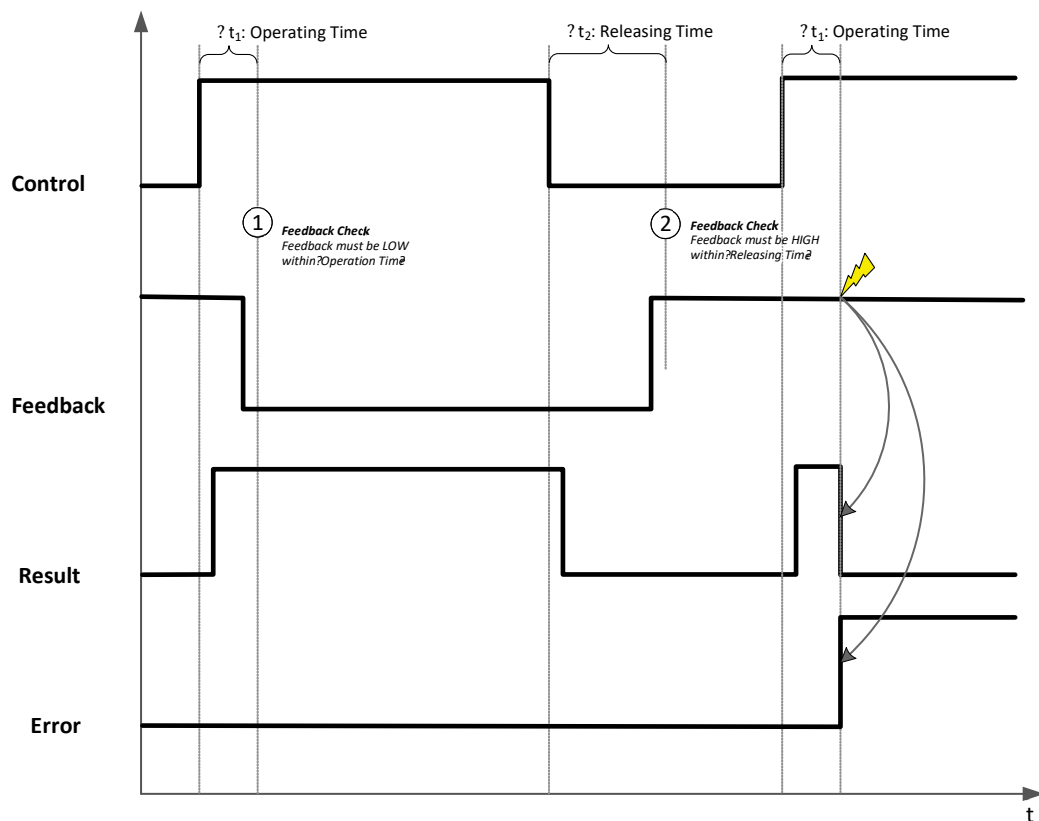
**Fig. 187 EDM function block**

**Table 29:**

Signal PLC Block	Description
Control	Activation signal for EDM monitoring
Feedback	Read back signal for external switch contact monitoring
Result	Activation signal at output 0: EDM output is inactive 1: EDM output is active
Error	Error diagnosis EDM 0: EDM is OK 1: EDM has diagnosed an error

**Table 30: Logic table**

Control	Feedback	Result	Error
0	0	0	1
0	1	0	0
1	0	1	0
1	1	0	1



## NOTE

- ▶ The EDM error is stored and can only be reset via Reset.
- ▶ If the feedback signal is "1", the function can only be reset. (inactive state)
- ▶ If an error is present, Result is always inactive, regardless of the status of the feedback signal.
- ▶ Adjacent feedback circuits of the safety monitoring block should have different signatures (Pulse1/Pulse2) in order to be able to detect a cross-circuit.



### 6.10.5.5 SEL (Safe Emergency Location)

Monitoring of the maximum movement range

- Number: cf. chapter 6.10.5.1 „Overview safety modules “
- Function: Monitoring of the permissible speed in relation to the relative distance to the maximum limit of the movement or to the maximum limit of the adjustment range. This function replaces the conventional emergency limit switch!
- Input: standardized position signal X from the encoder interface.
- RESET function: The violation of the permitted monitoring range is saved and requires a RESET acknowledgement. This is done alternatively via:
- RESET function in the “Input elements” group
  - Function button at the front part of a ctrlX SAFETY control
  - Input of F-Bus Reset

## **NOTE**

- Reset can only be carried out, if the current position is within the configured driving range .

Description of function:

- Calculation of the current velocity V from the position signal X
- Determination of the stop distance related to the current status of acceleration and velocity  
=> Cyclical determination of  $stop\_distance_{act.} = f(V, a)$  with a = acceleration
- Comparison:  $Pos_{act.} + stop\_distance_{act.} < target\_pos_{max}$
- Comparison:  $Pos_{act.} - stop\_distance_{act.} > target\_pos_{min}$

The calculation is based on a velocity profile that can be either trapezoidal or sigmoid. For a trapezoidal velocity profile, the limit curve results from parameterized acceleration, whereas for a sigmoid velocity profile additionally acceleration change is included in the calculation.

Trapezoidal velocity profile:

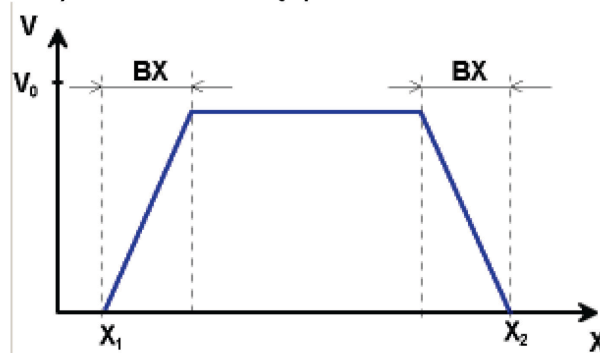


Fig. 188 Trapezoidal speed profile

$X_1$  = Min. position

$X_2$  = Max. position

$V_0$  = maximum speed for  $(X_1 + BX) < X < (X_2 - BX)$

F = type of the speed profile (trapezoidal or sigmoid)

**trapezoidal**

BX = brakes/proximity range

**sigmoidal**

AM = maximum acceleration

DA = type of acceleration

Sigmoid velocity profile

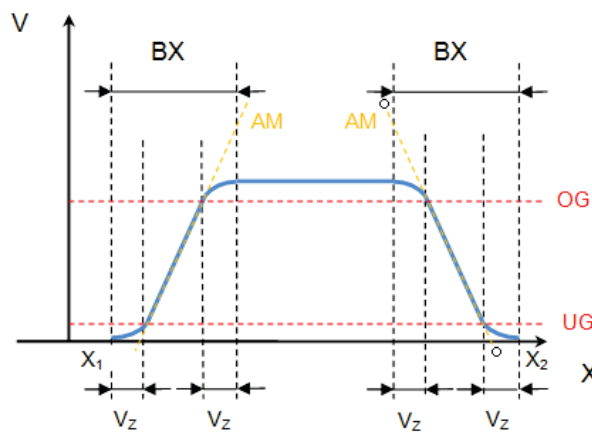


Fig. 189 Sigmoidal velocity profile

BX = brakes/proximity range

$X_1$  = Min. position

$X_2$  = Max. position

$V_z$  = scattering time S

AM = Max. acceleration

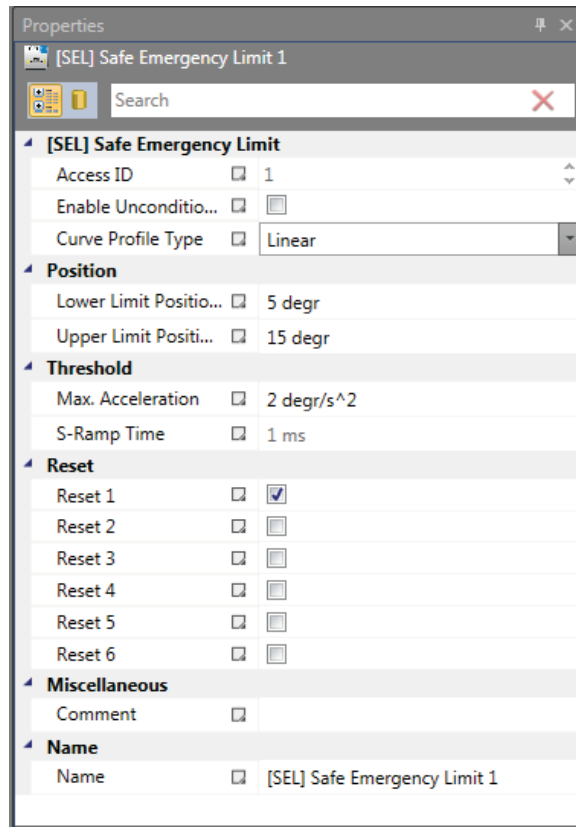
UG/OG = range of max. acceleration

Output function:

**Table 31:**

Range		HI	LO
X < X1	OR		X
X > X2			
X >= X1	AND		
X <= (X1 + BX)	AND	X	
V < limit curve			
X >= (X2 - BX)	AND		
X <= X2	AND	X	
V < limit curve			
X >= X1	AND		
X <= (X1 + BX)	AND		X
V >= limit curve			
X >= (X2 - BX)	AND		
X <= X2	AND		X
V >= limit curve			

Limit curve = velocity profile deduced from current parameterization



**Fig. 190 Properties of SEL monitoring**

Parameters:

**Permanently activate**

If this option is set, the monitoring function has no input connection. This function is active from the start of the device.

**Curve type**

- linear

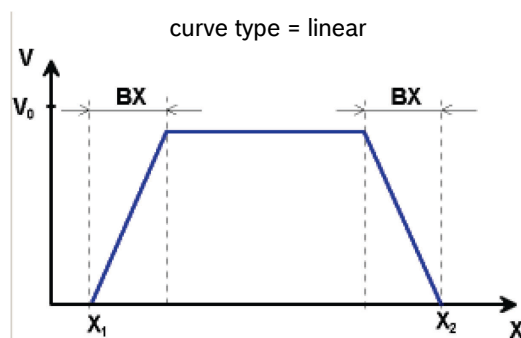


Fig. 191 Linear calculation method for the stop distance in relation to limit position

- sigmoidal

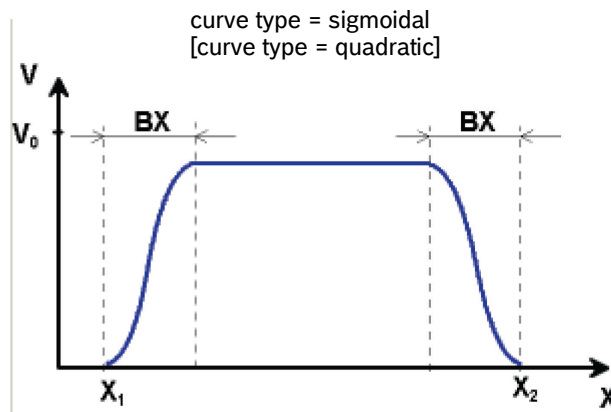


Fig. 192 Quadratic calculation method for the stop distance in relation to the limit position

**Lower limit position X1**

Lower limit position

**Upper limit position X2**

Upper limit position

**Max. acceleration**

Max. acceleration value within  $BX$

**Time of S ramp**

Edge time of acceleration => time from acceleration = 0 to max. acceleration

**Reset**

Select Reset.

Input example 1:

At a production machine, access to the work zone shall be guaranteed at certain positions of the main input axis for manual input or for settings. In this position, the drive remains active, and is only monitored for a standstill. The limits of the work zone are variable, and shall be monitored electronically in a safety-relevant mode instead of via mechanical safety limit switch. The movement that shall be actively monitored is a linear movement. An absolute encoder is connected with the main drive axis of the linear length measuring system. The drive functions with an electric motor with an integrated motor feedback system and an intermediate gear.

### 1. Limit position

The referential zero position of the main drive axle is situated in the top dead center.

The subordinate mechanical follow up is  $X1 = -5 \text{ mm}$ .

The lower limit position is at  $600 \text{ mm} + a \text{ 5 mm safety limit}$ .

=>  $X2 = 605 \text{ mm}$

### 2. Type of the speed selection

The drive regulator / the position regulator uses a ramp control (shock limiter) for acceleration with resulting S slip of velocity to minimize deviations and process markers

=> selection of the S shape

### 3. Selection of the limit value

The other limit values are taken from the plant setting.

Maximum acceleration =  $1000 \text{ mm/s}^2$

Maximum change of acceleration =  $3000 \text{ mm/s}^3$



### 6.10.5.6 SLP (Safe Limited Position)

Target position monitoring

**Number:** cf. chapter 6.10.5.1 „Overview safety modules“


**Input:** standardized position signal X from encoder interface

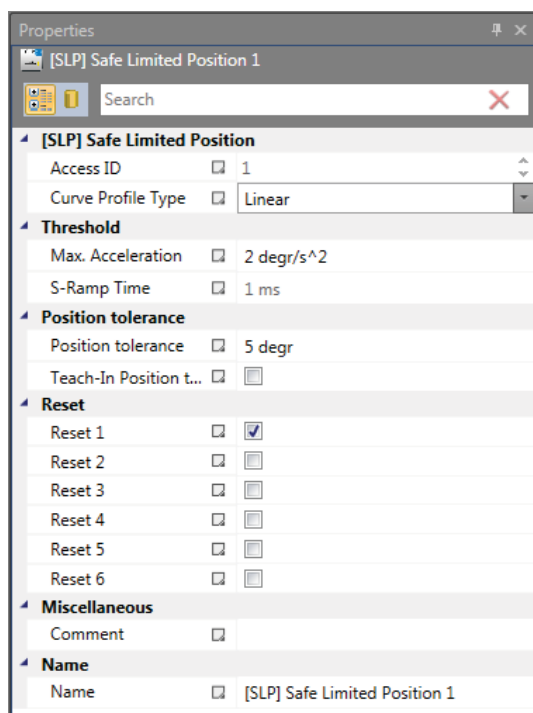
**RESET function:** The violation of the permitted monitoring range and requires a RESET confirmation. The RESET confirmation is alternatively carried out via:

- RESET- function in the group “Input elements”
- Function button at the front side of a ctrlX SAFETY control
- F-Bus Reset input

**Description function:**

- Calculation of the current velocity V from the position signal X
- Determination of the stop distance in relation to the current statuses of acceleration and velocity
- => Cyclical determination of the  $\text{Stop\_Distanz}_{\text{act.}} = f(V, a)$  with a = acceleration
- Comparison:  $\text{pos}_{\text{act.}} + \text{stop\_distance}_{\text{act.}} < \text{target\_pos}$
- Comparison:  $\text{pos}_{\text{act.}} - \text{stop\_distance}_{\text{act.}} > \text{target\_pos}$
- Direction dependent enabling of the function CW = count up CCW = count down

 If the function is enabled, it must be programmatically and automatically ensured that CW and CCW never are “1” at the same time because otherwise an alarm is triggered.



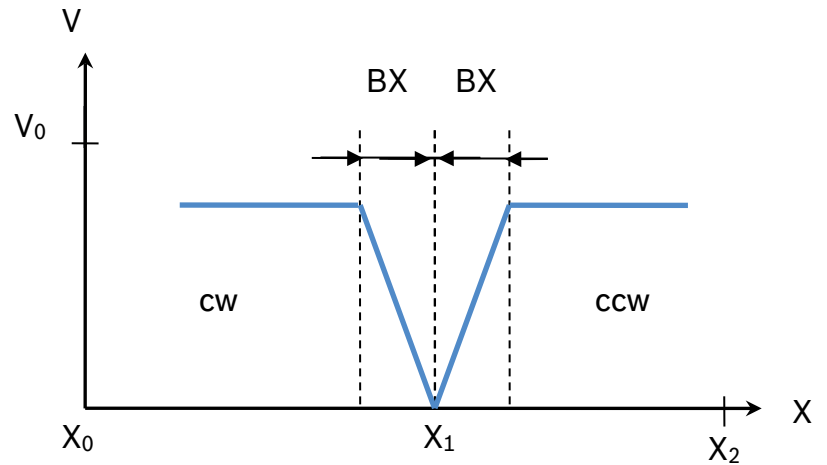
**Fig. 193 Properties of SLP-function**

**Parameters:**

**Curve type**

- linear

Linear calculating method for the stop distance in relation to the target position



BX = brake ratio-/proximity range

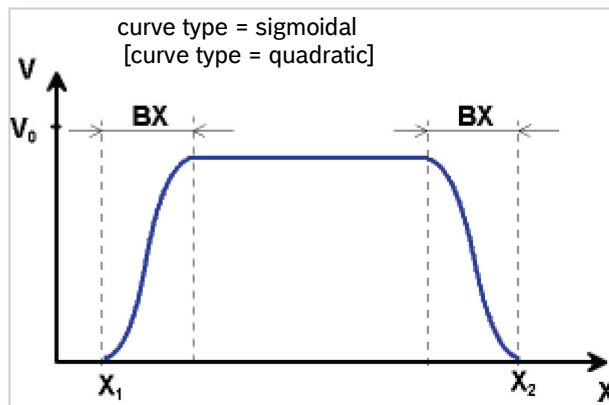
$X_2 - X_0$  = measured length, cf. Encoder configuration

$X_1$  = target position

cw = cw input enabled ( $Pos_{act.} + stop\_distance_{act.} < target\_pos$ )

ccw = ccw input enabled ( $Pos_{act.} - stop\_distance_{act.} > target\_pos$ )

- Sigmoidal  
Quadratic calculation method for the stop distance in relation to the target position



**Max. acceleration**

Max. acceleration value within  $BX$

**Max. acceleration change**

Value of maximum permissible acceleration change in  $BX$  when using the quadratic calculation method.

**Position tolerance**

Max. permitted position deviations to target position

**Reset**

Selection of Reset.

**Saving of the target position via the Teach-in**

The Teach-in option can be used to save the target position in the ctrlX SAFETY system without a subsequent manual setting. To do this, the following steps are necessary: By enabling the "Teach-In" button, the input field "target position" changes to "position range". At the same time, the input dialogue is enlarged by the SOS function.

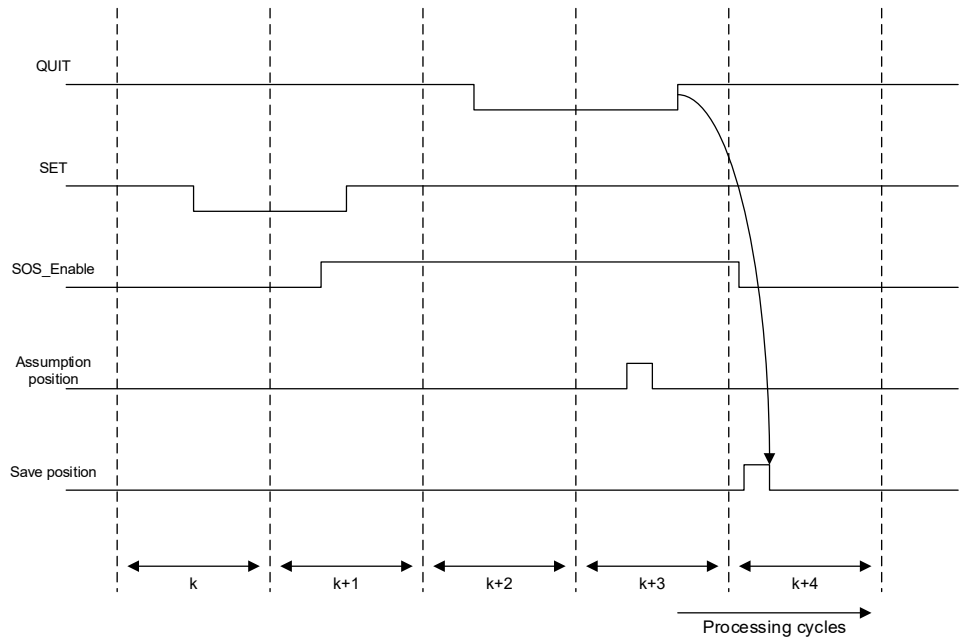
The recording of a position with the Teach-in option can only be carried out during a standstill with the SOS function being enabled and the SLP function being disabled. For the recording of a position, the two signals "Set" and "Quit" are necessary. These signals appear as input connections of the function module, if the Teach-in option is enabled.

The Teach In mode automatically activates the SOS function and checks the result of this function. The missing triggering of the SOS function is a condition for an active Teach In cycle.

The position is only recorded if the current position is situated within the determined position range. The successfully recorded Teach-in position appears in the process input image.

The Teach-in position is safely stored – also in case of a current interruption. The Teach-in position is reset after every configuration upload..

Time characteristics of the "SET/QUIT" process:



**Fig. 194** Display of the "SET/QUIT" process

The sequence is time-monitored and triggers an ALARM if the expected values are exceeded.

Attention: The maximum time frame is 3 seconds!

**Position tolerance**

Tolerance value for the TeachIn position.

$$cw \text{ (enabled)} = Pos_{Act.} + Stop\_distance_{act.} < target\_pos + \text{position tolerance}$$

$$ccw \text{ (enabled)} = Pos_{Act.} - Stop\_distance_{act.} < target\_pos - \text{position tolerance}$$

If the Teach-in function is used, the monitoring limit is enlarged by the position tolerance value. Without the Teach-in function, the position tolerance value is zero.

For the input "Setting" either a push-button switch must be used, or two position switches linked with AND must be assigned to the input. When the position tolerance is determined, the maximum permissible position must be considered. =>maximum position tolerance value = maximum position in the direction of travel – Teach-in position.

Parameters of the SOS dialogue: *cf. SOS function*



### 6.10.5.7 SCA (Safe Cam)

Monitoring of the position range by speed monitoring / velocity monitoring

**Number:** cf. chapter 6.10.5.1 „Overview safety modules“

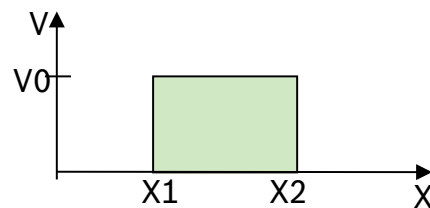
**Function:** monitoring of a parametrizable position range with assigned minimum limit and maximum limit. In the permitted range additionally monitoring of the speed .

**Input:** standardized position and velocity signal X and V by encoder interface

**RESET function:** The violation of the permitted monitoring range is not saved. No RESET confirmation is necessary.

**Description of function:**

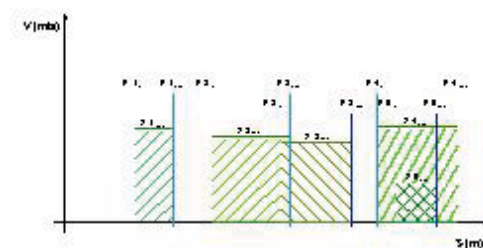
- Comparison of the current position to parametrized range limits
- Comparison of the current velocity to the parametrized limit
- Permanent activation of the block



**Output function**

Range	HI	LO
$X < X1$ $X > X2$	OR	X
$X \geq X1$ $X \leq X2$ $V < V0$	AND AND AND	X
$X \geq X1$ $X \leq X2$ $V \geq V0$	AND AND	X

Ranges can be defined as overlapping and as nested.



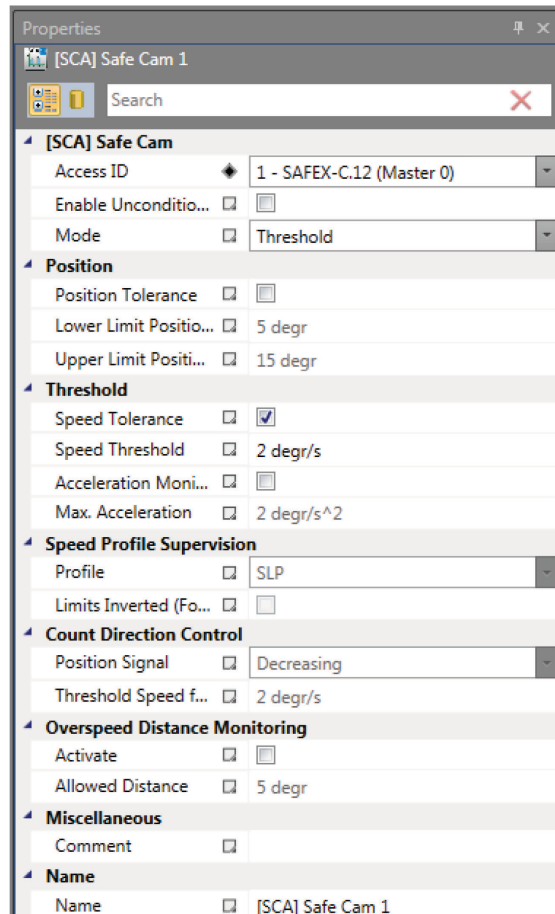


Fig. 195 Properties of SCA-function

Parameters:

**Permanent activation**

If this option is set, the monitoring function has an input connection. The function is active from the start of the device.

**Lower limit position X1**

Lower limit position

**Upper limit position X2**

Upper limit position

**Speed threshold**

Maximum permissible speed in set position range

**Max. acceleration**

Maximum permitted acceleration in set position range

**Direction independent release**

Currently not supported

**Negative encoder counting direction:**

Currently not supported

**Positive encoder counting direction:**

Currently not supported

**Activation and release of the speed direction**

Currently not supported

**Travel monitoring**

Currently not supported

Example of input:

At a production machine the access to the work zone for manual insert or rather, manual setting shall be released for certain positions of the main input axis. The drive remains in this position and is only monitored for standstill. The limits of the expansion stroke are variable and shall be monitored in an electronically safety-relevant way. The active movement to be monitored is a linear movement. An absolute encoder is directly interlocked with the main feed axis as a linear path measurement system. The main axis is the referential axis for the ctrlX SAFETY device.

## 1. Range selection

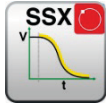
With the position monitor the position of the main axis in the upper zero point shall be monitored. The upper zero is also the referential zero point in the length measuring device of the feed axis. If the range is recognized, one protective device is released for opening.

Limit range X1 = upper position = 0 mm

Limit range X2= lower tolerance limit for position = 2 mm

Speed = tolerated speed for conservation of position = 3 mm/s


Acceleration = tolerated acceleration for conservation of position = 5 mm/s



### 6.10.5.8 SSX (Safe stop 1/2)

Function monitoring for emergency stop

<u>Number:</u>	cf. chapter 6.10.5.1 „Overview safety modules“
<u>Function:</u>	monitoring of an EMERGENCY STOP function
<u>Input:</u>	standardized speed signal X from encoder interface
<u>RESET function:</u>	Violation of the permitted monitoring range is saved and requires a RESET confirmation. The RESET confirmation is alternatively carried out via: <ul style="list-style-type: none"> <li>• RESET function in the group of “Input elements”</li> <li>• Function button at the front side of a ctrlX SAFETY control</li> <li>• F-Bus input via Reset block</li> </ul>

 If this function triggers an alarm, after a RESET, the device unit is reset to the normal state either on the device or via the configured input of the “Alarm Reset” block .

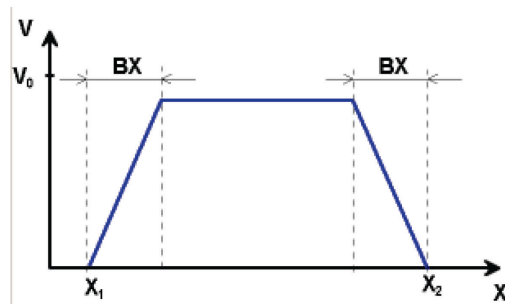
Before the reset, in the monitored periphery an operating state must have been achieved, in which the “Enable” input of the function is set to zero.

#### Description of the function:

Monitoring of the process of a controlled EMERGENCY STOP by comparison of the speed drop over time to a parametrized monitoring limit curve. The monitoring limit curve results from latency time, the maximum speed distance zu the limit curve and their characterization, computed from acceleration and acceleration change. After the activation of monitoring, the course of the limit curve is calculated on the basis of current speed.

Parameters:

- Linear curve type

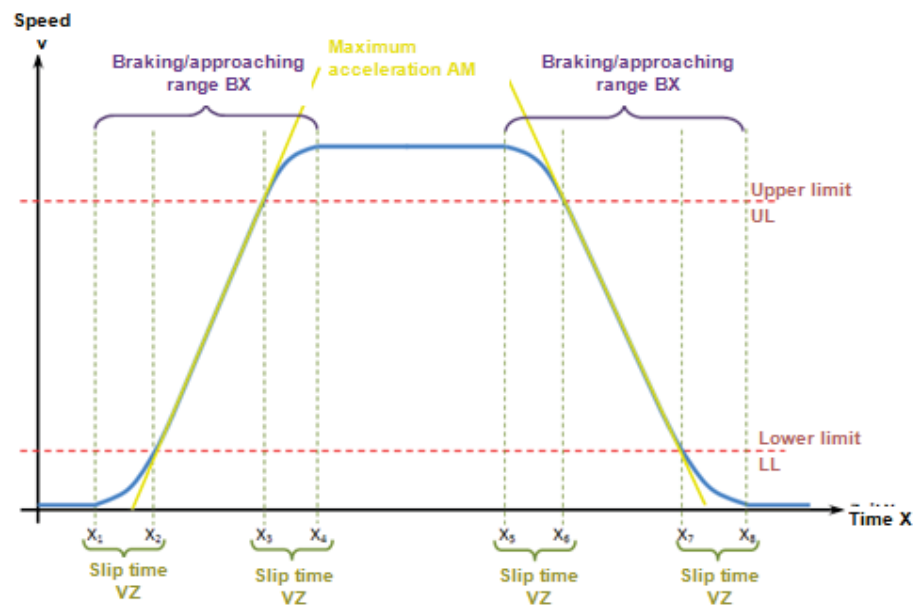


BX = braking range / proximity range

X1 / X2 = time for ramp function sequence

V0 = Start velocity of the ramp function

- Sigmoidal Speed Profile



**Fig. 196** The sigmoidal speed profile shows the change of speed over the time, or rather, the course of speed over the time.

**Max. acceleration AM**

Value of maximum acceleration within BX

**S smoothing time VZ**

The smoothing time VZ means the period in which speed does not change linearly, or rather, the period for acceleration change from  $a=0$  or  $a=a_{max}$  or vice versa.

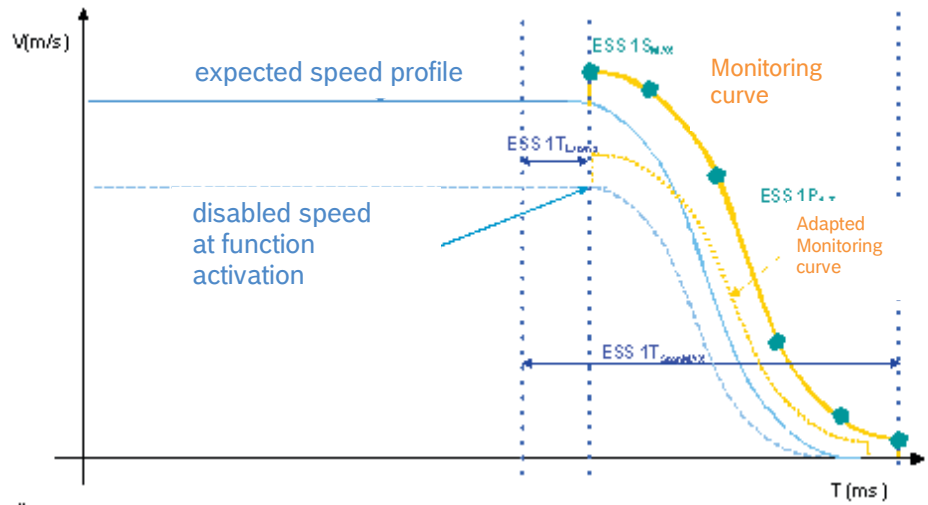


Fig. 197 Monitored limit curves at a sigmoidal course of speed

Output function

Table 32:

Range		HI	LO
$T < T_{Latency}$		X	
$T > T_{Latency}$	AND	X	
$V < V_{Limit\ curve}$			
$T > T_{Latency}$	AND		X
$V > V_{Limit\ curve}$			

Every function block can be parametrized to stop-category 1 or stop-category 2. In STOP-category 2, after the expected standstill the SOS function is activated automatically.

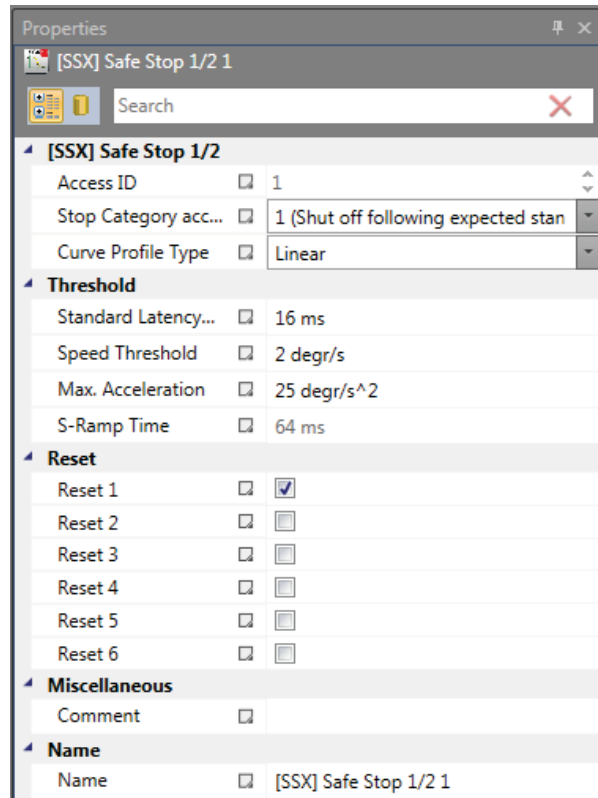


Fig. 198 Properties of SSX-monitoring

#### Parameters:

##### **Stop category 1**

This option allows monitoring the controlled EMERGENCY STOP according to EN 60604. According to the definition in the standard, the current supply must be disconnected after the standstill of the drive. The separation is supported by the shift of the initial value of the SSX function from "1" to "0".

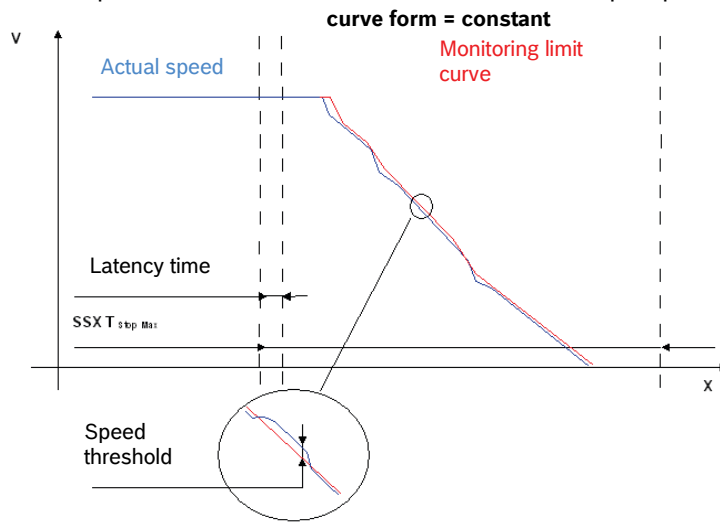
##### **Stop category 2 (SOS after expected standstill)**

Currently not supported.

**Curve type**

- linear

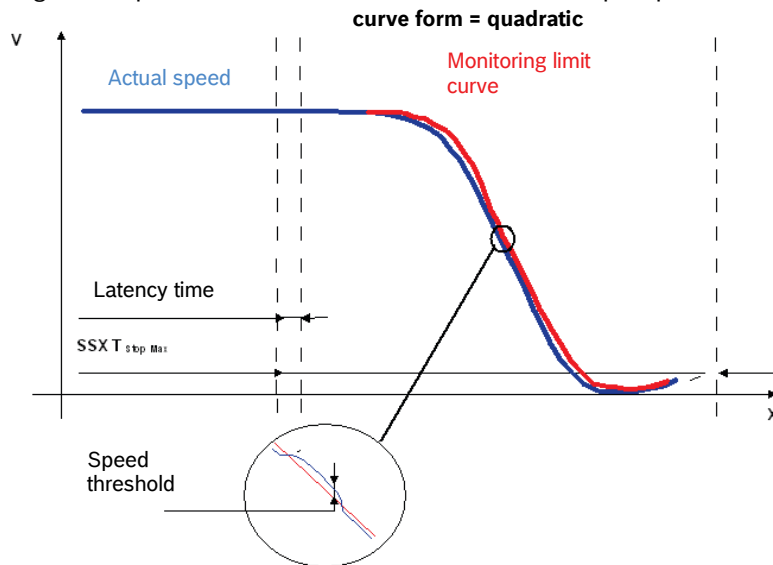
Linear speed and constant acceleration curve for the stop sequence



\* ermittelt aus aktueller Geschwindigkeit und konfigurierter Beschleunigung

- Sigmoidal curve type

Sigmoidal speed and linear acceleration curve for the stop sequence



\* Determined from current speed and configured acceleration

**Latency time standard**

Latency time until the active delay occurs.

**Max. speed (speed threshold)**

Tolerance value of current speed.

If the current speed is greater than the current limit curve + tolerance value, energy supply is disconnected.

### **Max. acceleration**

Determines the increase of the stop curve.

### **S- slip time**

The slip time indicates the period, in which the curve's form is sigmoidal. The period before and after the acceleration  $a_{max}$ .

### **Reset**

Select Reset

#### Input example:

At a production machine, at certain position of the main input axis access to the work zone shall be guaranteed for manual input or for settings. In this position, the drive remains active, and is monitored only for a standstill. The limits of the work zone are variable and shall be monitored electronically in a safety-relevant mode instead of being monitored by a mechanical safety limit switch. The movement, that shall be monitored electronically, is a linear movement. An absolute encoder is connected to this main drive axis of the linear length measuring system. The drive functions with an electric motor with an integrated motor feedback system and an intermediate transmission.

### **1. Selection of the stop category**

To keep machine downtime and restarts as short as possible, the stop category must be used according to DIN 60604-1 (Controlled stop with subsequent actively controlled drive to  $V = 0$ ) => selection of stop category 2

### **2. Type of speed selection**

The drive regulator / the position regulator uses a ramp limiter (shock limiter) for acceleration with the resulting S-slip to minimize deviations and process. => selection of S-slip

### **3. Selection of the limit value**

For monitoring, the most unfavorable latency from the occurrence of the emergency-stop to the start of the braking process must be entered. The braking process must be carried out with the standard control. The sequency time of the programme of the standard control causes latency = cycle duration \* 2 = 50 ms

The other limit values are taken from the setting of the plant.

Maximum infeed speed = 300 mm/s<sup>2</sup>

Maximum acceleration = 1000 mm/s<sup>2</sup>

Maximum acceleration change = 3000 mm/s<sup>3</sup>



### 6.10.5.9 SLI ( Safely limited increment)

Monitoring of the maximum increment

- Number: cf. chapter 6.10.5.1 „Overview safety modules“
- Function: monitoring of the maximum increment
- Input: standardized position signal / speed signal V and X from encoder interface. Direction LEFT / RIGHT.
- RESET function: Violation of the permitted monitoring range is saved and requires a RESET confirmation. RESET confirmation is alternatively carried out via:
- RESET function in the group Input elements.
  - Function button at the front side of a ctrlX SAFETY control
  - Fieldbus inputs via reset block



It must be program technically ensured that in case of a triggering event. Otherwise, the SLI block could not be reset again.

When activating the function, it must be program technically ensured that CW and CCW never become 1 at the same time. Otherwise, an alarm is emitted.

#### Description of function:

- Monitoring of the maximum permitted increment = relative travel ranges for continuous travel in the jog mode.
- Calculation of the current rotational direction RX from the position signal / the speed signal X
- Determination of the relative travel distance after the start of the movement
- Monitoring for observation of the given direction and of the max. given travel distance

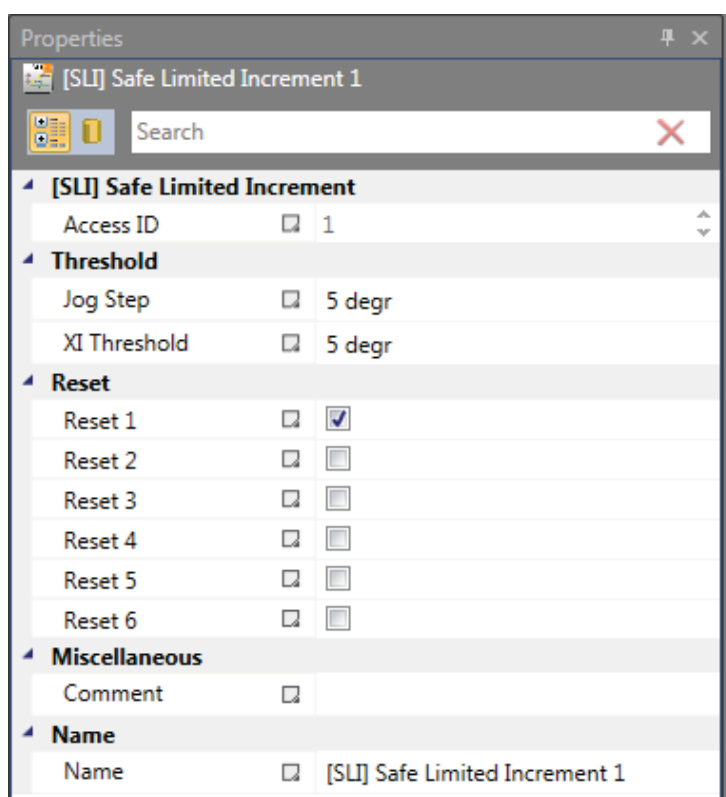
## **NOTE**

### **Setting connections of block**

In case of a reset, connections in the block must be reset to “0”. Otherwise, the function cannot be reset .

**Table 33:**

Range		HI	LO
V < 0	AND		
DIRECTION FLAG = LEFT	AND	X	
Relative travel distance < max. increment			
V >= 0	AND		
DIRECTION FLAG = RIGHT	AND	X	
Relative travel distance < max. increment			
V < 0	AND		
(DIRECTION FLAG = RIGHTS	OR		X
Relative travel distance > max. increment			
V > 0	AND		
(DIRECTION FLAG = LEFT	OR AND		X
Relative travel distance > max. increment)			



**Fig. 199 Properties of SLI-monitoring**

Parameters:

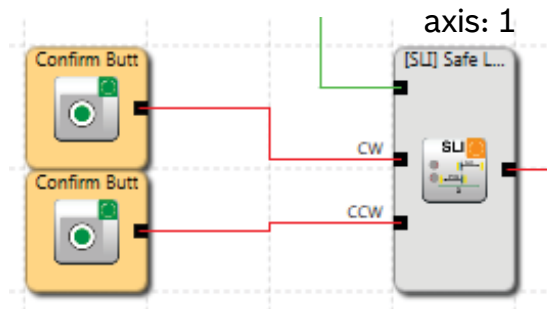
**Increment**

Maximum relative travel distance after activation of the monitoring function

**XI threshold**

Tolerance threshold for the monitoring of the travel distance in the opposite direction

Example of an activation:



**Fig. 200** Activation of SLI

Input example:

The max. travel distance of the material feeding system of a production plant shall be safely monitored in jog operation. According to the risk analysis this travel distance is no more than 50 mm. A wrong travel distance in the opposite direction shall be monitored.

### 1. Jog step

The relative travel distance (only available in the incremental encoder) is monitored => input of max. travel distance according to risk analysis with a tolerance = 55 mm

### 2. Monitoring of the travel distance

Permitted travel distance in opposite direction (=creep movement of the drive) = 1 mm/s

### 3. Monitoring input

The monitoring has two inputs to indicate the direction. An active direction signal activates the monitoring function.

After the activation of the monitoring device, the direction must be indicated by an unambiguous signal => Switches for the direction are directly connected to the standard inputs of the ctrlX SAFETY => selection I 01, I 02

## **NOTE**

### **Both input signals on „1“**

If both input signals are “1”, this is recognized as an impermissible status.

► an alarm message is enabled



### 6.10.5.10 SDI (Safe direction Indication)

Recognition of the direction

- Number: cf. chapter 6.10.5.1 „Overview safety modules“
- Function: monitoring of the given rotational direction / motion direction
- Input: standardized position signal / speed signal X from encoder interface. Direction flag LEFT / RIGHT.
- RESET function: Violation of the permitted monitoring range is saved and requires a RESET confirmation. RESET confirmation is alternatively carried out via:
- RESET function in the group “Input elements”
  - Function button at the front side of a ctrlX SAFETY control
  - F-Bus inputs via Reset block

#### **NOTE**

It must be program-technically ensured that the inputs of the SDI block do not remain on 1 in the event of a trigger .

▶ Otherwise, the SDI block could not be reset any more .

#### **NOTE**

If the function is activated, it must be program-technically ensured that at no time CW and CCW become 1 at the same time .

▶ because otherwise an alarm is emitted .

Example: cf. SLI ( Safely limited increment).

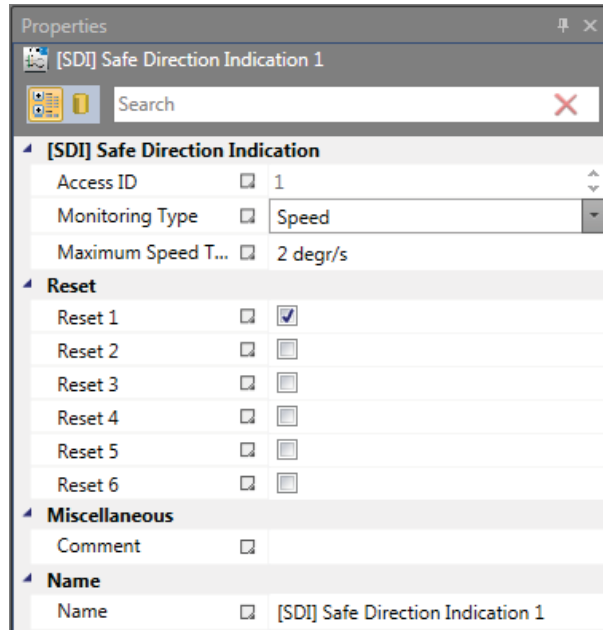
Description of function:

- Monitoring of the given rotational direction / the given motion direction
- Calculation the current rotational direction RX from the position signal / speed signal X

Output function:

**Table 34:**

Range		HI	LO
V < 0	AND	X	
DIRECTION FLAG = LEFT			
V >= 0	AND	X	
DIRECTION FLAG = RIGHT			
V < 0	AND		X
DIRECTION FLAG = RIGHT			
V > 0	AND		X
DIRECTION FLAG = LEFT			



**Fig. 201 Properties of SDI-monitoring**

Parameters:

**Speed monitoring mode**

Maximum tolerance threshold for speed in opposite direction

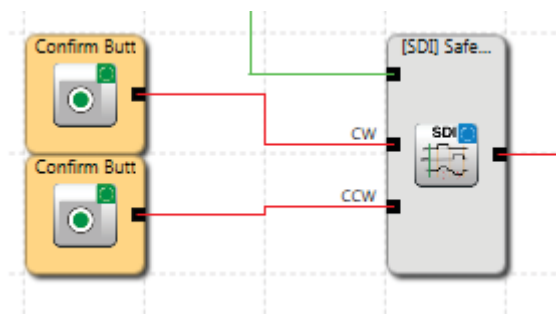
**Position monitoring mode**

Maximum tolerance threshold for position in opposite direction

**Reset**

Select Reset.

Example of an activation:



Example of input:

At a production device the speed of certain manual processes must be monitored for a safety reduced value, and for the standstill direction and the movement direction must be monitored. The movement that shall be actively monitored is a rotating movement. The drive functions with an electric motor with and integrated motor feedback system and an intermediate transmission.

### 1. Input for the monitoring function

Speed monitoring (only incremental encoder available)

=>Speed

### 2. Speed monitoring

Permitted speed in opposite direction (= creep movement of drive) from the plant parameter = 1 mm//s

### 3. Monitoring input

The monitoring module has two inputs to indicate the direction. An active direction signal activates the monitoring function.

## **NOTE**

If both input signals are "1", this is recognized as an invalid status .

▶ an alarm message is enabled .



### 6.10.5.11 SLS (Safe Limited Speed control)

Monitoring of a minimum speed

- Number: cf. chapter 6.10.5.1 „Overview safety modules“
- Function: monitoring of a minimum speed
- Input: standardized position signal X from the encoder interface
- RESET function: Violation of the permitted monitoring range is saved and requires a RESET confirmation. The RESET confirmation is alternatively carried out via:
- RESET function in the group of the input elements.
  - Function button at the front side of a ctrlX SAFETY control
  - F-Bus inputs via Reset block

Description of function:

- Monitoring of the maximum speed or the maximum rotational speed of a drive
- Calculation of the current speed V from the position signal, or rather, from the digital speed signal X Comparison of the actual speed to the parametrized speed threshold
- Monitoring of a change of speed from fast to slow.
- Error distance monitoring with the selected SSX ramp



Output function

**Table 35:**

Range	HI	LO
$V < V_0$	X	
$V \geq V_0$		X

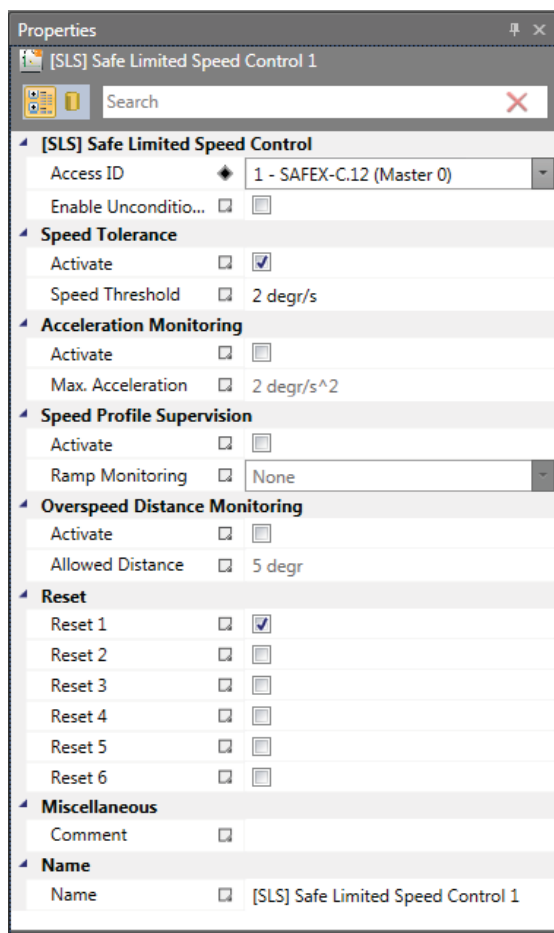


Fig. 202 Properties of SLS-monitoring

Parameters:

**Activate permanently**

The monitoring function is always active and does not have an input connector.

**Speed tolerance**

To activate speed monitoring

**Travel curve monitoring**

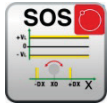
Currently not supported.

**Error distance monitoring**

Currently not supported.

**Reset**

Selection of Reset.



### 6.10.5.12 SOS (safe operational stop)

Standstill monitoring

Number: cf. chapter 6.10.5.1 „Overview safety modules“

Function: standstill monitoring

Input: standardized position signal / standardized speed signal

RESET function: Violation of the permitted monitoring range is saved and requires a RESET confirmation. RESET confirmation is alternatively carried out via:

- RESET function in the group of the input elements.
- Function button at the front side of a ctrlX SAFETY control
- F-Bus inputs via Reset block

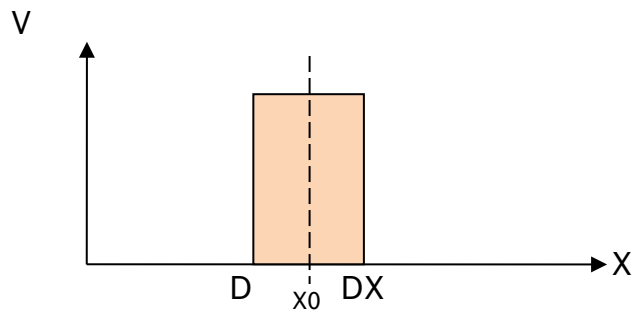
**NOTE**

it must be program-technically ensured that the input of the SOS block does not remain 1 in case of a trigger event .

► Otherwise, the input cannot be reset.

Description of function:

- Standstill monitoring of the drive at current position with released drive and, if necessary, with enabled position controller.
- Calculation of the current speed V from current position signal or from current speed signal X
- Comparison of the current speed with the parametrized monitoring window



**Table 36:**

Range	HI	LO
$X > (X0 - DX)$ AND $X < (X0 + DX)$	X	
$X \leq (X0 - DX)$		X
$X \geq (X0 + DX)$		X

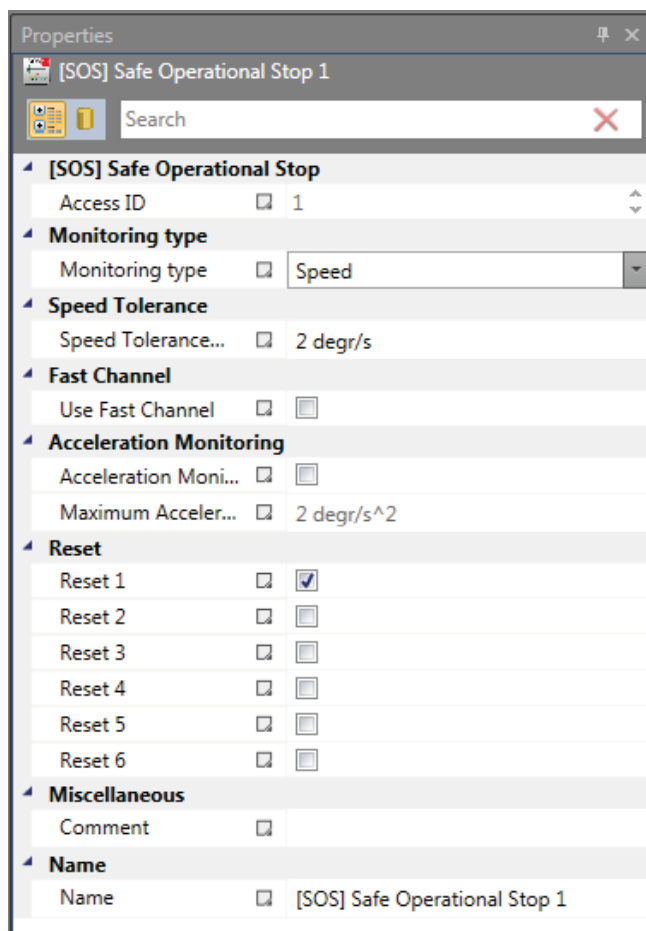


Fig. 203 Properties of SOS-monitoring

**Monitoring mode**

Determination of the monitoring mode for standstill up to a minimum speed threshold or up to a position range

**Maximum speed tolerance / maximum position tolerance**

Minimum speed or a permitted relative deviation from the current position at the time when the SOS function was enabled.

**Fast Channel**

Currently not supported

**Acceleration monitoring**

Optional maximum value for speed monitoring during an active SOS function.

**Reset**

Selection of Reset.

Input example 1:

In a production device, at certain manual processes speed shall be monitored for a safely reduced value. Additionally, standstill and travel direction shall be monitored. The active movement to be monitored is a rotating movement. The drive is an electronic motor with integrated motor feedback system and an intermediate gear.

**1. Selection of type**

Only speed is monitored (e. g. via incremental encoder) => speed monitoring

**2. Speed monitoring**

Specification of the tolerated value of the speed monitoring

Input example 2:

At a production machine, the access to the work zone shall be released for manual insert or for manual configuration shall be released at certain positions of the main drive axis. In this position, the drive remains active and is only monitored for standstill. The limits of the expansion stroke are variable, and shall be monitored in an electronically safety-relevant way instead of being monitored by a mechanical safety end-switch. The active movement to be monitored is a linear movement. An absolute encoder is a directly interlocked connection to the main drive axis. The main drive axis is driven by an electronic motor with an integrated motor feedback system and an intermediate gear.

**1. Selection of type**

The position is monitored (absolute encoder at hand) => position monitoring

**2. Position monitoring**

Specification of the tolerable value for position monitoring



### 6.10.5.13 MPM (Safe Synchronization monitoring)

synchronization monitoring

Number: cf. chapter 6.10.5.1 „Overview safety modules“

Access-ID: identification of the function element

Axis assignment: 1 Master axis  
2-12 Slave axes

Function: synchronization monitoring

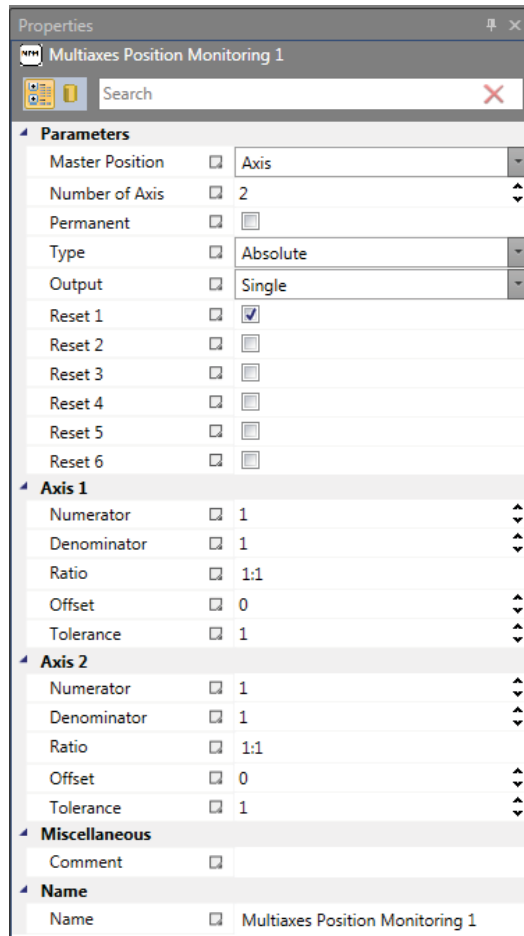
Input: Standardizes position signals from the encoder interface

RESET function: Violation of the permitted monitoring range is stored, and a confirmation is necessary. The confirmation can be made in the following way:

- RESET function in the group of the input elements
- Function button on the front side of a ctrlX SAFETY control
- F-Bus reset-element

Description of function:

Monitoring of the synchronous movement of a configurable Master axis with an axis that is available in the system. The standardization, or rather, the unit of the comparable axes does not have to be identical. The standardization of the axes towards each other takes place in the monitoring function.



**Fig. 204 Properties of Multiaxes position monitoring**

**Position of the Master**

Selection (mode) between Axis and Functional. Currently only one axis is supported. The supported axis is the referential axis for the comparison with the other axes.

**Number of axes**

Number of comparative axes 1...12

**Permanent**

If the function is enabled, it is permanently enabled.

**Type**

Selection between:

- Absolute: Configuration of the Offset of the referential axis to comparative axis
- Incremental: calculation of the offset of the referential axis to the comparative axis with rising activation of the function.



If incremental is used, the activation of “Permanent” cannot be used.

### Output

Selection between:

- Single: result of comparison of every axis as group feedback
- Per Axis: result of comparison of every individual axis

### Reset

Selection of reset.

### Axis x:

Numerator

Numerator for the nomination of the position to the Master axis

Denominator

Denominator for standardization position to Master axis

Ratio

Display of nominator / denominator

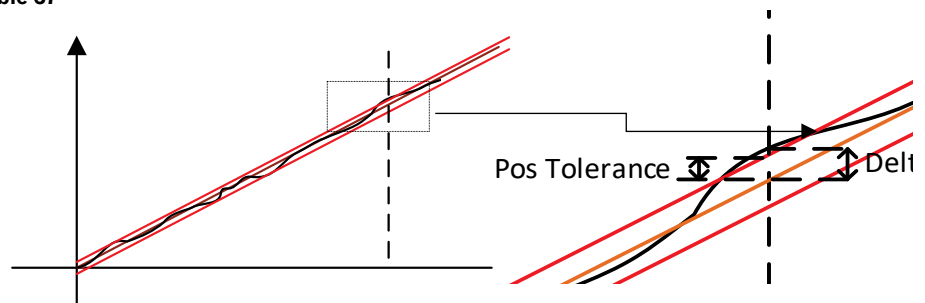
Offset

Only with Type-> Absolute. The offset is added on comparison axis

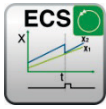
Tolerance

Tolerance for comparison of Master with comparison axis

Table 37



### 6.10.6 Muting functions



#### ECS (Encoder Control Supervisor)

User-defined evaluation of the encoder status.

- Number:** cf. chapter 6.10.5.1 „Overview safety modules “
- Function:** Muting of encoder error
- RESET function:** Violation of the permitted monitoring range is stored and requires a RESET confirmation. The confirmation can alternatively be made via:
- RESET function in the group of the input elements.
  - Function button at the front side of a ctrlX SAFETY control
  - Input of F-Bus reset

## NOTE

#### Safety of the application

The ECS function can considerably influence the safety of an application.

- ▶ It must be ensured that no safety critical situations occur due to the use of the ESC function!

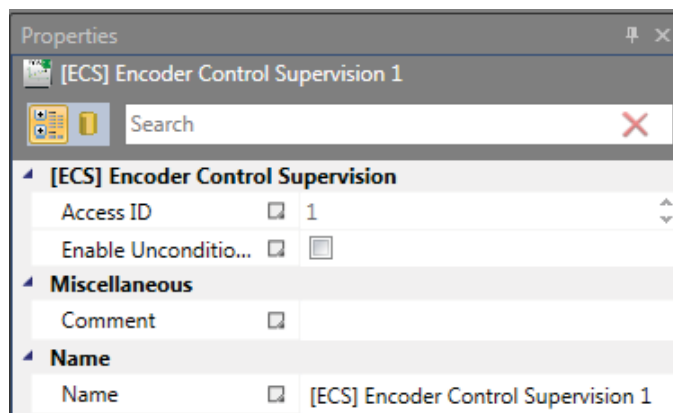


Fig. 205 Properties of ECS function

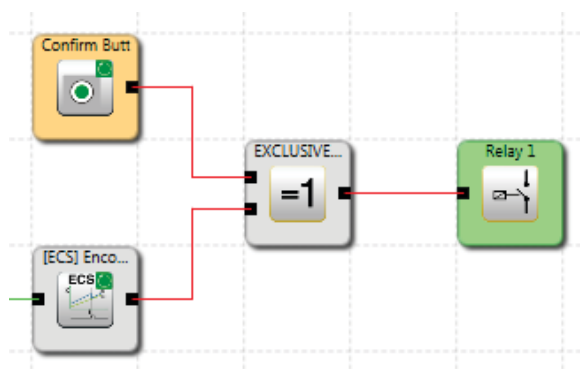


Fig. 206 Example for the use of the ECS function




## DEM (Dynamic Encoder Errors Muting)

Number: cf. chapter 6.10.5.1 „Overview safety modules “

Function: muting of the alarm of encoder diagnostics functions from an adjustable limit speed.

RESET function: no reset necessary

 The DEM function can only be used for axes that have been set without position processing.

### Operating:

Alarm mute by encoder diagnostics functions, if a settable speed tolerance has been exceeded while the function was active.

When a safety function is activated by the same axis, the DEM function is deactivated.

The alarm status of the encoder diagnostics is saved internally. The status “FALSE” (encoder alarm) is deleted, when the speed moderation becomes inactive.

The saved alarm status generates an alarm an alarm, when a different safety function is activated during the alarm mute.

### Output:

The output signalizes the status of this function (only diagnostics). Depending on the damping function, the output is deleted.

## **WARNING**

### **DEM function check**

- ▶ The speed threshold of the active safety function should always be much larger than the speed threshold of other safety functions with the same axis number.
- ▶ The DEM output should be evaluated. The evaluation is not safety relevant, and can be carried out in a non-safe control unit.
- ▶ Like the safety function that is used, the signal for the activation of the DEM function must be the highest SIL level or the highest PL level. The signal for the activation of the activation of the DEM function must be situated on the same axis as the safety function that is used.

### Example:

DEM function axis1 with SLS according to Pld and SOS according to Ple.

The enabling of DEM takes place when the door is closed. The closed status is controlled with a block for the door control.

Highest PI level = Ple, input must be Ple

Door control signal must be Ple

2 pole: 2 pole, positive door contact in the electrical and in the mechanical layout according to Ple in the ctrlX SAFETY input interface with active short circuit control.

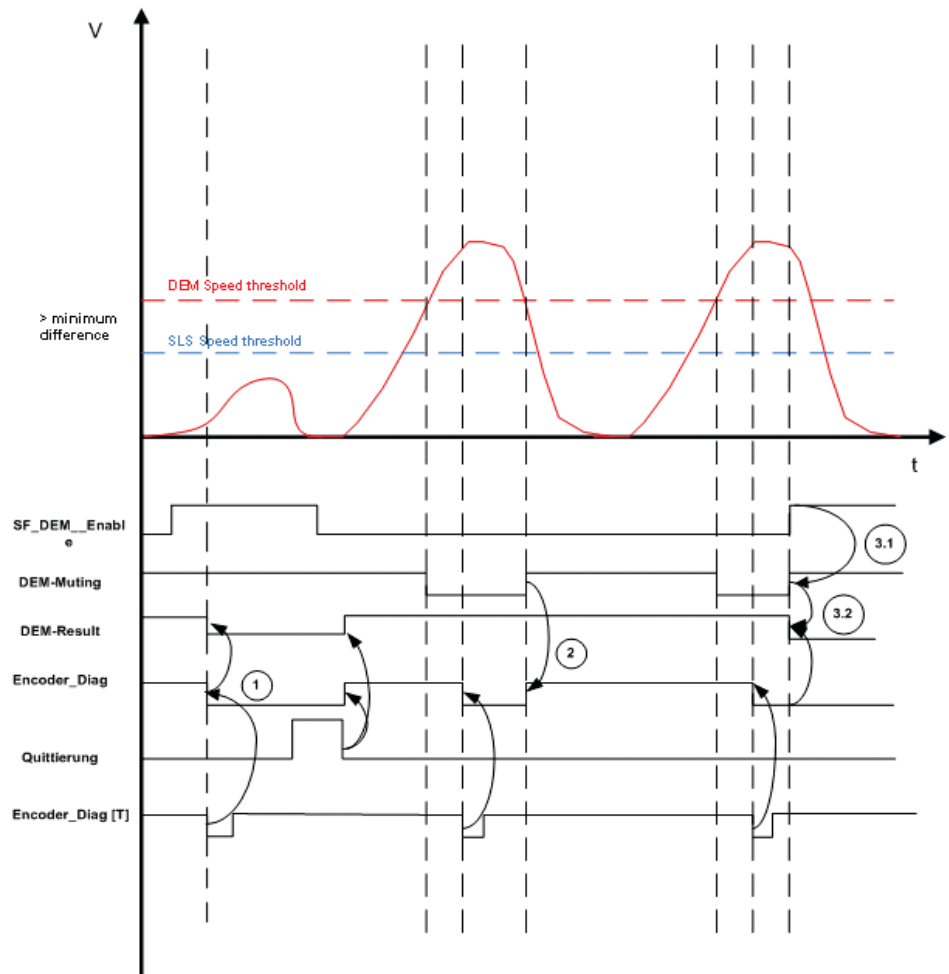


Fig. 207 Function time diagram

	SF_Enable (at least one different safety function activated)	V_System > speed sthreshold + hysteresis	Input DEM	Encoder_Diag (marker for encoder error)	Encoder alarm	DEM_Output
<b>Encoder monitoring = true (no alarm occurred)</b>	irrelevant	irrelevant	irrelevant	true	true	(1)
	untrue	irrelevant	irrelevant	untrue	true	1
	true	irrelevant	irrelevant	untrue	untrue	0
<b>Encoder monitoring = untrue (an alarm occurred)</b>	true	irrelevant	irrelevant	untrue	untrue	0
	untrue	true	untrue	untrue	untrue	0
	untrue	true	true	untrue	true	1
	untrue	untrue	irrelevant	untrue	untrue	0

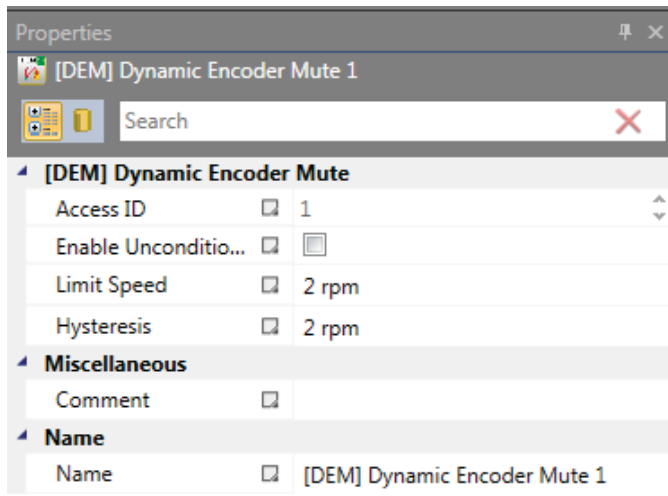


Fig. 208 Properties of DEM function

Parameters:

**Permanently activated:**

If this field is selected, the function is permanently enabled. The input connector of the block is deleted.

**Limit speed:**

When the speed value that is given in this case is exceeded, the muting function is enabled. If the activation is permanently disabled, additionally the status of the function block input is linked.

The limit speed also determines the maximum input values for the speed limit in the functions SLS, SOS, SLI and SCA. The input values of the functions SLS, SOS, SLI and SCA must always be lower than the muted speed limit.

**Hysteresis:**

To prevent a switching of the enabled function, a hysteresis value can be set:

Enabled function: speed threshold + hysteresis

Disabled function: speed threshold

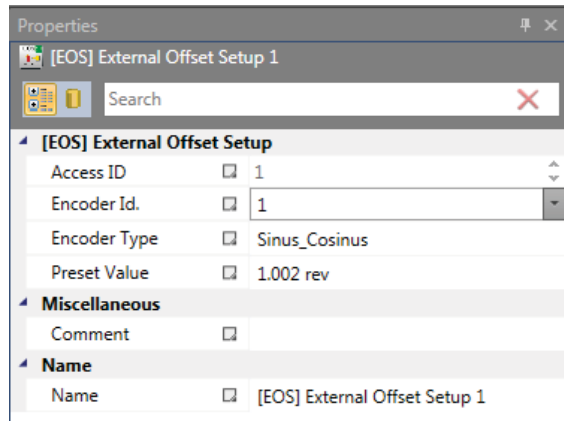


## EOS (External Offset Setup)

Setting of the encoder positions to the configured position value

<u>Number:</u>	cf. chapter 6.10.5.1 „Overview safety modules “
<u>Access-ID:</u>	identification of the function element
<u>Function:</u>	Calculation of a shift value for position encoders for a position encoder on the basis of a settable setting position on the basis of the current encoder position. By the activation of the EOS function, the current position value is adjusted to a preset parametrizable value by the revaluation and the setting of the shift value.
<u>Input:</u>	Position signal X by the encoder interface. Selection module / axis and encoder
<u>RESET function:</u>	no reset necessary
<u>Operation:</u>	The activation of this function starts with a rising edge at the input of this function.  The EOS function can be used only after the activation position processing and after setting of the absolute encoder (e. g. SSI encoder) in the selected encoder channel.
<u>Parameters:</u>	

Then, this module can be set in the functional scheme. For this purpose, the sensor channel is selected via the axis and the encoder number. The specification of the preset value happens in the physical unit that has been selected for the measuring distance.



**Fig. 209 Properties of EOS function**

**Encoder-ID:**

Selection of the sensor that is connected to encoder A (= 1) or to encoder B (= 2).

**Encoder type**

Selection of encoder type.

**Preset value**

preset value (set position) for the selected encoder.



At the most one EOS function can be used for the absolute encoder value.

An operational activation of the EOS function must be excluded. The function serves for maintenance and servicing. This must be ensured by the selection of appropriate equipment. Appropriate equipment is e. g. key-operated switches that are accessible only for qualified maintenance and service personnel.

Suitable organisational measures must be taken to grant the continuation of the physical position on the axis according to the set position.

The calculated shift value must be saved in a voltage protected manner.

For correct functioning, the ECS function must be activated while the EOS function is used.

### 6.10.7 Global network elements

The global network elements include an SMMC output block and the corresponding input elements.

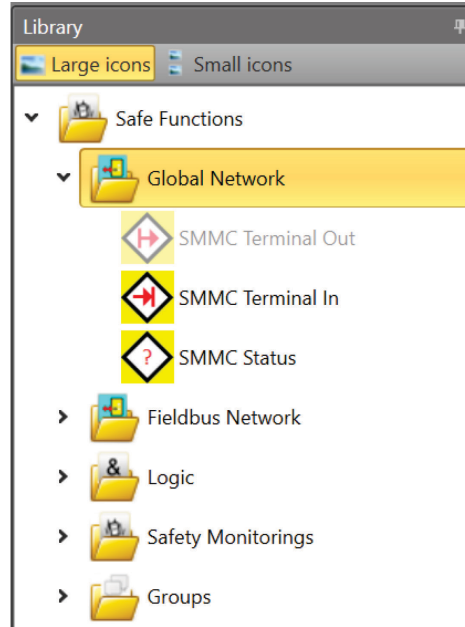


Fig. 210 Global network in library window

#### SMMC „Terminal Out“

This block represent the output of the SMMC. Every device can write 32 bits as output on SMMC. By the connection to SMMC. These bits are defined by connection to SMMC as “SMMC Terminal out”.

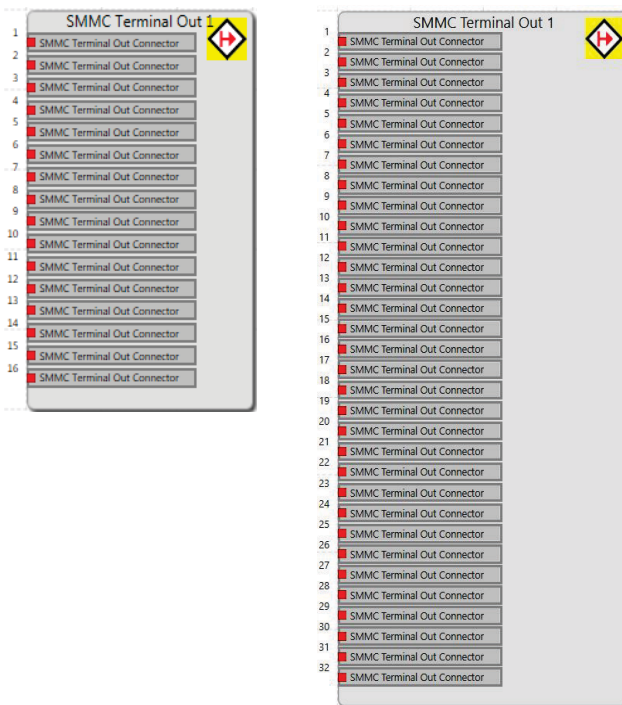


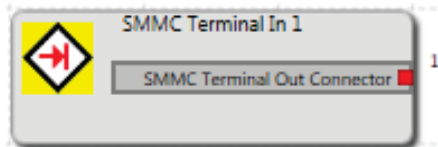
Fig. 211 SMMC Terminal Out block, from FW version 1.0.1.19 with 32 Bit

Comment: The user can set a descriptive text for the SMMC connection.

Name: The user can change the name of every output SMMC connection used.

**SMMC „Terminal In“**

This block maps the input of the SMMC. It is freely available after the user has configured the corresponding “Terminal out” [connection off] in a random functional scheme.



**Fig. 212 SMMC Terminal In-Block**

Number of Bits: number of available bits for the input. The number must be greater or equal to 1 and smaller than or equal to 16.

Device: Selection of SMMC device.

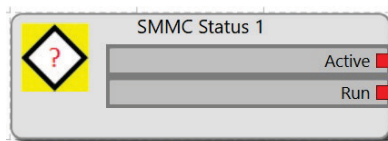
Bits: The range of the available bits depends on the selected number of bits.

Comment: The user can set a descriptive text for the SMMC connection.

Name: The user can choose a name for the connection.

**SMMC „Status“**

This block can display the status of each SMMC connection as a logical value. Two bits per connection are displayed. (see chapter 6.9.1.4)



**Fig. 213 SMMC Status Baustein**

Device: Selection of SMMC device.

Comment: The user can set a descriptive text for the SMMC status.

Name: The user can choose a name for SMMC-Status.

### 6.10.8 Fieldbus network elements

In the library, the elements of the fieldbus network are shown in the folder of the fieldbus network. The elements of the fieldbus network are shown in the library in the fieldbus folder, if the „functional scheme“ tab has been selected. These elements are shown in the screenshot below. The displayed functions depend on the selected device and from the connection. You find a description of the elements in 6.9.3 „Reset via network“.

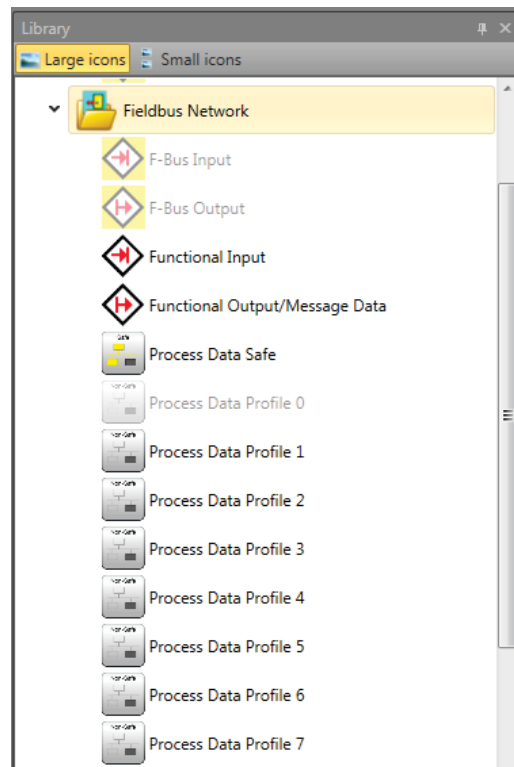


Fig. 214 Fieldbus network in library window

### 6.10.9 Connections

These elements are intended to provide a clear representation of the function charts.

These elements provide “Input connection points / Output connection points”.

Afterwards, the connections between the elements are drawn.



#### Terminal In [Input connection point]

These elements provide connections for outputs. The reference points of the connection points are created automatically. If a block for the input connection point is chosen, also the corresponding output connection points are chosen if a new output is chosen. When the input with the corresponding number has been chosen, the output with the corresponding number can be added. For identical multipoint connection points, drag the connections out of the configuration window.

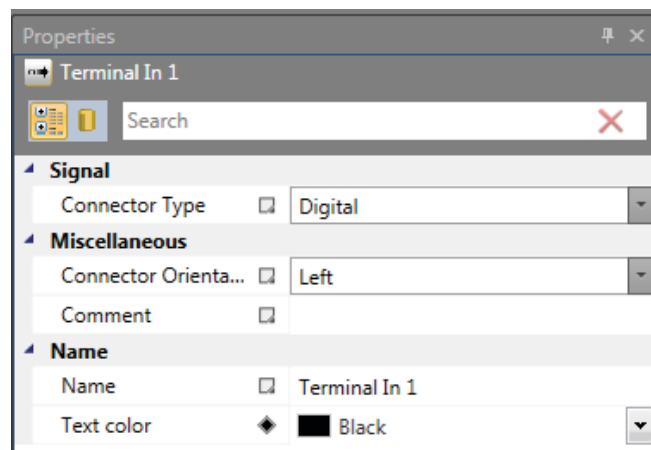




Fig. 215 Properties window of Connection „Terminal In“

Connection number: identification number of the terminal point.

 When deleting connection point elements that are referenced by output blocks, the user receives a warning. If this warning is confirmed, the dependent function block is deleted. If no corresponding output block has been indicated for marking, this caused a compiler error “Nichtreferenzierter ‘Eingestellter Anschlusspunkt ‘Baustein [‘Not referenced ‘Set connection point ‘block]“.

 Use the comment area. The input commentary facilitates the assignment of elements.



## Terminal Out

This element facilitates the continuation of a signal that leads to an “Terminal In” [Set connection point] block. Thus, these elements can only be inserted after a set connection point has been defined.

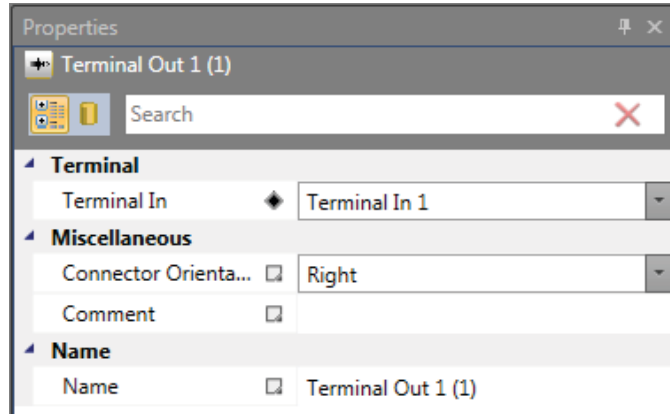



Fig. 216 Properties of Terminal Out

Connection direction: selection of the direction of the connection point on worksurface (canvas).

Terminal In: identification code of the set connection number.

 As this element refers to the set connection point, the comment for this element is shown.

### 6.10.10 Groups

Function groups connect several function/logic blocks parameterized by the user to an encapsulated function. Via the group interface the outer logic can be connected to the “group” block.

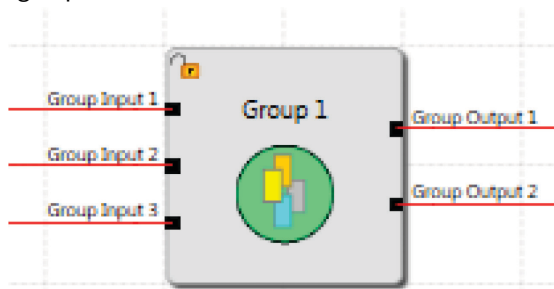


Fig. 217 Function block group

Groups contain the functionalities parameterized by the user. These can consist of logic and monitoring functions.

By this grouping, the function block diagram gets a clearer structure, and permits the creation of an individual function library via the export function / the import function. Saved groups can therefore be reused or made available to other users at any time.

## NOTE

### Multiple use of groups

In case of multiple use of a group, a copy is inserted in to the functional scheme.

- ▶ If changes are made within one of these groups, the copied groups will not be updated!

### 6.10.10.1 Creating a group


Groups can be created from scratch or from existing logic programs.

#### Option 1: Creation of a new function group

Add a "group" block to the functional scheme. The procedure is as follows:

##### 1. Add a "group" block

Creating a unique function group

The library window contains an element for a new group under the "Groups" folder. To add a new group, drag the symbol „New group“  from the library window and paste it in the workspace of the functional scheme.



The created group does not have an input/output interface.

These are added in step 3 using the "group" tab and the number is specified.

##### 2. Adding function blocks to the group

The group's work surface can either be appeared with a double click in the group frame in the functional scheme or via the group sheet listed in the browser tree of the configuration. A further "Groups" tab appears in which function blocks can be inserted.

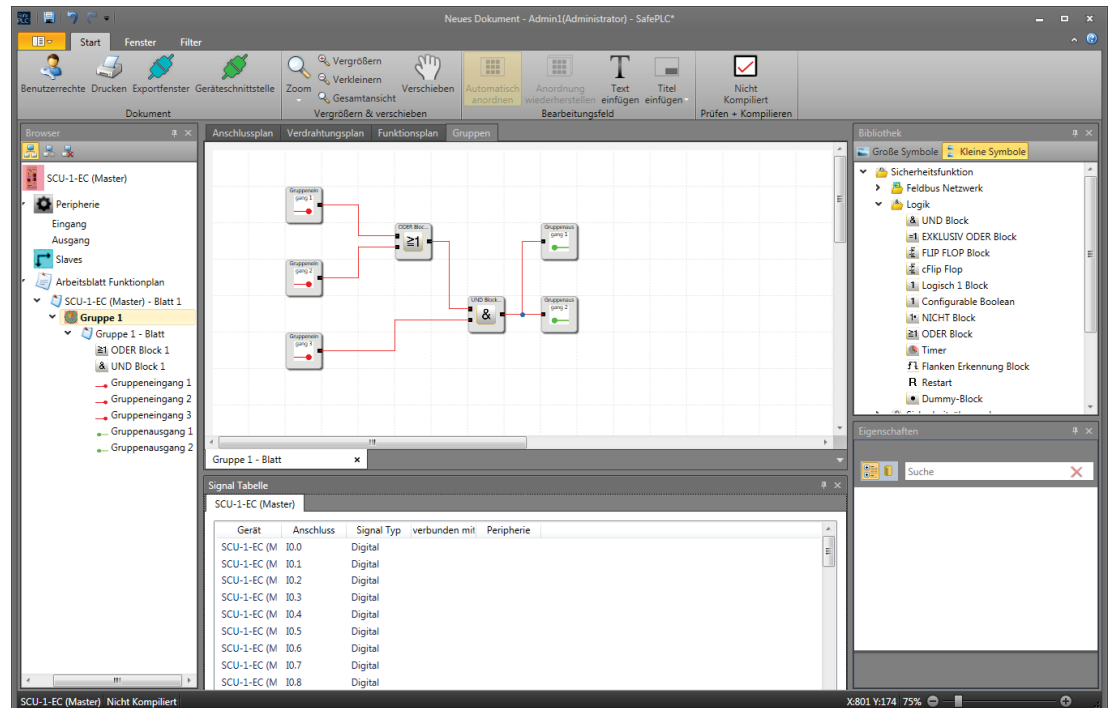



Fig. 218 Function block in tab "Groups"

In this section, function blocks can be added, shifted or deleted. The function blocks are inserted into the group via drag & drop, unless the group has been locked. In this case, the error message also displays the name of the function group.

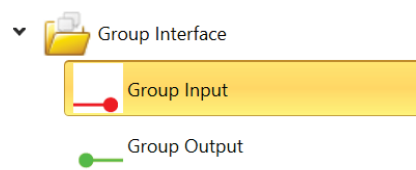
 A group can be edited only as long as the group is unlocked.

**Please note:**

- In the functional scheme Function blocks cannot be added by shifting the “group” block. To add function blocks to the group, the "Groups" tab must be activated.
- The following block types cannot be part of a group. They are filtered, when the modules are shifted to the frame section.
  - Input elements
  - Output blocks
  - All function blocks, predefined in the functional scheme (e. g. encoders,
  - analogous modules, I/O)
  - Signal channel modules
- The maximum number of blocks is determined by sheet size and the available resources.

### 3. Adding of the Group Interface

The connection between "Functional scheme" and "Groups" is made via the "Group input" or "Group output" blocks. Further information can be found in the chapter 6.10.10.4 “Group interface”.



**Fig. 219** Tab „Group interface“ in library

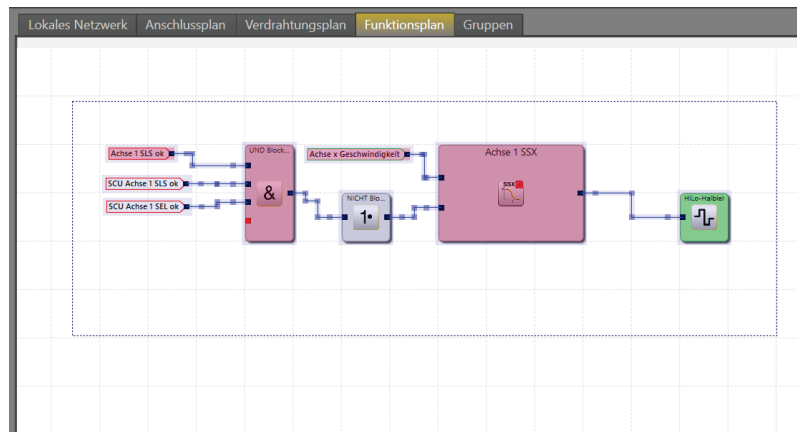
## Option 2: Creating a function group from selection

If blocks that have already been connected shall be added to a group by shifting, you should proceed as follows:

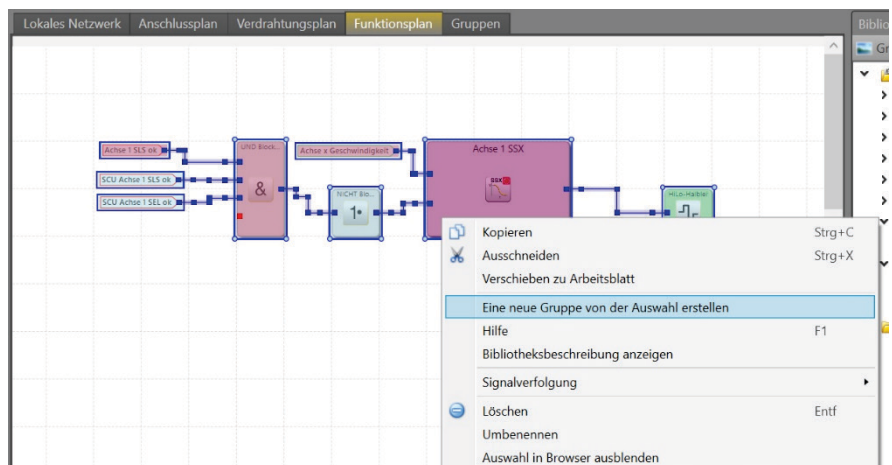
### 1. Selection of group elements


The size of the group is determined with the cursor:

- ▶ Position the mouse pointer with the left mouse button in the upper left corner of the group frame and press and hold the mouse button.
- ▶ Then, while holding down the left mouse button, drag the mouse pointer to the desired lower edge of the group section.



- ▶ Click on the selection with the right mouse button, and create a new group. This group is inserted in the group frame, and whose tab "Group" and be opened for editing.



 The block types that cannot be included in a group are filtered. An info display shows the filtered blocks

There is also the possibility after selecting the group elements to add them to a group via Copy & Paste. Drag the "New Group" element from the folder "Groups" of the library into the functional scheme and double-click to open the "Groups" tab to paste the copied functionality.

## 2. Adding the group interface

The connection between "Function chart" and "Groups" is made via the "Group input" or "Group output" blocks of the group interface. Further information can be found in the chapter 6.10.10.4 "Group interface".

## 3. Connecting the group interface

The function blocks in a group can only be connected to the function elements outside the group via the group interface blocks described above. The group interface blocks allow a description of the input and output of the function group. The description should be documented in the comment field.

### 6.10.10.2 Setting the group administration

If you right-click on the group, the context menu for the lock management function appears.

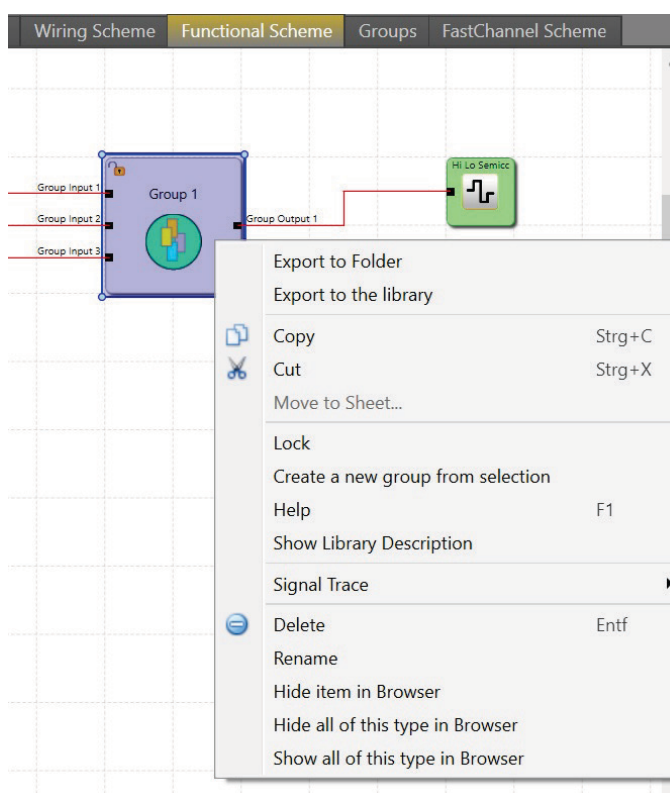


Fig. 220 Context menu, after right mouse click on the group

## Context menu

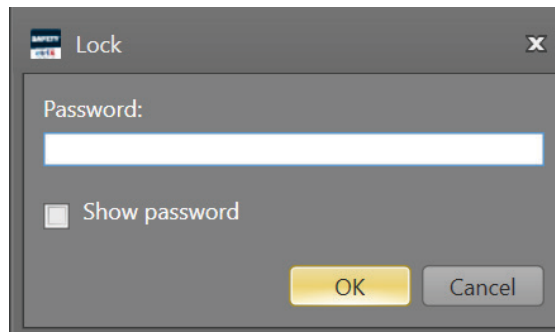
### Export to library

After selecting this option, the group will appear in the folder „User Group „. For further information see chapter 6.10.10.3.1 "Export to library".

### Lock

After completion of the group, it can be locked for modifications by password. By right-clicking on the group, the context menu with the "Lock" function appears. Afterwards a window appears, which requests a password input.

With this password the function group can be locked/unlocked.

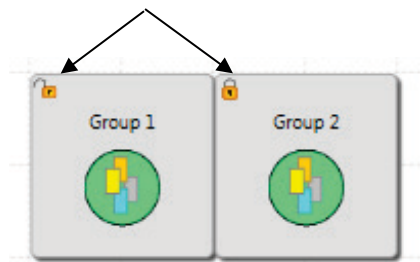


**Fig. 221 Window "Lock", standard**

If the group is locked:

- Module cannot be deleted from the group any more, but parameter configuration is still permitted.
- When a group frame is deleted, also all group blocks are deleted.
- No new blocks can be added to the group.

The group status "disabled" is indicated by the lock symbol in the upper left hand corner.



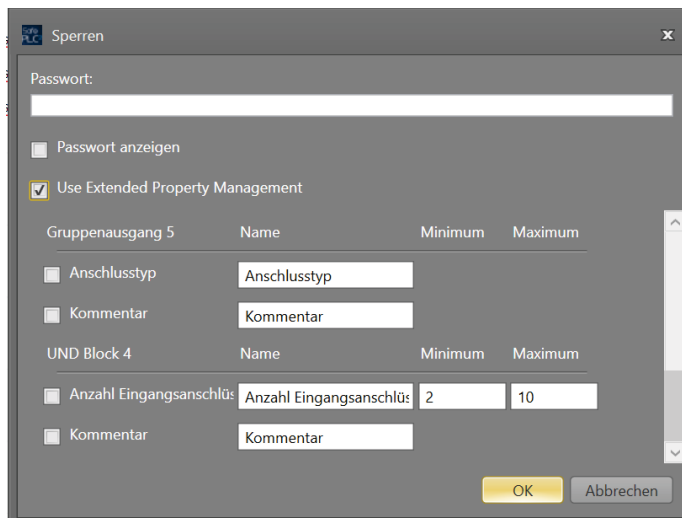
**Fig. 222 group locked / unlocked**

When a new group is added, in the beginning the lock function is not set.



If a new group is created, the lock function is not set initially.

## Locking with selection of "Extended Properties Management"



**Fig. 223 Window „Lock“ with selection of „Extended Property Management“**

If the group has been created and locked by the user with a password, a parameter management option is available. This is an extension of the "Password" dialog window, where the user can select the properties of all available elements of this group, which can be changed when using the group. The user can select individual properties and change their names and limits. These properties with their new names and limits are available in the properties grid of the user group. The logic and properties within the group are locked and cannot be changed unless the group is unlocked. The final user group is then saved under a custom name and can be exported as a .zip file. This .zip file can be imported into ctrlX SAFETY Engineering from another PC and then used in the ctrlX SAFETY Engineering project.



**The „Use Extended Property Management“ option is available from software version 1.7.1.8225.**

### Create a new group from the selection

After selecting the group elements or already existing logic programs, they can be created to a new group, see "Create group".

### Show library description

Opens the window with the definition to a "group" in the user interface

### Signal trace

Previous or subsequent connections can be tracked by this. These are colored blue when this option is activated.

### Delete

Delete a group

### Rename

The name of the „group“ block can be changed.

**Hide selection in browser**


The marked selection is hidden in the browser tree.

**Hide / show all elements of this type in the browser.**

All elements of a type can be hidden or shown after selection in the browser tree of the configuration.

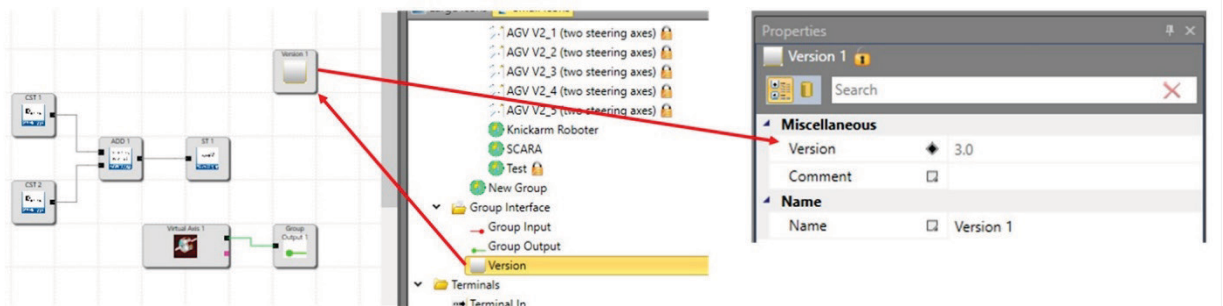
**6.10.10.2.1 Group versioning**

For groups, versions can be assigned. These will then be displayed as a property for locked groups.

 To display the versioning as a property, the version block must be used in the group and the group must be locked.

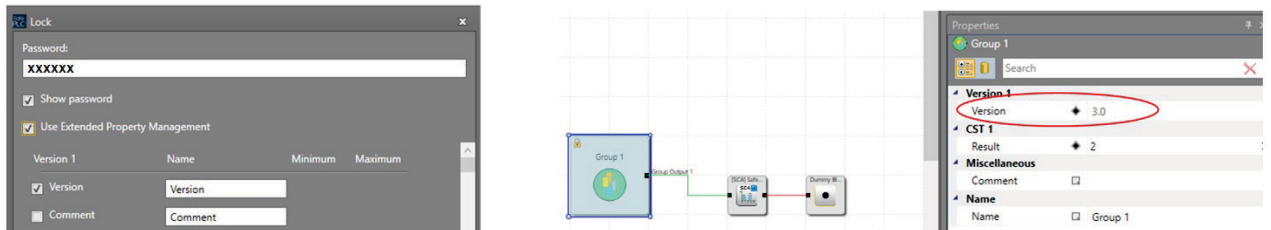
The following steps are necessary:

1. Add the "Version" block to the "Groups" functional scheme.
2. Define the version number in the now appearing property window.



**Fig. 224 Function group, adding a "Version" block**

3. When locking the function group, the checkmarks for "Extended property management" and the version of the version block must be set.



**Fig. 225 Function group, setting during group lock**

xxxxxx is used as a placeholder for the respective password



Versioning of groups is available from software version 1.7.1.8225.

### 6.10.10.3 Export/Import of a function group

A right mouse click on the group shows the selection for export.

- Export to folder
- Export to library

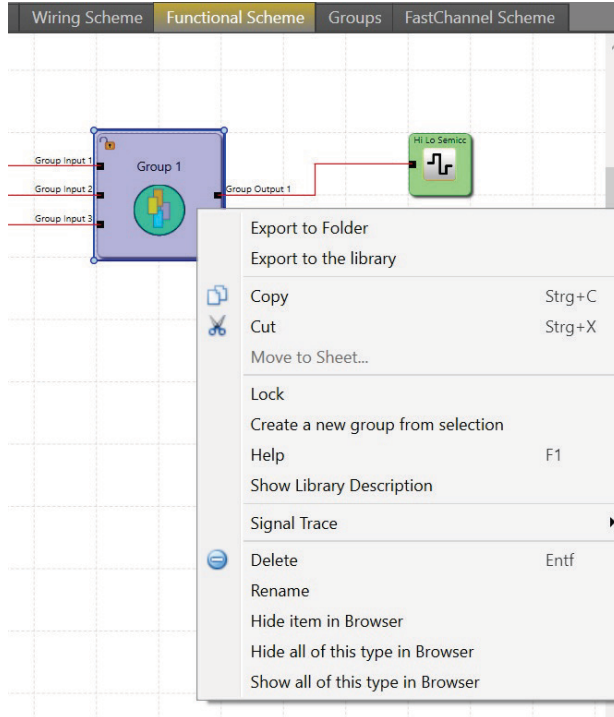


Fig. 226 Functional scheme, group context menu

#### 6.10.10.3.1 Export to library

Created groups can be exported to the library. There they appear in the "User group" folder. An exported group can be imported into a different ctrlX SAFETY Engineering. This export allows you to create a function library., see chapter 6.10.10.3.3 "Import of a group".

The group cannot be renamed in the library. The user can change the image in the "Groups" module of the exported groups.

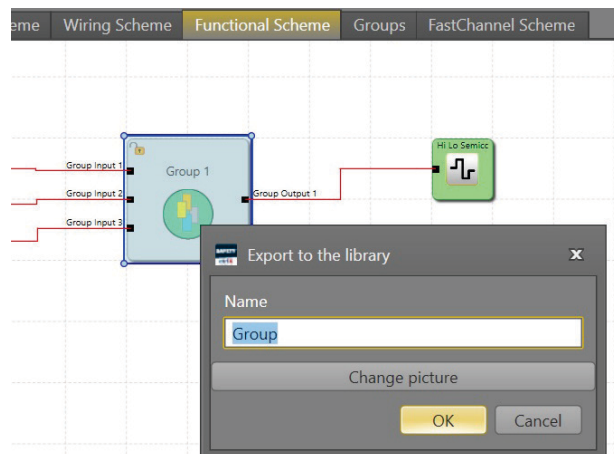


Fig. 227 Group, export to library

### 6.10.10.3.2 Export to folder

After selecting this option, the location must be set to Windows. The user group is saved under a custom name and stored as a .zip file. In addition, the group is also exported to the library.

This .zip file can be imported into ctrlX SAFETY Engineering from another PC and then used in the ctrlX SAFETY Engineering project. A function group can in this way be made available to other users.

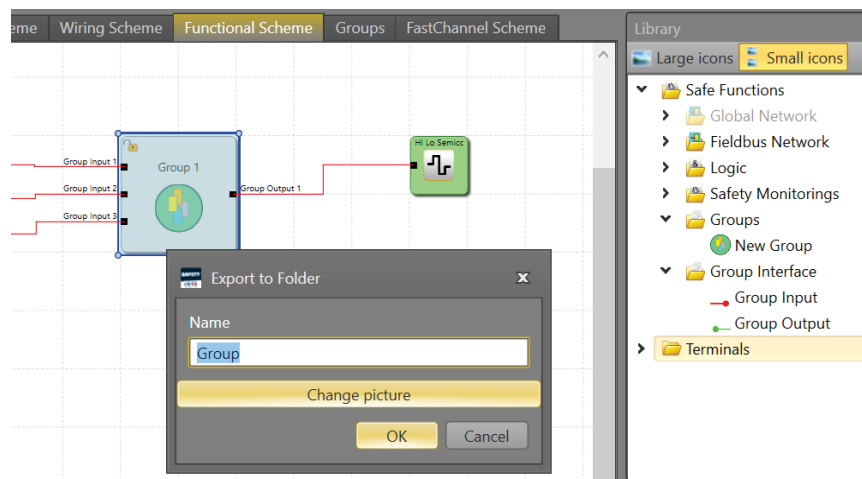


Fig. 228 Group, Export to folder

### 6.10.10.3.3 Import of a group

The import includes the verification of the resources of all used blocks. The group can be imported only if the resources for all elements are ready. The parameters used must be verified. If a resource is no longer available, an error message appears. In case of resource errors, you must make sure that the parameters meet the requirements of the group.

A created user group can be imported into new projects. For this purpose the group to be imported must first be saved in a folder. (as a zip.-file)

There are two possibilities:

1. **Option: via library** – right mouse click on the group and select "Export to Folder"

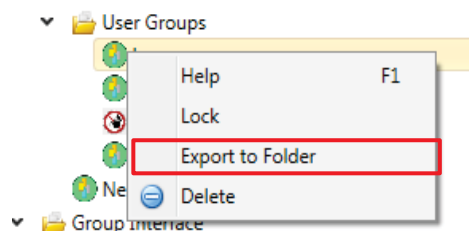
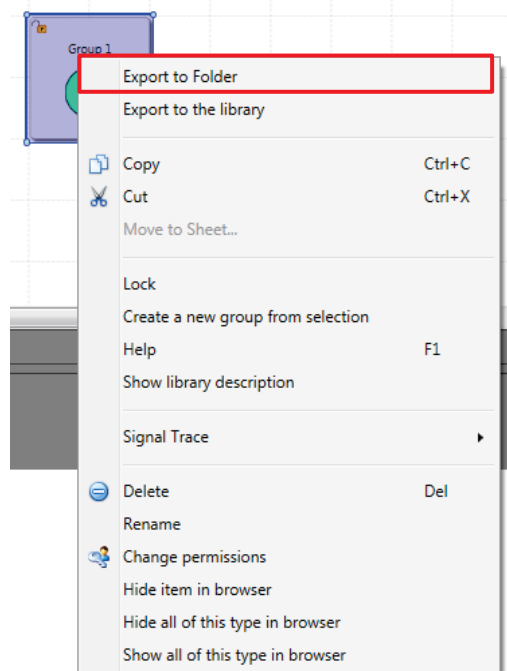


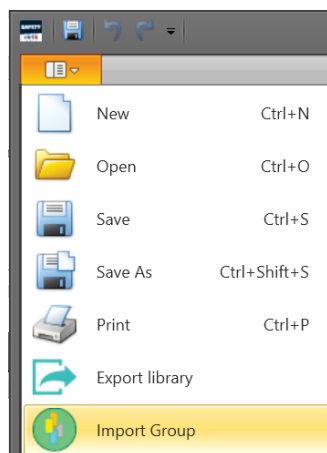
Fig. 229 Group, Exporting a group to folders via library

2. **Option: Directly in work space (canvas)** – right mouse click on the group to display the "Export to Folder" in the context menu.



**Fig. 230 Export of a group via context menu of the group**

After successful saving, select the respective "Group" file in the new project via the Start menu > "Import Group" button and add it or existing ones.



**Fig. 231 Main menu „Import Group“ in new project**

#### 6.10.10.4 Group interface

The blocks of the group interface are the interface from the function group to the elements outside the group. Connections to function blocks outside the group are only possible via the group interface. You can insert a block for a group interface by dragging a group input / a group output into the library of the group interfaces and inserting it in the respective group block (or in the group on the function chart). After you have added a block to a group, the group interface is added. In the interface modules, the connection type can be selected arbitrarily. However, the same connection constellation is necessary to import the group into a different functional scheme.

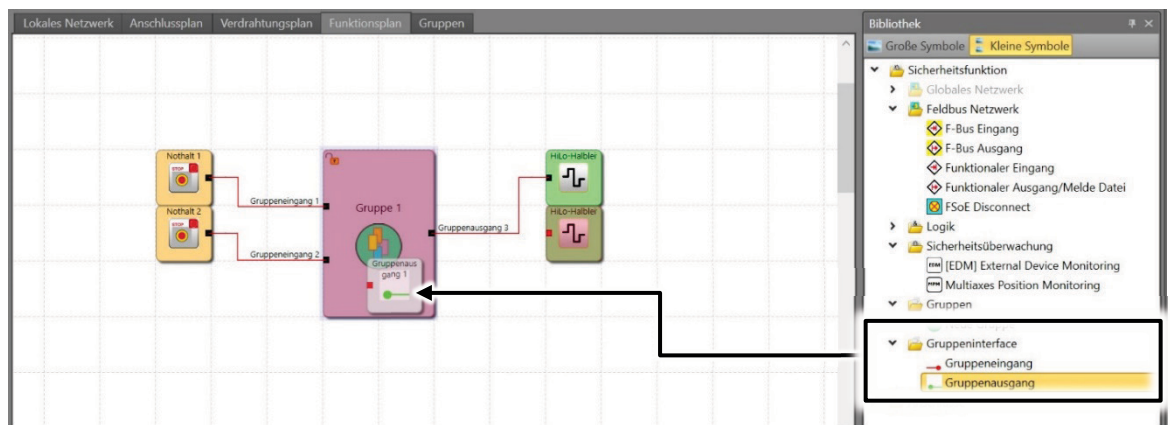


Fig. 232 Add Group output via functional scheme

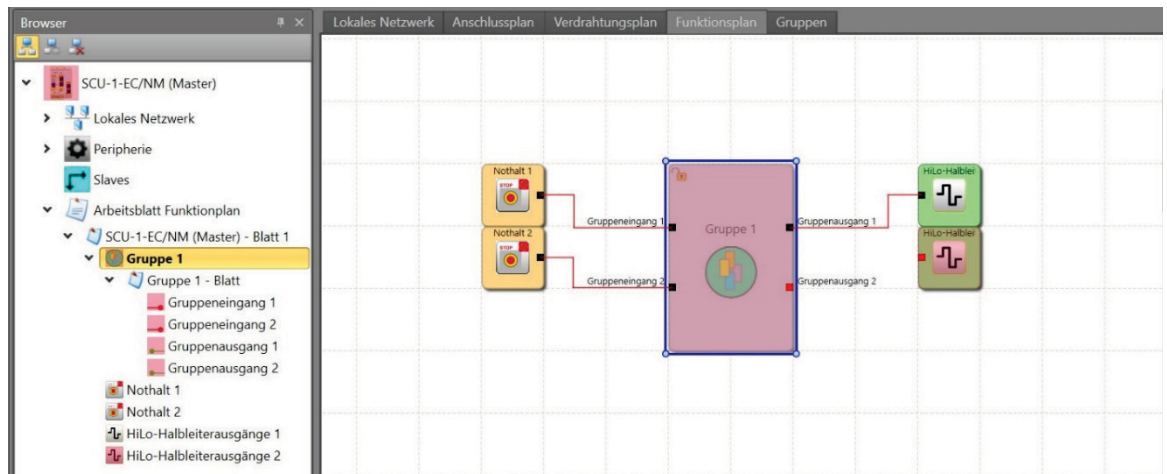


Fig. 233 View functional scheme, new connection point for group output

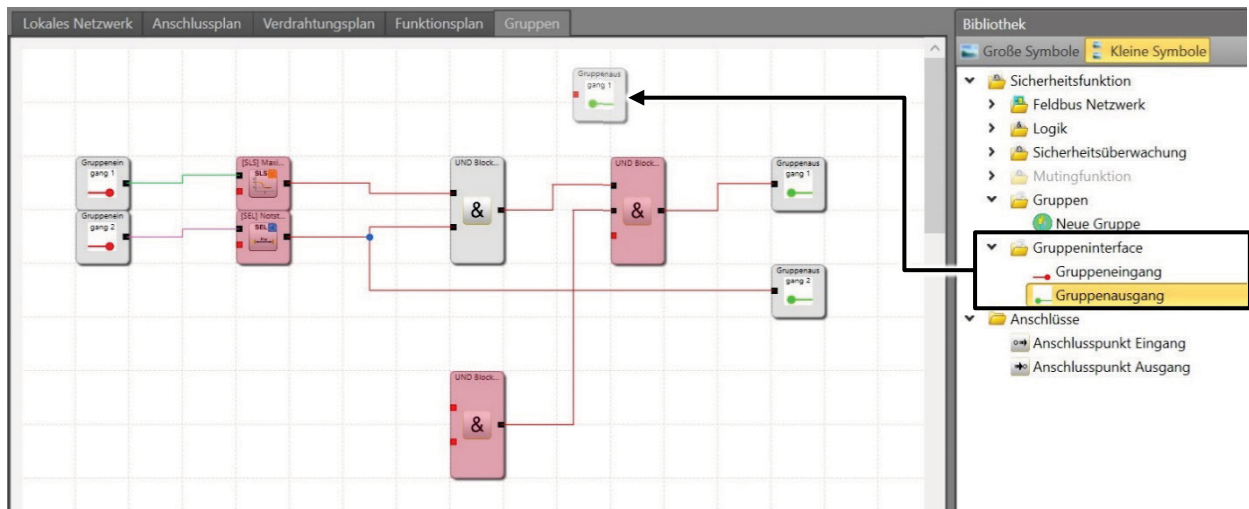


Fig. 234 Add Group output directly from the "Group" tab

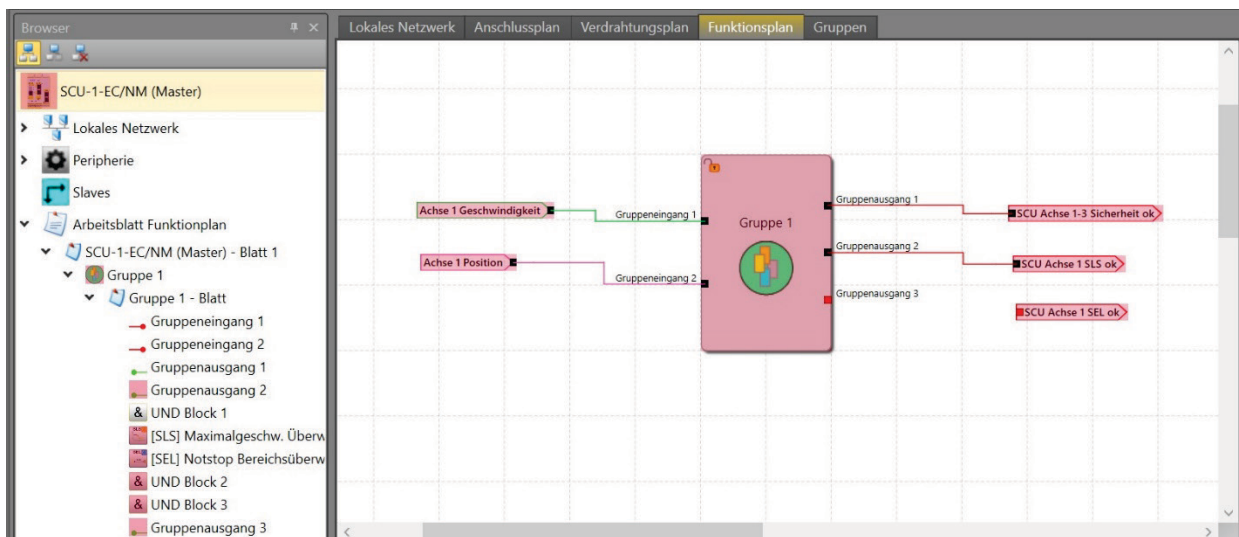
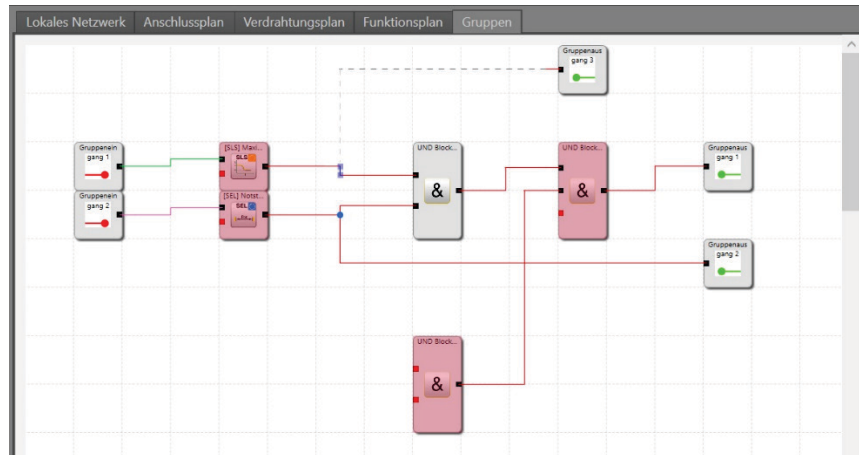


Fig. 235 View of functional scheme, new connection point for group output 3

After you drag an input or output block into a group, the group interface is added.

The connection type can be selected as desired in the properties of the group input or output.



Connection type: This option can be used to set elements of the group inputs and group outputs and to avoid improper assignments.

Proper connection is checked by ctrlX SAFETY Engineering and connecting of different signals is prevented.

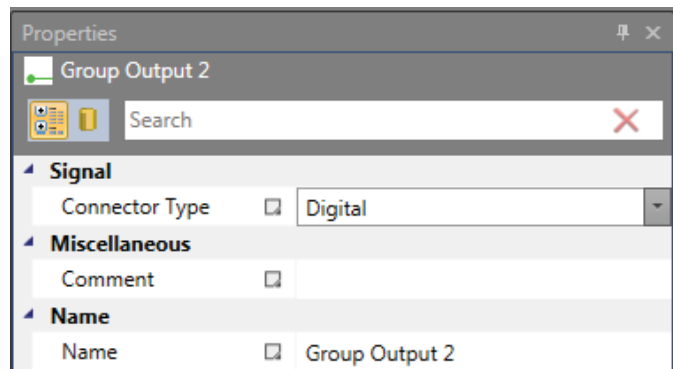




Fig. 236 Properties of group output

With this setting, the connection properties of the block can be determined as group input.

### Group input

 This element shows the connection of the function blocks outside the group to external group elements. If possible, the block shall be situated on the left side of the group area. The output connection must be forwarded within the group.

### Group output

 With this symbol a result is transmitted from the group to external elements of the function block diagram.

Input blocks / output blocks can only be deleted in the group sheet.

## 7 Commissioning

The machine may only be commissioned and its functional tests performed if these products are operated according to their intended function.

### **DANGER**

#### **Danger to life due to bypassing of safety functions**

Resulting in death or serious bodily injury as well as damage to connected devices and machines:

- ▶ Please note that a transfer to production can only take place after the correct execution of the safety-related functions (according to the validation plan) has been ensured.

### **NOTE**

#### **Commissioning of the controller**

The compact safety controller can only be used after it has been programmed.

- ▶ Please note this document

As a minimum, the commissioning of the ctrlX SAFETY devices SAFEX-C.1\* should include the following steps (without programming / debugging):

1. Connection of the provided peripheral elements
2. Importing of the safe AWL program
3. Validation of the peripherals and the AWL program
4. Acceptance test of the specified safety functions
5. Documentation and countersignature of the acceptance test

### **7.1 ctrlX SAFETY Engineering**

The standard commissioning is performed via the ctrlX SAFETY Engineering programming software.

You can find more information about the commissioning in „Installation manual for ctrlX SAFETY devices SAFEX-C.1\* with ctrlX SAFETY Engineering DOK-XSAFE\*-SAFEX-C.1XC-COxx-EN-P<sup>2)</sup>).

You can find the procedure for integration in a ctrlX AUTOMATION environment in the „Application description for the integration of the ctrlX SAFETY SAFEX-C.1\* devices in ctrlX AUTOMATION DOK-XSAFE\*-SAFEX-C.1XC-APxx-EN-P<sup>4)</sup>).

## 7.2 $\mu$ SD memory card

The  $\mu$ SD memory card is provided as an option for commissioning in the following application scenarios:

- Data backup and recovery when devices are replaced without tools
- Serial commissioning of identical devices
- Optional project storage

## 7.3 Switch-on sequence and device status

After each restart of the ctrlX SAFETY compact safety controller, the following phases are run through with error-free operation and displayed as the device status in the ctrlX SAFETY Engineering programming software:

**Table 38: Switch-on sequence - in programming software ctrlX SAFETY Engineering**

Power-up sequence, Device status	Phase or device status identifiers	Description
„1“	Init (STARTUP)	Synchronization between both processor systems and verification of configuration-/firmware data
„2“	Self-test (SENDCONFIG)	Distribution of configuration-/firmware data and re-check of this data. Then range check of the configuration data.
„3“	Bus Init	If available, initialization of a bus system
„4“	RUN	Normal operation of the system. All outputs are switched according to the current state of the logic.
„5“	STOP	Parameter and program data can be loaded externally in stop mode.
„6“	Error	Error mode of the device. All outputs switched off. The error can only be reset via ON/OFF of the device.
„7“	Alarm	Alarm mode of the device. All outputs switched off. The alarm can be reset via a digital input or the front acknowledgement button.
„8“	Run Intern	Local operation of the device as FSoE Master (FSoE slave user not yet in Run). Normal operation without network connection

*Note: This run-up phase is only visible on the ctrlX SAFETY safety controller via the light pipe (PF01). For a detailed description of the LED device diagnostics, please refer to the chapter "Device diagnostics" of the respective ctrlX SAFETY device.*

## 7.4 LED display/device diagnostics

The ctrlX SAFETY device has 2 LEDs: NET ST and NET ST(PF31):

### 7.4.1 ctrlX SAFETY SAFEX-C.12

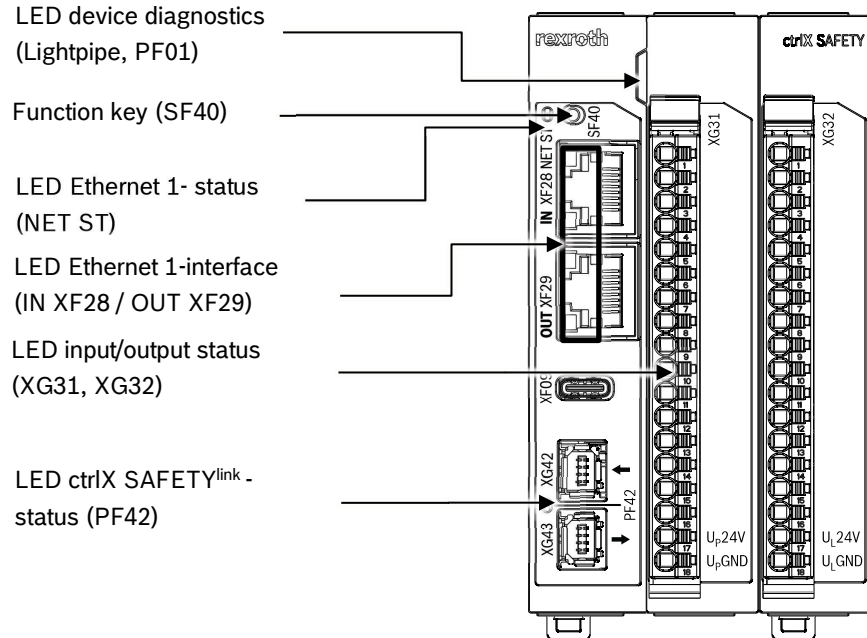


Fig. 237 LED overview SAFEX-C.12

Table 39: Overview of LED and control elements

LED	Color	Description
LED device diagnostics (Lightpipe, PF01)	Green/Yellow/Red	Status display
LED Ethernet 1 status (NET ST)	Green/Red	1 LED
LED ctrlX SAFETY <sup>link</sup> status (PF42)	Green/Red	1 LED
LED Ethernet 1-interface (IN XF28 / OUT XF29)	Green/Yellow	2 LEDs per Ethernet socket (RJ 45) <sup>1)</sup>
LED input/output status (XG31, XG32)	Green	1 LED per input or output
Function key (SF40)	-	Can be operated from the front side

<sup>1)</sup> The exact usage of the LEDs can be seen in Fig. 238: Activated LEDs at Ethernet 1 - LINK / LAN and Fig. 239: Activated LEDs at Ethernet 1 - EtherCAT L/A

**Table 40: LED device diagnostics (Lightpipe, PF01) – LED flashing pattern**

PF01	Start-up phase, Device status	Color	Flashing pattern	Meaning
	-	-	Off	No voltage supply
	Init, Self-test, Stop, BusInit	Yellow	Flashing	The controller is in the startup phase or STOP or a program/firmware download is being performed.
	RunIntern	Yellow	Permanently illuminated	Local operation of the device as FSoE master (FSoE slave user not yet in Run)
	Run	Green	Flashing	The controller is functioning correctly; the application is running, but has not (yet) been validated.
	Run	Green	Permanently illuminated	The controller is functioning correctly; the application is running and validated.
	Alarm	Red	Flashing	Alarm (application error) - the device is in a safe operating state. Error status and safety program can be reset. <sup>1)</sup>
	Error	Red	Permanently illuminated	Fatal error - the device is in a safe operating state. The error state can only be reset via POR.

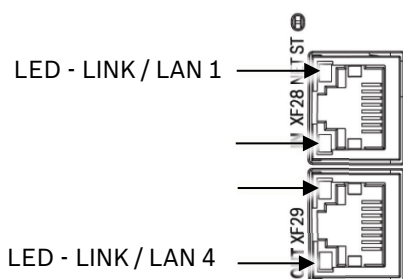


Fig. 238: Activated LEDs at Ethernet 1 - LINK / LAN

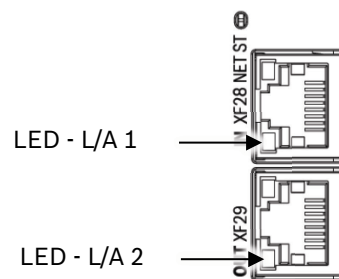


Fig. 239: Activated LEDs at Ethernet 1 - EtherCAT L/A

Table 41: LED Ethernet 1- interface: LINK / LAN and EtherCAT L/A

LINK / LAN Ethernet	Color	Flashing pattern	Meaning
	-	Off	No connection
	Green	Permanently illuminated	A connection to the network is available
	Yellow	Flashing	A connection to the network is available with telegram traffic (Ethernet communication active)

L/A EtherCAT	Color	Flashing pattern	Meaning
	Yellow	Off	No link to EtherCAT master is available
	Yellow	On	Link to EtherCAT master is available, no activity on the bus
	Yellow	Flashing	Link to EtherCAT master is available with active data transmission

### EtherCAT- Diagnostics

Table 42: LED Ethernet 1 status - EtherCAT, combination of NET ST and Error LED

Fieldbus status (NET ST)	Color	Flashing pattern	Meaning
	-	Off	Initialization
	Green	Flashing	PRE-OPERATIONAL
	Green	Flashes once	SAFE-OPERATIONAL
	Green	Permanently illuminated	OPERATIONAL
	-	Off	No error
	Red	Flashing	Invalid configuration
	Red	Flashes once	Local error
	Red	Flashes twice	Watchdog timeout

ctrlX SAFETY<sup>link</sup>Table 43: ctrlX SAFETY<sup>link</sup> LED

ctrlX SAFETY <sup>link</sup> (PF42)	Color	Flashing pattern	Meaning
	-	Off	No voltage supply
	Green	Flashing	The bus is in the start-up phase
	Green	Permanently illuminated	The connection is working without errors - cyclic operation
	Red	Permanently illuminated	Incorrect bus operation during startup or incorrect data exchange

## Inputs and outputs

Table 44: Input/output LED

I/O	Color	Flashing pattern	Meaning
	-	Off	Inputs and outputs inactive, LOW logic status
	Green	Permanently illuminated	Inputs and outputs are activated, HIGH logic status

Table 45: Input/output status

I/O	Logic status	Level	Meaning
	LOW	$-3V \leq U_{LOW} \leq 5V$	Inputs and outputs are inactive
	HIGH	$15V \leq U_{HIGH} \leq 30V$	Inputs and outputs are activated

## 7.4.1.1 Ethernet 1 interface

Table 46: LED Ethernet 1 - interface: LINK / LAN

LINK / LAN	Color	Flashing pattern	Meaning
	-	Off	No connection
	Green	Permanently illuminated	A connection to the network is available
	Yellow	Flashing	A connection to the network is available with telegram traffic (Ethernet communication active)

**EtherCAT- diagnostics****Table 47 LED Ethernet status - EtherCAT, combination of NET ST and Error LED**

<b>Fieldbus status (NET ST)</b>	<b>Color</b>	<b>Flashing pattern</b>	<b>Meaning</b>
	-	Off	Initialization
	Green	Flashing	PRE-OPERATIONAL
	Green	Flashes once	SAFE-OPERATIONAL
	Green	Permanently illuminated	OPERATIONAL
	-	Off	No error
	Red	Flashing	Invalid configuration
	Red	Flashes once	Local error
	Red	Flashes twice	Watchdog timeout

## 7.4.2 ctrlX SAFETY SAFEX-C.15

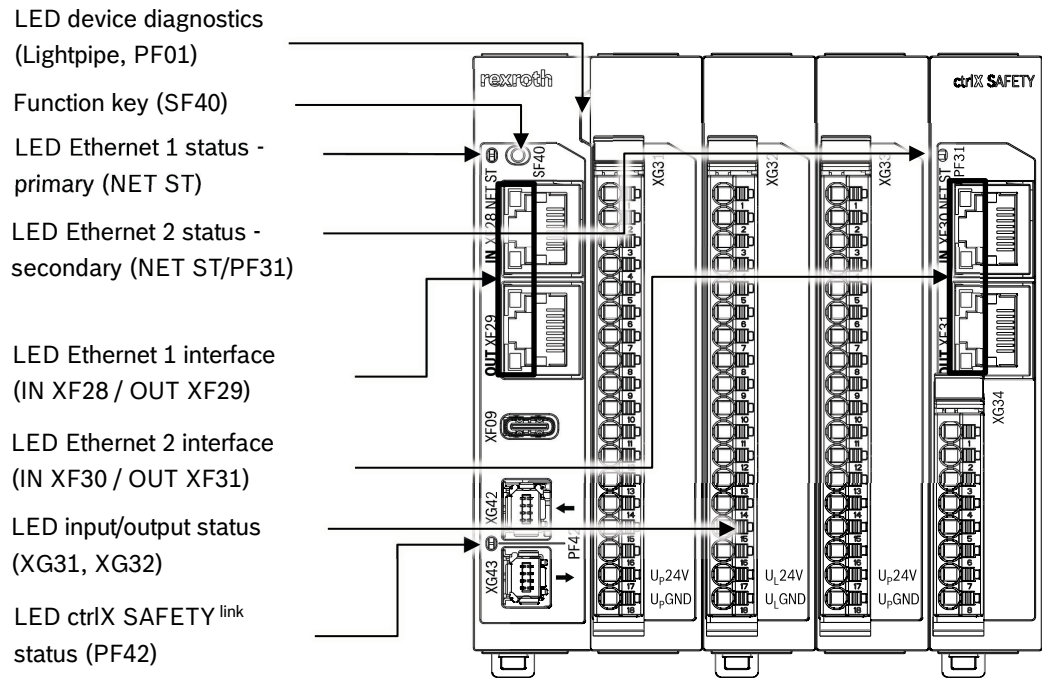


Fig. 240 LED overview SAFEX-C.15

Table 48 Overview of LED and control elements

LED	Color	Description
Device status LED (Lightpipe, PF01)	Green/Yellow/Red	Status display
Ethernet 1 status LED – primary (NET ST)	Green/Red	1 LED
Ethernet 2 status LED - secondary (NET ST / PF31)	Green/Red	1 LED
ctrlX SAFETY <sup>link</sup> status LED (PF42)	Green/Red	1 LED
LED for Ethernet 1-interface (IN XF28 / OUT XF29)	Green/Yellow	2 LEDs per Ethernet socket (RJ 45) <sup>1)</sup>
LED for Ethernet 2-interface (IN XF30 / OUT XF31)	Green/Yellow	2 LEDs per Ethernet socket (RJ 45) <sup>1)</sup>
LED inputs/outputs	Green	1 LED per input or output
Function key (SF40)	-	Operable from the front

<sup>1)</sup> The exact usage of the LEDs can be seen in Fig. 238: Activated LEDs at Ethernet 1 - LINK / LAN and Fig. 239: Activated LEDs at Ethernet 1 - EtherCAT L/A

Table 49 LED device diagnostics (Lightpipe, PF01)

PF01	Start-up phase, Device status	Color	Flashing pattern	Meaning
	-	-	Off	No voltage supply
	Init, Self-test, Stop, BusInit	Yellow	Flashing	The controller is in the startup phase or STOP or a program/firmware download is being performed.
	RunIntern	Yellow	Permanently illuminated	Local operation of the device as FSoE master (FSoE slave user not yet in Run)
	Run	Green	Flashing	The controller is functioning correctly; the application is running, but has not (yet) been validated.
	Run	Green	Permanently illuminated	The controller is functioning correctly; the application is running and validated.
	Alarm	Red	Flashing	Alarm (application error) - the device is in a safe operating state. Error status and safety program can be reset. <sup>1)</sup>
	Error	Red	Permanently illuminated	Fatal error - the device is in a safe operating state. The error state can only be reset via POR.

ctrlX SAFETY<sup>link</sup>Table 50 ctrlX SAFETY<sup>link</sup> –LED

ctrlX SAFETY <sup>link</sup> (PF42)	Color	Flashing pattern	Meaning
	-	Off	No voltage supply
	Green	Flashing	The bus is in the start-up phase
	Green	Permanently illuminated	The connection is working without errors - cyclic operation
	Red	Permanently illuminated	Incorrect bus operation during startup or incorrect data exchange

## Inputs and outputs

Table 51 Input/Output LED

I/O	Color	Flashing pattern	Meaning
	-	Off	Inputs and outputs are inactive, LOW logic status
	Green	Permanently illuminated	Inputs and outputs are activated, HIGH logic status

Table 52 Input/output status

I/O	Logic status	Level	Meaning
	LOW	$-3V \leq U_{LOW} \leq 5V$	Inputs and outputs are inactive
	HIGH	$15V \leq U_{HIGH} \leq 30V$	Inputs and outputs are activated

### 7.4.2.1 Ethernet 2 interface

#### EtherCAT

(see Table 46 and Table 47)

#### Profinet

**Table 53 LED Ethernet 2 – interface: LINK / LAN**

LINK / LAN	Color	Flashing pattern	Meaning
	-	Off	No connection
	Green	Permanently illuminated	A connection to the network is available
	Yellow	Permanently illuminated	A connection to the network is available with telegram traffic (PROFINET communication is active)

**Table 54 Profinet Diagnostics**

PROFINET status	Color	Flashing pattern	Meaning
	-	Off	The device does not have a valid IP address or is switched off.
	Green	Flashing	The device has booted up with a valid IP address, but does not have a cyclic connection.
	Green	Permanently illuminated	The I/O connection is established without errors.
	Red	Flashing	The existing I/O connection was terminated unexpectedly (e.g. Watchdog).
	Red	Permanently illuminated	A “Duplicate-IP-Address-Check” detected that the configured IP address already exists in the network.
	Red-green	Flashing	The device is in the start-up phase and performs a self-test.

## NOTE

For all operating states except RUN, the outputs are passivated by the firmware, i.e. safely switched off. In the RUN state the state of the outputs depends on the implemented PLC program.


### 7.5 Configuration

The configuration is performed via the ctrlX SAFETY Engineering programming software. A USB Type C cable is required for sending the data to the ctrlX SAFETY devices. The ctrlX SAFETY devices can also be configured via EoE when using EtherCAT. The configuration for **ctrlX SAFETY SAFEX-C.1\*** devices in which at least one Ethernet interface for standard Ethernet is configured can be set via this Ethernet interface, as long as that this interface is not used for safe cross-communication between controllers via SMMC.

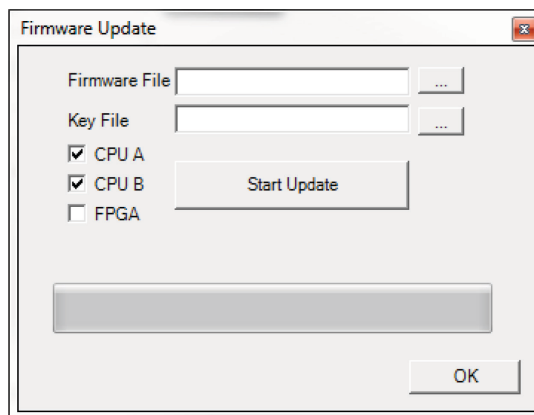
### 7.6 Firmware update

The customer has the possibility to update the firmware of the device (CPU + FPGA) by means of the ctrlX SAFETY engineering or via the  $\mu$ SD memory card.

A corresponding key file + data file from the device manufacturer is required. In the following the firmware update procedure via ctrlX SAFETY Engineering is explained.

 Firmware update via  $\mu$ SD memory card, see following chapter 7.7 “ $\mu$ SD - memory card”.

The firmware update can be started via



A correct key file + data file must be set. The device checks whether the key file is valid. After the update, the device must be restarted via POR.

## NOTE

- ▶ All files or individual files can be updated.
- ▶ Only after a POR the new firmware is transferred to the device.
- ▶ Update time CPUs approx. 20 min, FPGA approx. 45 min

## CAUTION

- ▶ The diagnostics must be closed during the Upload. Timeout time connection must be set to 10 s.
- ▶ Update 1.0.0.x to 1.0.0.y via ctrlX SAFETY Engineering
- ▶ Update 1.0.0.x to 1.0.1.y via service order to DC-AE/SVC432
- ▶ Update 1.0.1.x to 1.0.1.y via ctrlX SAFETY Engineering 1.0.0.x to 1.0.1.y via service order to DC-AE/SVC432

A reboot is required after the update. Depending on the update, the following must be observed:

### **7.6.1 Update CPU A/B only**

After the reboot the device needs approx. 15s until the new firmware is updated. The device runs into the RUN state after the update process is finished.

## CAUTION

After POR, the device may only be switched off again after 15s. Otherwise the device must be returned to the manufacturer.

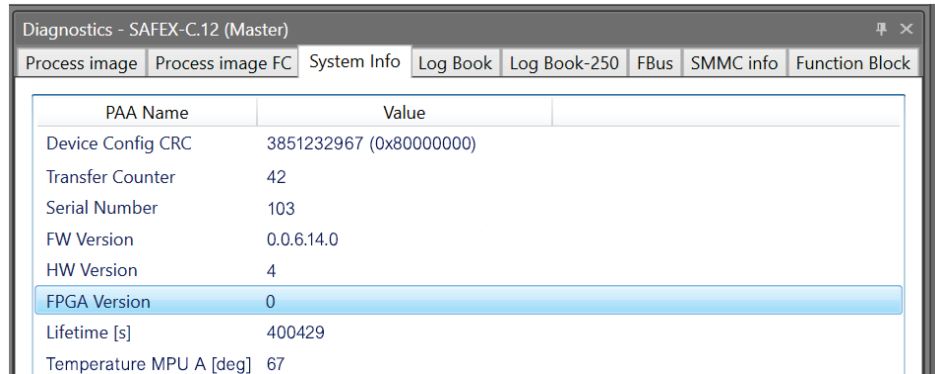
### **7.6.2 Update FPGA**

After the reboot the device needs approx. 15s until the new FPGA is updated. The device runs into the RUN state after the update process is finished.

Inside the FPGAS the NIOS kernel must also be loaded and takes up to max. approx. 2 minutes.

The completion of the update process can also be observed in the diagnostic field:

### After Reboot FPGA Version is „0“



PAA Name	Value
Device Config CRC	3851232967 (0x80000000)
Transfer Counter	42
Serial Number	103
FW Version	0.0.6.14.0
HW Version	4
<b>FPGA Version</b>	<b>0</b>
Lifetime [s]	400429
Temperature MPU A [deg]	67

After finishing the FPGA update process the old version number is entered into the field "FPGA Version".


The device must then be rebooted again. Only then the new FPGA version is updated.

## ! CAUTION

- ▶ The device must not be switched off during the FPGA update. Duration approx. 2 minutes or after completion of update process (see above). Otherwise the module must be sent back to the manufacturer.

### 7.6.3 Error messages update process

Error messages can occur during the update process.

-  Error messages see Error list / Diagnostic messages for ctrlX SAFETY SAFEX-C.1\* devices DOK-XSAFE\*-SAFEX-C.1XC-RExx-EN-P<sup>3)</sup>

### 7.7 µSD - memory card

The device has a µSD memory card slot (CF01) on the top.

This enables the configuration data to be transferred to the device or a firmware update to be carried out when the device is replaced or a back-up is made.

Furthermore, the project file can be stored administratively on the µSD memory card.

To ensure the individual functionalities, the  $\mu$ SD memory card must be formatted accordingly:

File name in folder	Description
/Configfiles/Tocfiles/ <b>config.toc</b>	TOC Configuration (*.toc)
/Projectfiles/Splfiles/ <b>project.spl2</b>	ctrlX SAFETY Engineering Project file
/Securityfiles/Device-password.psw	Security Password
/Updatefiles/Datafile/ <b>datafile.frm</b>	Firmware Update File
/Updatefiles/Keyfiles/ <b>keyfile.frm</b>	Key file for Firmware update

## NOTE

- ▶ In order for the files to be recognized by the device, they must be inserted in the folders provided.
- ▶ Only one \*.toc, \*. Spl2 and a \*.frm file may be stored on the  $\mu$ SD memory card.
- ▶ Several \*.key files with different serial numbers may be stored on the  $\mu$ SD memory card.

### 7.7.1 Uses

#### 7.7.1.1 Data transfer

The following steps must be observed when recording a device:

Make sure that the device is in a de-energized state.

Insert the  $\mu$ SD memory card with the correct data into the  $\mu$ SD memory card slot (CF01) provided for this purpose.

Then supply the respective module with voltage again.

During the startup phase, the configuration data or firmware update files are checked.

##### Configuration data and update files are identical:

If the data match, the host module is up to date and starts up normally or the status LED flashes red.

##### Configuration data different:

If the CRCs of the configuration data are different after the POR of the device, the A1211/A1212 alarm is displayed on the host module or the status LED flashes blue.

##### Firmware update files different:

If there is a valid firmware update file after the POR of the device, the alarm A1213/A1214 is displayed on the host module or the status LED flashes white.

The system waits for confirmation from the user. This is done when the user starts the data transfer by pressing and holding the function key (SF40).

## CAUTION

- ▶  $\mu$ SD memory card must not be removed during data transfer!

### 7.7.1.1.1 Update Configuration data

After activating configuration data transfer via the function key (SF40), the configuration file is automatically uploaded to the device.

During the data transfer, the device is in stop mode.

After the data transfer is finished, the device is restarted automatically.

After updating the configuration data, the user must validate the configuration data.  
validate.

## NOTE

- ▶ After update configuration, validation must be done by the user.
- ▶ After data transfer, the module is restarted automatically.
- ▶ During data transfer not by POR

### 7.7.1.1.2 Firmware Update

After activating the firmware update via the function key (SF40), the update files are automatically transferred to the device.

During the data transfer the device is in stop mode.

After the data transfer is finished, the device is restarted automatically.

For firmware update with FPGA the device remains in the error state Fatal Error for approx. 2 minutes in the error state Fatal Error, before the second restart takes place.

## NOTE

- ▶ After firmware update, validation must be performed by the user..
- ▶ The device is automatically restarted after the data transfer. The module can be restarted twice during a firmware update.
- ▶ Update process + restart takes approx. 10 minutes.

## WARNING

**The voltage supply to the device must not be interrupted during the data transfer and restart process.**

### 7.7.1.2 Save/load project file

The user then saves and loads the project file on µSD memory card via ctrlX SAFETY Engineering.

### 7.7.1.3 Save/load \*.toc file

The user can save the current configuration on the device to the µSD memory card via ctrlX SAFETY Engineering.

<b>NOTE</b>
<ul style="list-style-type: none"> <li>▶ Configuration data must be loaded into the device before it is saved.</li> <li>▶ Parallel to saving *.toc file, the security password is stored on the µSD memory card.</li> </ul>

Diagnosis:

Message	Remedy
[None] 7:41:22 AM: Transfer unsuccessful. Error: 0	Entfernen des KeyFile

## 7.8 Security

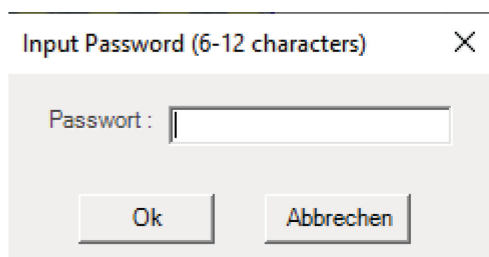
After connecting ctrlX SAFETY Engineering to the safety device, the device is in "Secure" mode.

In secure mode, the following actions are not allowed::

- Upload/download configuration files
- Locking of configuration data
- Firmware update

### 7.8.1 Activation

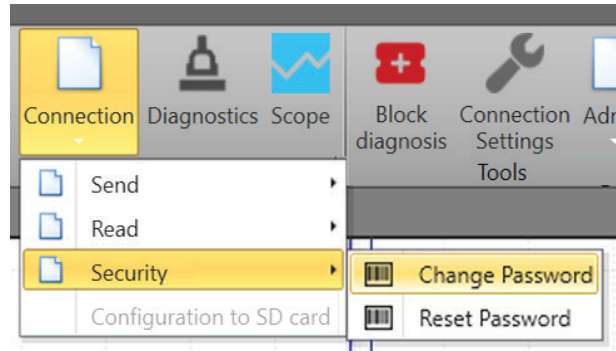
With a click on "Secure" the user must enter the password



In the message window appears "Access granted" if password is correct. Otherwise "Access denied".

<b>NOTE</b>
<ul style="list-style-type: none"> <li>▶ The security password is not updated on the µSD memory card until the configuration data has been transferred.</li> </ul>

## 7.8.2 Change Password



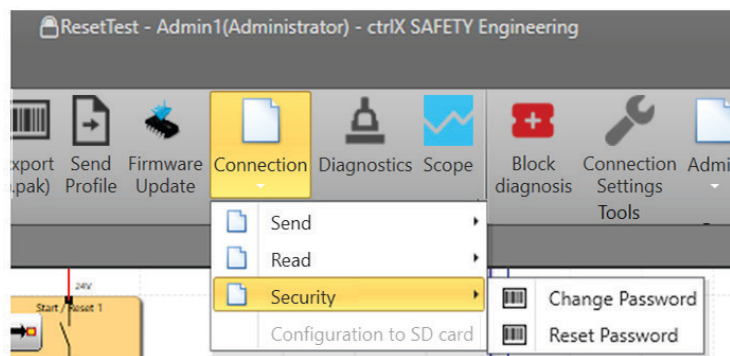
To save a new password, the user must send the "old" and the "new" password to the device.

- Minimum length 6 characters
- Maximum 12 characters

In the message window appears "Password changed" if password is correct.

## 7.8.3 Reset Password

In case of a forgotten password, the user has the possibility to reset the password to the default one.

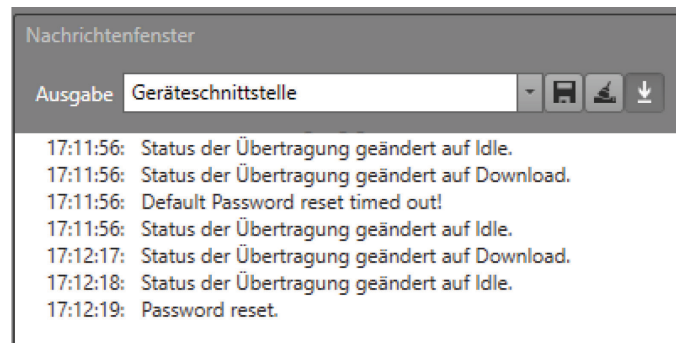


After activating "Reset password", the user must press the function key (SF40) within 10 seconds.

If successful, the message "Password reset" is generated in the message window.

After an error, the message "Default Password reset timed out!" is generated.

Default password: **boschrexroth**



## 7.9 Validation

Each safety function must be validated after implementation to ensure its correct functioning and reliability. A validation of safety functions takes place at different levels and is explained in more detail by the EN 13849-2 standard:

### **NOTE**

- ▶ Validation of the safety function in the ctrlX SAFETY Engineering programming software
- ▶ Additional validation of the safety function on the finished machine
- ▶ Performance of functional tests of diagnostic measures and shutdowns in the event of failure
- ▶ Implementation of error detection measures to verify the correct cable installation on the machine.

In addition to functional testing, the validation of safety-related controllers also includes a detailed analysis and, if necessary, error simulations. This analysis should be performed at the beginning of the design process to enable the identification of problems at an early stage.

The scope of the analyses and tests carried out as part of the validation depends on the complexity of the controller and its integration into the machine or system.

A validation plan must be created for the validation. Depending on the complexity of the controller or machine to be tested, this plan contains the following information:

- Requirements for implementation
- Operating and ambient conditions
- Basic and proven safety principles
- Proven components
- Fault assumptions and fault exclusions
- Applied analyses and tests

In order to maintain the performance of safety-related controllers and to ensure their safety, regular maintenance and servicing with periodic tests are required. (see chapter 7.11 „Maintenance“)

### 7.9.1 Procedure

In order to verify the implemented safety functions, the user must check and document the parameters and links after commissioning and configuration. This is supported by the ctrlX SAFETY Engineering programming software in form of a configuration report.

The concept for the **ctrlX SAFETY SAFEX-C.1\*** assumes the following basic requirements:

Parameter and AWL data stored in the flash memory of the **ctrlX SAFETY SAFEX-C.1\*** cannot change on its own. This is verified by online tests and corresponding signatures in the course of basic measures.

However, the configuration itself cannot be evaluated from the **ctrlX SAFETY SAFEX-C.1\***. This applies to the program and its logic, as well as the configuration of the sensors, threshold and limit values.

The correctness of the configuration can only be verified through a check by an appropriate specialist. This process corresponds to validation.

After a successful commissioning, the user must confirm that the data of the configuration report matches the parameter data located on the **CtrlX SAFETY SAFEX-C.1\***.

The configured values for the measuring section, sensors and monitoring functions must be individually verified and logged by the user in the course of a functional test.

In addition, the programmed AWL functions must be verified and logged by the user by means of a code inspection for each link. For this purpose, it is recommended to design the controller in such a way that the limit values of the **ctrlX SAFETY SAFEX-C.1\*** can be tested. (validation/configuration report)

## 7.9.2 Configuration report

The validation of the compact safety controller is carried out on the basis of a configuration report. All set parameters must be checked and confirmed.

### 7.9.2.1 Procedure for the configuration report

The configuration report contains the following data:

- A header area with the checksums and fields for entering general data of the project
- A section with the list of AWL instructions (PLC code)
- An overview of the inputs and outputs used and their parameterization
- All monitoring functions used and their parameters

Example: SCA configuration data

Safe Cam (SCA)				
Index	Parameter	Value	Unit	validated
<b>SCA - 0</b>				
	Axis	EncBox(0)Enc(0)		<input type="checkbox"/>
	Speed Tolerance			
	Speed	10000	deg/s	<input type="checkbox"/>
	Position monitoring			
	Lower Limit Position X1:	-10000	deg	<input type="checkbox"/>
	Upper Limit Position X2:	-9000	deg	<input type="checkbox"/>
<b>SCA - 1</b>				
	Axis	EncBox(0)Enc(0)		<input type="checkbox"/>
	Speed Tolerance			
	Speed	10000	deg/s	<input type="checkbox"/>
	Position monitoring			
	Lower Limit Position X1:	22000	deg	<input type="checkbox"/>
	Upper Limit Position X2:	44500	deg	<input type="checkbox"/>
<b>SCA - 2</b>				
	Axis	EncBox(0)Enc(1)		<input type="checkbox"/>
	Speed Tolerance			
	Speed	9	deg/s	<input type="checkbox"/>
	Position monitoring			
	Lower Limit Position X1:	-10	deg	<input type="checkbox"/>
	Upper Limit Position X2:	95	deg	<input type="checkbox"/>
<b>SCA - 3</b>				
	Axis	Robot Axis(1)		<input type="checkbox"/>
	Robot	Yes		<input type="checkbox"/>
	Speed Tolerance			
	Speed	40	mm/s	<input type="checkbox"/>

Fig. 241 Configuration data Safe Cam (SCA)

### 7.9.2.2 Creation of the configuration report

A configuration report of the connected device can be created via the connection dialog of the ctrlX SAFETY Engineering programming software.

For this purpose, the necessary data is downloaded from the connected device and legibly stored in a \*.pdf document. The storage location of the document can be determined by the user when the document is created.

The corresponding fields can be entered directly in the PDF document. The validation can also be performed using a printout of the configuration report.

### 7.9.2.3 Filling out the configuration report

The configuration report is filled out as follows:

- Fill out the system-specific data in the "Header" area. This data is of informative nature, but should be coordinated with the acceptance point / validator regarding its content and scope.
- Set all checkmarks in the Header area if the displayed data (serial number, device type, CRC of the configuration) are identical to the data of the device .
- Validate the PLC application program and make sure that the executed code corresponds to the specified function.
- Set the check marks in the Inputs/Outputs area for each entry that matches the actual connection of the ctrlX SAFETY SAFEX-C.1\*.
- Set the check marks for all safety functions (e.g. SLS, SCA, etc.) if the configured parameters match the requirements.

## **NOTE**

The correct program and parameter data must be loaded to create the configuration report.

- ▶ All listed parameters and program instructions must be validated on the system / machine and confirmed in the configuration report.
- ▶ The validator must validate all configured data in the configuration report by checking all configured limit values of the monitoring functions used by means of a functional test.

## 7.9.3 Validation: IL [AWL]- Program

### 7.9.3.1 General

The IL [AWL] program is structured in the following way:

Index	Operator	Operand
1	LD	CBool.0
2	ST	MX.1

Index: sequential no = line IL[ AWL] program

Command: for all permitted commands, c. f. the list “IL – commands“

Operand: for the processing code cf. the list “IL-Operand“. There are three operand types

Type1 -> Operand.x

x: bit number

Type2 -> Operand.x.y

x: Index assembly/instance

y: bit number

Type3 -> Operand x.y.z

x: index assembly

y: instance operand

z: bit number

### 7.9.4 Input elements

The input elements are marked in the il [AWL] code.

SQH	8e
LD	MX.46
AND	FE0.20
ST	MX.75
SQC	55539.1

SQH marks the start of an input element and

SQC marks the end of an input element.

SQH marks the number of the input element

SQC marks the backup value of the input element logic.

Input elements marked with SQH/SQC must only be checked with respect to their instance and with respect to their bit location. Their logic is checked in the assembly.

### 7.9.5 Monitoring functions

For the monitoring functions, there are two way of processing that generate additional IL code.

#### 7.9.5.1 Cascading

The following functions are cascadable:

SEL, SLS, SOS:

The following code is generated:

Example SOS:

```
LDMX.x
ST DriveSOS_EN0.0.0
NOT
AND MX.y
ORDriveSOS0.0.0
STMX.y
STDriveSOS0.0.0
```

SCA

```
Special case
LDMX.x
STDriveSCA_EN0.0.0
NOT
ORDriveSCA0.0.0
STDriveSCA0.0.0
```

If “enable unconditioned“ is used, the following code is generated:

Example SLS:

```
S1 DriveSLS_EN0.0.0
```

With all other monitoring functions, simple LD commands and simple ST commands are used.

### 7.9.5.2 Axis groups

Monitoring functions can be combined using axis groups. Basically, one monitoring block is one monitoring block is provided for every axis in an axis group. In the IL [AWL] code, the individual results are summarized (AND).

Example SLS (Axis group with 3 axes)

```
LD MX.63
ST DriveSLS_ENO.5.0
ST DriveSLS_ENO.6.0
ST DriveSLS_ENO.7.0
NOT
AND MX.64
ST MX.64
LD DriveSLS0.7.0
AND DriveSLS0.6.0
AND DriveSLS0.5.0
OR MX.64
ST MX.64
ST DriveSLS0.5.0
```

### Attention!

Special function SCA

Example SCA with 2 axes:

```
LD MX.58
ST DriveSCA_ENO.4.0
ST DriveSCA_ENO.5.0
NOT
ST MX.71
LD DriveSCA0.5.0
AND DriveSCA0.4.0
OR MX.71
ST DriveSCA0.4.0
```

Special function SRS

Result: axis group is already edited in the function. Thus, the result of the smallest entity is used.

Example: SRS axis group with 6 axes

```
LD MX.35
ST DriveSRS_ENO.0.0
ST DriveSRS_ENO.1.0
ST DriveSRS_ENO.2.0
ST DriveSRS_ENO.3.0
ST DriveSRS_ENO.4.0
ST DriveSRS_ENO.5.0
//-----
LD DriveSRS0.0.2
ST FA0.19
//-----
LD DriveSRS0.0.1
ST FA0.20
//-----
LD DriveSRS0.0.0
ST FA0.21
//-----
LD DriveSRS0.0.3
ST FA0.22
```



Special function SRX: Result: axis group is differently linked.

Example: SRX axis group with 6 axes

```
LD MX.44
ST DriveSRX_ENO.0.0
ST DriveSRX_ENO.1.0
ST DriveSRX_ENO.2.0
ST DriveSRX_ENO.3.0
ST DriveSRX_ENO.4.0
ST DriveSRX_ENO.5.0
LD MX.49
ST DriveSRX_ENO.0.1
ST DriveSRX_ENO.1.1
ST DriveSRX_ENO.2.1
ST DriveSRX_ENO.3.1
ST DriveSRX_ENO.4.1
ST DriveSRX_ENO.5.1
LD MX.50
ST DriveSRX_ENO.0.2
ST DriveSRX_ENO.1.2
ST DriveSRX_ENO.2.2
ST DriveSRX_ENO.3.2
ST DriveSRX_ENO.4.2
ST DriveSRX_ENO.5.2
LD MX.51
ST DriveSRX_ENO.0.3
ST DriveSRX_ENO.1.3
ST DriveSRX_ENO.2.3
ST DriveSRX_ENO.3.3
ST DriveSRX_ENO.4.3
ST DriveSRX_ENO.5.3
LD DriveSRX0.5.0
AND DriveSRX0.4.0
AND DriveSRX0.3.0
AND DriveSRX0.2.0
AND DriveSRX0.1.0
AND DriveSRX0.0.0
ST DriveSRX0.0.0
LD DriveSRX0.5.1
OR DriveSRX0.4.1
OR DriveSRX0.3.1
OR DriveSRX0.2.1
OR DriveSRX0.1.1
OR DriveSRX0.0.1
ST DriveSRX0.0.1
```

## 7.10 Safety-related verification

To ensure the implemented safety functions, the user must check and document the parameters and links after commissioning and parameterization. This is supported by the ctrlX SAFETY Engineering.

The following data must be checked:

- Check index for consecutive numeration
- Check command available in list "IL – commands"
- Check operand available in list "IL-Operand" and type correct
  - index: Slave number
  - instance: cf. "Process image"
  - Bit number: cf. "Process image"
- Check additional IL [AWL] code monitoring functions
  - Functional test
- Lock configuration data on assembly after successful test

A configuration report of the connected device can be created via the connection dialog in ctrlX SAFETY Engineering.

General information about the plant can be given on the first two pages. On the following pages of the validation report, all the functions used are printed with their parameters as an itemization of the safety-related test.

After the transfer of the configuration data and the program data to ctrlX SAFETY device, the status LED shows the status "not yet validated". (see chapter "LED display/device diagnostics"). This indicates that the configuration data has not yet been validated.

By confirmation of the "Lock configuration" button at the end of the validation dialog, the data is marked as "Validated" and the status LED indicates the "validated" status (see chapter "LED display/device diagnostics").

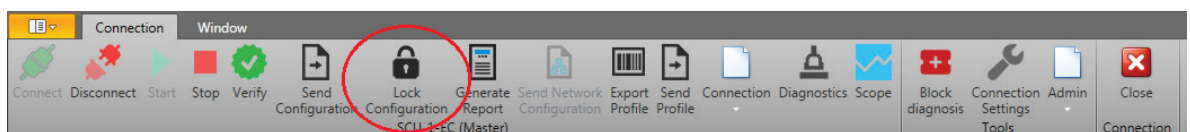


Fig. 242 Tab "connection", lock configuration

## 7.11 Maintenance

### **NOTE**

**Maintenance work in the device may only be performed by trained personnel!**

- ▶ To replace hardware and software components, please contact the Bosch Rexroth Service department and only have this work carried out by trained personnel.

### **7.11.1 Regular maintenance activities**

Include the following activities in your maintenance plan:

- Check all plug and terminal connections of the components for correct seating and damage at least once a year
- Check the cables for breakage or pinching
- Have damaged parts replaced immediately
- Replacement of the device after a maximum service life of 20 years
- To ensure the safety of the device, a functional test of the safety functions must be carried out at least once a year.
- Check all blocks and elements used in the parameterization (inputs, outputs, monitoring functions and logic modules) for their function or deactivation

## 8 Causes and correction of errors

If the device does not work properly, it automatically switches to the safe state and indicates the fault state via LED.

Please first check the displayed error code using the error list of ctrlX SAFETY (Error list and diagnostic messages)

If it is not possible to eliminate the faulty condition, please contact the manufacturer immediately.

### 8.1 Reset behavior

The reset function can be divided into a start function after restoration of the voltage supply (general reset) and an alarm reset (internal reset). The latter is triggered by the function button (SF40) on the front panel and by a corresponding input (reset element) with the "alarm reset" function activated or by the bus (FSoE or CoE). The table below provides an overview of the reset functions and their effects.

#### 8.1.1 Reset types and triggering events

**Table 55 Reset types and triggering events**

Reset type	Triggering element	Meaning
General reset (General reset Alarm/Fatal Error)	Restoration of voltage supply / commissioning of the device	No voltage supply
Internal reset	Front function button (SF40) or Start/Reset element (configuration alarm)	Triggering of the internal reset for alarm by the frontal function key or configuration of a reset input
	Reset via network	Triggering of the internal reset for alarm via F-bus
Block reset	Start/Reset element (configuration block reset)	Configuration of up to 6 block reset elements for resetting errors of monitoring functions

#### 8.1.1 Reset timing

The reset input for the internal reset is time-monitored in "RUN" mode. An internal reset is triggered with a falling edge of the reset input under the condition  $4 \text{ ms} < T < 3000 \text{ ms}$  between rising and falling edge.

The time interval between 2 reset signals is time-monitored. A second reset is only permitted after a certain period of time ( $\geq 1$  s) after the first reset has elapsed.

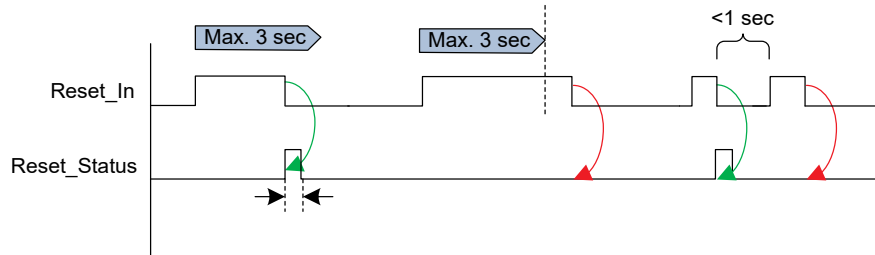


Fig. 243 Reset timing

### 8.1.2 Reset function

Table 56 Reset functions

Functional unit	General reset	Internal reset	Function
Fatal error	X		Reset error
Alarm	X	X	Reset alarm
Monitoring functions	X	X	Reset of an addressed monitoring function
Flip-flop	X	X	Status = Reset
Timer	X	X	Timer = 0

The status of the monitoring functions is re-initialized after a reset.

- If the parameterized limits are exceeded, process values do not lead to any change in the output status of the monitoring function.
- Time-based functions - Timers reset the output status of the monitoring function. A response only takes place when the parameterized limit values are exceeded again.

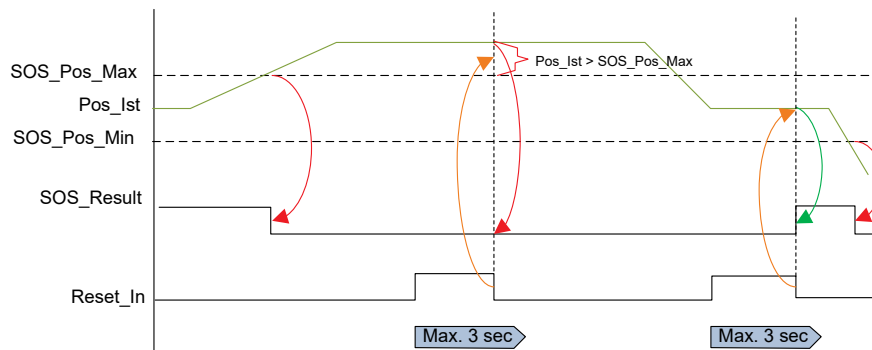
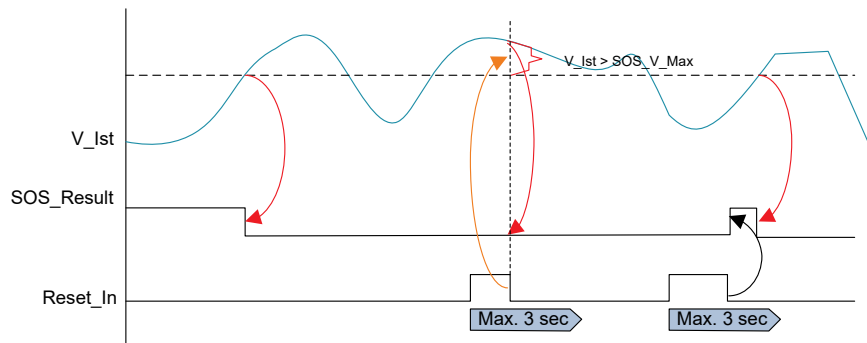
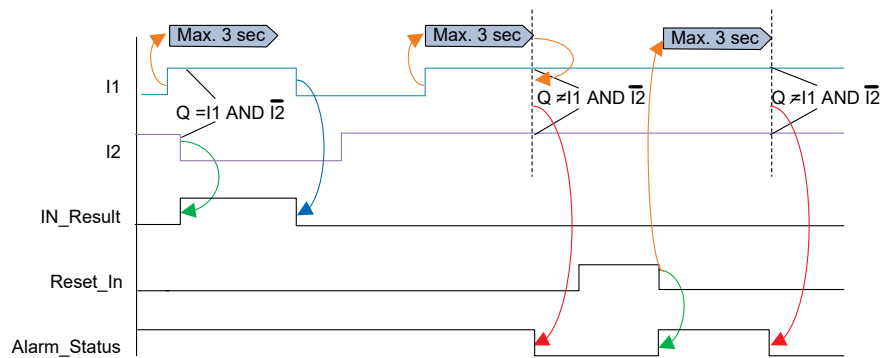


Fig. 244 Reset function 1: Process value (position) > no change of the output status for a reset in the alarm state



**Fig. 245 Reset function 2: Process value (speed) > no change of the output status for a reset in the alarm state.**



**Fig. 246 Reset function 3: Time-based function > Reset of the output state, response if the limit is crossed again.**

## NOTE

- ▶ With time-based functions, e.g. time-based monitoring of complementary input signals, the output state is reset and a defined error state is only detected if the (time-based) limit value is exceeded again.
- ▶ In order to protect against incorrect use, e.g. repeated triggering of the reset function to circumvent an alarm state, application-based measures may have to be taken in the AWL programming.

## 9 Appendix

### 9.1 CoE Object list

Obj.ID	Parameter	Amount	Byte	Type	Unit	Access	Process config	Description
0x1	<b>Type label EtherCAT</b>	1						
0x1000	Device type	1	4	UNSIGNED32		R		Device type
0x1008	Manufacturer device name	1	24	STRING		R		Device name
0x1009	Manufacturer hardware version	1	32	STRING		R		HW version EtherCAT
0x100A	Manufacturer software version	1	32	STRING		R		FW version EtherCAT
0x1018	Identity object	1				R		
0	Number of subindizes	1	1	UNSIGNED8		R		Number of subindizes
1	Vendor ID	1	4	UNSIGNED32		R		EtherCAT Vendor ID
2	Product code	1	4	UNSIGNED32		R		Product code ctrlX SAFETY
3	Revision number	1	4	UNSIGNED32		R		Revision number ctrlX SAFETY
4	Serial number	1	4	UNSIGNED32		R		Serial number ctrlX SAFETY
0x6	<b>Type label Device</b>	1						
0x60B0	<b>Functional Outputs</b>	32	1	UNSIGNED8		R		Functional Outputs ctrlX SAFETY of which 5 bytes header + 18 bytes binary data output
0x7	<b>Type label Device</b>	1						
0x70B0	<b>Functional Inputs</b>	18	1	UNSIGNED8		R		Functional Inputs ctrlX SAFETY 18 bytes binary data input
0x9	<b>FSoE Connection Communication Parameter</b>	1						
0x9nn1								
1	<b>Version</b>	2	1	STRING		R		Supported FSoE Version = 01
2	<b>FSoE Slave Address</b>	1	2	UNSIGNED16		R		FSoE Slave Address
3	<b>Connection ID</b>	1	2	UNSIGNED16		R		FSoE Connection ID
4	<b>Watchdog Time</b>	1	2	UNSIGNED16		R		FSoE Watchdog Time
5	<b>Unique device ID</b>	6	1	STRING		R		6 Byte unique device ID (0 if not used)

6	<b>Connection Type</b>	1	1	ENUM		R	1: Slave connection 0: Master Connection
7	<b>ComParameter Length</b>	1	2	UNSIGNED16		R	Number of bytes of the communication parameter
8	<b>AppParameter Length</b>	1	2	UNSIGNED16		R	Number of bytes of the application parameter
9	<b>SRA CRC</b>	1	4	UNSIGNED32		R	CRC checksum of the safety related application parameter set
0xA	<b>Connection diagnosis</b>	1					
0xAnn0							
1	<b>Connection state</b>	1	2	ENUM[16]		R	100 = Reset 101 = Session 102 = Connection 103 = Parameter 104 = Data 105 = Failsafe
2	<b>Connection diagnosis</b>	1	2	UNSIGNED16		R	Diagnosis bits of FSoE Connection Bit 0..3: 0 = no error 1 = wrong command 2 = unknown command 3 = wrong connection ID 4 = wrong CRC 5 = watchdog expired 6 = wrong FSoE address 7 = wrong data 8 = wrong communication parameter length 9 = wrong communication parameter 10 = wrong application parameter length 11 = wrong application parameter 12 = unexpected session command 13 = if failsafe data are communication error: failsafe data received  Bit 4: 0 = error in FSoE Master 1 = error in FSoE Slave Bit 5: 1 = FSoE slave sends no process data Bit 6: 1 = connection in startup Bit 7: 1 = FSoE Master sends no process data (FSoE Master in failsafe)

## 9.2 Functional Output

For usage of additional error diagnostic it has to be activated in the device property.

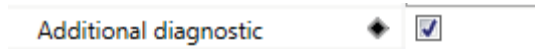


Fig. 247 Activation of Additional diagnostic in device property

### 9.2.1 Functional Output PROFINET

Structure of functional outputs

Table 57 Assignment of functional outputs, Profinet

Byte	Bit	„Run“ mode (1, 2, 3, 4, 8)	Error case (6, 7)
Byte 0	0..3	Device status 1 = Init, 2 = Self-test, 3 = BusInit, 4 = Run, 5 = Stop, 8 = RunIntern	6 = FatalError, 7 = Alarm,
	4	0x1 (define)	0x1 (define)
	5..7	Alive counter (3 Bit)	Alive counter (3 Bit)
Byte 1	0..7	0	1
Byte 2	0..7	0	0
Byte 3	0..7	0 = no error Error code low Byte	0 = no error Error code low Byte
Byte 4	0..7	0 = no error Error code high Byte	0 = no error Error code high Byte
Byte 5	0..7	Functional Output (0..7)	
Byte 6	0..7	Functional Output (8..15)	
Byte 7	0..7	Functional Output (16..23)	
Byte 8	0..7	Functional Output (24..31)	
Byte 9	0..7	Functional Output (32...39)	
Byte 10	0..7	Functional Output (40...47)	
Byte 11	0..7	Functional Output (48..55)	
Byte 12	0..7	Functional Output (56..63)	Additional Error Diag (0...7) *)
Byte 13	0..7	Functional Output (64...71)	Additional Error Diag (8..15) *)
Byte 14	0..7	Functional Output (72...79)	Additional Error Diag (16..23) *)
Byte 15	0..7	Functional Output (80...87)	Additional Error Diag (24..31) *)

\*) if Byte 1 == "1" && Byte 2 == "0"

Additional Error Diag Bit																															
3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0		
1	0	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0
I0.31	I0.30	I0.29	I0.28	I0.27	I0.26	I0.25	I0.24	I0.23	I0.22	I0.21	I0.20	I0.19	I0.18	I0.17	I0.16	I0.15	I0.14	I0.13	I0.12	I0.11	I0.10	I0.9	I0.8	I0.7	I0.6	I0.5	I0.4	I0.3	I0.2	I0.1	I0.0

### 9.2.2 Functional Output EtherCAT

Structure of functional outputs

**Table 58 Assignment functional outputs, EtherCAT**

Byte	Bit	„Run“ mode (1, 2, 3, 4, 8)	Error case (6, 7)
Status Word	0..3	Device status 1 = Init, 2 = Self-test, 3 = BusInit, 4 = Run, 5 = Stop, 8 = RunIntern	6 = FatalError, 7 = Alarm,
	4	0x1 (define)	0x1 (define)
	5..7	Alive counter (3 Bit)	Alive counter (3 Bit)
	0..7	0	1
Byte Out 0	0..7	0	0
Byte Out 1	0..7	0 = no error Error code low Byte	0 = no error Error code low Byte
Byte Out 2	0..7	0 = no error Error code high Byte	0 = no error Error code high Byte
Byte Out 3	0..7	Functional Output (0..7)	
Byte Out 4	0..7	Functional Output (8..15)	
Byte Out 5	0..7	Functional Output (16..23)	
Byte Out 6	0..7	Functional Output (24..31)	
Byte Out 7	0..7	Functional Output (32...39)	
Byte Out 8	0..7	Functional Output (40...47)	
Byte Out 9	0..7	Functional Output (48...55)	
Byte Out 10	0..7	Functional Output (56...63)	
Byte Out 11	0..7	Functional Output (64...71)	
Byte Out 12	0..7	Functional Output (72...79)	
Byte Out 13	0..7	Functional Output (80...87)	
Byte Out 14	0..7	Functional Output (88...95)	
Byte Out 15	0..7	Functional Output (96...103)	
Byte Out 16	0..7	Functional Output (104...111)	
Byte Out 17	0..7	Functional Output (112...119)	Additional Error Diag (0...7) *
Byte Out 18	0..7	Functional Output (120...127)	Additional Error Diag (8..15) *
Byte Out 19	0..7	Functional Output (128...135)	Additional Error Diag (16..23) *
Byte Out 20	0..7	Functional Output (136...143)	Additional Error Diag (24..31) *

\*) if Byte 1 == "1" && Byte 2 == "0"

Additional Error Diag Bit																															
3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	9	8	7	6	5	4	3	2	1	0		
I0.31	I0.30	I0.29	I0.28	I0.27	I0.26	I0.25	I0.24	I0.23	I0.22	I0.21	I0.20	I0.19	I0.18	I0.17	I0.16	I0.15	I0.14	I0.13	I0.12	I0.11	I0.10	I0.9	I0.8	I0.7	I0.6	I0.5	I0.4	I0.3	I0.2	I0.1	I0.0


### 9.3 Diagnostics Logbook [Log Book]

	Operating Time	Number	Info	State
1	4d 15h 23m 51s	10006	0	Info
2	4d 15h 23m 59s	10001	0	Info
3	4d 15h 28m 21s	10005	0	Info
4	3d 16h 9m 59s	7609	0	Alarm
5	3d 16h 10m 6s	10003	0	Info
6	3d 16h 10m 9s	7609	0	Alarm
7	3d 16h 10m 15s	10003	0	Info
8	3d 16h 10m 18s	7609	0	Alarm
9	3d 16h 10m 23s	10003	0	Info
10	3d 16h 10m 29s	7609	0	Alarm
11	3d 16h 10m 34s	10003	0	Info
12	3d 16h 59m 53s	10006	0	Info
13	3d 16h 59m 56s	10005	0	Info
14	3d 17h 0m 49s	10006	0	Info
15	3d 17h 0m 50s	10005	0	Info
16	3d 17h 1m 24s	10006	0	Info
17	3d 17h 1m 25s	10005	0	Info
18	3d 17h 2m 41s	10006	0	Info
19	3d 17h 2m 42s	10005	0	Info
20	3d 17h 4m 27s	7609	0	Alarm
21	3d 17h 5m 14s	10003	0	Info
22	3d 17h 5m 15s	7611	0	Alarm
23	3d 23h 8m 59s	10004	0	Info

**Fig. 248** Diagnostics window, Tab „Log Book“

**Table 59** Overview Log Book column description

Value	Description
Operating time	Operating hours meter in s
Number	Number of errors [decimal display]
Info	Info [decimal display]
State	1: Fatal Error 2: Alarm 3: Info [text display]

 Description of the error numbers, see Error list / Diagnostic messages for ctrlX SAFETY SAFEX-C.1\* devices DOK-XSAFE\*-SAFEX-C.1XC-RExx-EN-P <sup>3)</sup>

## 9.4 IL (AWL) processing

### 9.4.1 IL – commands

Table 60 IL command list

Operator	Operand	Description
LD	All input operands and all output operands	Equals the current result to the operand
LD NOT	All input operands and all output operands	Equals the current result to the operand and inverts the operand
ST	Only output operands	Stores current result under the operand address
AND	All input operands and all output operands	Boolean AND
AND NOT	All input operands and all output operands	Negated Boolean AND
OR	All input operands and all output operands	Boolean OR
OR NOT	All input operands and all output operands	Negated Boolean OR
XOR	All input operands and all output operands	Boolean Exclusive OR
NOT	All input operands and all output operands	Inverts the value of the accumulator
S	PLC_FLAG in the output image	Sets FlipFlop
R	PLC_FLAG in the output image	FlipFlop reset
S1	All input operands and all output operands	Sets operand to 1
R1	All input operands and all output operands	Sets operand to 0
SQH (MACRO_INFO)	Description of macro element	Operand field : 2 bytes for identification of macro
SQC (MACRO_CRC)	CRC of the preceding macro field	Operand field
INFO	Info box	1. Operand: CRC_LO ( 8 Bit )

## 9.4.2 Resource assignment

Table 61 Resource assignment

Element	In	Out	Anz. MX	IN/OUT Process image	PLC-Code	IL display
AND2	2	1	1	0	LD x1.y1 AND x2.y2 ST MX.z	3
AND5	5	1	1	0	LD x1.y1 AND x2.y2 AND x3.y3 AND x4.y4 AND x5.y5 ST MX.z	6
OR2 .. OR5					Analog AND	3 ... 6
XOR 2					Analog AND	3
NOT	1	1	1	0	LD x1.y1 NOT ST MX.z	3
RS-Flipflop	2	1	0	Output = 1	LD x1.y1 ( Quelle S ) S M.z LD x2.y2 ( Quelle R ) R M.z	4
Permanent Flipflop (RS)	2	1	2	Input = 2 Output = 1	LD MX.0 ST CFlipFlop_EN0.0 LD MX.1 ST CFlipFlop_EN0.1 LD CFlipFlop0.0 ST MX.2	6
Timer	1	1	0	Output = 1	Timer freigeben : LD x1.y1 ST PLCTimer_EN.z	2
Single semiconductor output	1	1	0	Output = 1	LD x1.y1 ST DO.x_y	2
Semiconductor output Redundant	1	2	0	Output = 2	LD x1.y1 ST DO.x_P ST DO.x_M	3
EDM	2	2	0	Input = 2 Output = 2	LD MX.0 ST DriveEDM_EN0.0.1 LD MX.2 ST DriveEDM_EN0.0.0 AND DriveEDM0.0.0 ST DriveEDM0.0.0	6
Restart	2	2	2	Input = 2 Output = 2	LD MX.0 ST Restart_En0.0 LD MX.1 ST Restart_EN0.1 AND Restart0.1 ST Restart0.1 LD Restart0.0 ST MX.2 LD Restart0.1 ST MX.3	10
Edge deduction (rising)	1	1	2	0	LD MX.0 AND NOT MX.1	5

					ST MX.2 LD MX.0 ST MX.1	
Edge deduction (falling)	1	1	3	0	LD NOT MX.0 AND MX.1 ST MX.2 LD MA.0 ST MX.1	5
Edge deduction (rising / falling)	1	1	3	0	LD MX.0 XOR MX.1 ST MX.2 LD MA.0 ST MX.1	5
FBus In	0	1	0	Output = 1	LD FBus_In0.0	1
FBus Out	1	0	0	Input = 1	ST FBus_Out0.0	1
Functional In	1	1	2	Input = 1 Output = 1	SQHx.y LD MX.0 AND FE0.0 ST MX.1 SQCx.y	5
Functional Out	1	0	1	Input = 1	LD MX.0 ST FA0.0	2

### 9.4.3 IL-Operand

In the following all supported operands with indication of the number places.

**Table 62 IL operand**

Operand	Position	Description
DriveSAC	3	Result monitoring function SAC
DriveSDI	3	Result monitoring function SDI
DriveSLI	3	Result monitoring function SLI
DriveSEL	3	Result monitoring function SEL
DriveSSX	3	Result monitoring function SSX
DriveBase	3	Result monitoring function DriveBase
DriveSLP	3	Result monitoring function SLP
DriveSLS	3	Result monitoring function SLS
DriveSCA	3	Result monitoring function SCA
DriveEOS	3	Result monitoring function EOS
DriveSOS	3	Result monitoring function SOS
DriveECS	3	Result monitoring function ECS
DriveACS	3	Result monitoring function ACS
DriveICS	3	Result monitoring function CS
DriveDEM	3	Result monitoring function DEM
DriveEDM	3	Result monitoring function EDM
Drive ESA	3	Result monitoring function ESA
Drive SBT	3	Result monitoring function SBT
PLC Timer	1	Result PLC timer
E Timer	2	Result start element
Starttest	1	Result start up test
Twohand	1	Result two hand switch
Masterswitch	1	Result Master switch
Edge	1	Result edge detection
Restart	1	Result Restart element
SDI	2	Digital inputs Master / binary inputs Slave
E Address	2	Binary input data Slave assembles
FE	2	Functional input
SCO_Status	2	SOC status
DriveSZMc	3	Result monitoring function SZMc
DriveSLSc	3	Result monitoring function SLSc
DriveSCUc	3	Result monitoring function SCUc
DriveSOM	3	Result monitoring function SOMc
DriveSAC_EN	3	Enable monitoring function SAC
DriveSDI_EN	3	Enable monitoring function SDI
DriveSLI_EN	3	Enable monitoring function SLI
DriveSEL_EN	3	Enable monitoring function SEL
DriveSSX_EN	3	Enable monitoring function SSX
DriveBase_EN	3	Enable monitoring function DriveBase
DriveSLP_EN	3	Enable monitoring function SLP
DriveSLS_EN	3	Enable monitoring function LS
DriveSCA_EN	3	Enable monitoring function SCA
DriveEOS_EN	3	Enable monitoring function EOS
DriveSOS_EN	3	Enable monitoring function SOS
DriveECS_EN	3	Enable monitoring function ECS
DriveACS_EN	3	Enable monitoring function ACS
DriveICS_EN	3	Enable monitoring function ICS
DriveDEM_EN	3	Enable monitoring function DEM
DriveEMU_EN	3	Enable monitoring function EDM
DriveESA_EN	3	Enable monitoring function ESA
PLC Timer_EN	1	Enable PLC timer

E Timer_EN	1	Enable input timer
Starttest_EN	1	Enable start testt
Twohand_EN	1	Enable two hand switch
Masterswitch_EN	1	Enable Master switch
Edge_EN	1	Enable edge detection
Restart_EN	1	Enable restart element
DO	2	Digital outputs
SDO	2	Safe Digital Output
SRO	2	Safe Relay Output
DOut	2	Non safe digital output
S_Hi	2	Safe HISIDE output
S_Lo	2	Safe LOSIDE output
A Address	2	Binary outputs
PLCMXMerker	1	Flag elements for PLC cache
SCO_cmd	2	Data internal system bus
DriveSZMc_EN	3	Enable monitoring function SZMc
DriveSLSc_EN	3	Enable monitoring function SLSc
DriveSCUc_EN	3	Enable monitoring function SCUc
DriveSOM_EN	3	Enable monitoring function SOMc
EAE	2	Safe input, safe inputs extension device
EAA	2	Safe output extension module
FA	2	Functional output
CBool	1	Configurable Boolean
CFlipFlop	2	Result configurable saveable FlipFlop
CFlipFlop_EN	2	Enable configurable saveable FliipFlop
DriveFDB	3	Result FSoE disconnect block
DriveFDB_EN	3	Enable FSoE disconnect block
DriveSRX	3	Result Safe Referencing
DriveSRX_EN	3	Enable Safe Referencing
DriveSRS	3	Result Safe Referencing State
DriveSRS_EN	3	Enable Safe Referencing State
DriveSRTc	3	Result Robotic block
DriveSRTc_EN	3	Enable Robotic block
DriveSLA	3	Result monitoring function SLA
DriveSLA_EN	3	Enable monitoring function SLA
FBus_Slave_In	2	Profisafe input data
FBus_Slave_Out	2	Profisafe Output data
SSF_Slave_In	2	Special Function Input Slave device
SSF_Slave_Out	2	Special Function Output Slave device
GBox_State	2	Status GBox
DriveESM	3	Result Encoder Standstill Monitoring
DriveESM_EN	3	Enable Encoder Standstill Monitoring

### Agenda:

3 digits: e.g. LD DriveSLS\_ENx.y.z (corresponds to 3 digits below)

x: number of assembly where block is carried out. (0: Master, 1: Slave with logical address 1, etc.

y: Instance of the block

z: Bit address of the block

2 digits: e.g.: LD SDIx.y

x: number of the assembly where block is carried out. (0: Master, 1: Slave with logical address 1, etc..

y: Instance of the block

1. digit: e.g. CBool.x (implementation only on Master device)

x: Instance of the block

## 9.5 Accessories and spare parts

Table 63 Accessories and spare parts

Material No.	Type code	Description	Note
R911404022	XACC-0-SD016GB	µSD memory card	Project storage, backup and serial commissioning (optional)
R911405499	XACC-0-USBCA3M	USB Engineering Cable	USB-C (controller) to USB-A (Engineering PC)
R911405500	XACC-0-USBCC3M	USB Engineering Cable	USB-C (control) to USB-C (Engineering PC)
R911410768	XACC-3-CSRTB12_L	<b>Connector set, SAFEX-C.12, consisting of</b> <ul style="list-style-type: none"> <li>• Terminal block, 18-pin, XG31, mechanically coded A</li> <li>• Terminal block, 18-pin, XG32, mechanically coded B</li> </ul>	<b>Connection of inputs/outputs and supply voltage,</b> <b>Spare part,</b> <b>Change Index: AA1-AC1</b>
R911410769	XACC-3-CSRTB15_L	<b>Connector set, SAFEX-C.15, consisting of</b> <ul style="list-style-type: none"> <li>• Terminal block, 18-pin, XG31, mechanically coded A</li> <li>• Terminal block, 18-pin, XG32, mechanically coded B</li> <li>• Terminal block, 18-pin, XG33, mechanically coded C</li> <li>• Terminal block, 8-pin, XG34, uncoded</li> </ul>	<b>Connection of inputs/outputs and supply voltage,</b> <b>Spare part,</b> <b>Change Index: AA1-AC1</b>
R911414364	XACC-3-CSRTB12_H	<b>Connector set, SAFEX-C.12, consisting of</b> <ul style="list-style-type: none"> <li>• Terminal block, 18-pin, XG31, mechanically coded A</li> <li>• Terminal block, 18-pin, XG32, mechanically coded B</li> </ul>	<b>Connection of inputs/outputs and supply voltage</b> <b>Change Index: AD1 et sqq.</b>
R911414365	XACC-3-CSRTB15_H	<b>Connector set, SAFEX-C.15, consisting of</b> <ul style="list-style-type: none"> <li>• Terminal block, 18-pin, XG31, mechanically coded A</li> <li>• Terminal block, 18-pin, XG32, mechanically coded B</li> <li>• Terminal block, 18-pin, XG33, mechanically coded C</li> <li>• Terminal block, 8-pin, XG34, uncoded</li> </ul>	<b>Connection of inputs/outputs and supply voltage</b> <b>Change Index: AD1 et sqq.</b>
R911171065	VAP01.1H-W23-024-010-NN	<b>Power supply unit</b>	<b>24 V DC voltage supply</b>

R911340676	RKB0020/00.35	<b>Bus cable - 0.35 m</b>	Ethernet connection
R911340673	RKB0020/000.5	<b>Bus cable - 0.5 m</b>	Ethernet connection
R911389192	RKB0021/000.8	<b>Bus cable - 0.8 m <sup>1)</sup></b>	Ethernet connection
R911389194	RKB0021/001.0	<b>Bus cable - 1.0 m <sup>1)</sup></b>	Ethernet connection
R911389196	RKB0021/002.0	<b>Bus cable - 2.0 m <sup>1)</sup></b>	Ethernet connection
R911389198	RKB0021/002.5	<b>Bus cable - 2.5 m <sup>1)</sup></b>	Ethernet connection
R911389200	RKB0021/003.0	<b>Bus cable - 3.0 m <sup>1)</sup></b>	Ethernet connection
R911389203	RKB0021/004.0	<b>Bus cable - 4.0 m <sup>1)</sup></b>	Ethernet connection
R911389205	RKB0021/005.0	<b>Bus cable - 5.0 m <sup>1)</sup></b>	Ethernet connection
R911389207	RKB0021/006.0	<b>Bus cable - 6.0 m <sup>1)</sup></b>	Ethernet connection
R911389209	RKB0021/007.0	<b>Bus cable - 7.0 m <sup>1)</sup></b>	Ethernet connection
R911389211	RKB0021/008.0	<b>Bus cable - 8.0 m <sup>1)</sup></b>	Ethernet connection
R911389213	RKB0021/009.0	<b>Bus cable - 9.0 m <sup>1)</sup></b>	Ethernet connection
R911389215	RKB0021/010.0	<b>Bus cable - 10.0 m <sup>1)</sup></b>	Ethernet connection
R911389216	RKB0021/011.0	<b>Bus cable - 11.0 m <sup>1)</sup></b>	Ethernet connection
R911389217	RKB0021/012.0	<b>Bus cable - 12.0 m <sup>1)</sup></b>	Ethernet connection
R911389218	RKB0021/013.0	<b>Bus cable - 13.0 m <sup>1)</sup></b>	Ethernet connection
R911389219	RKB0021/014.0	<b>Bus cable - 14.0 m <sup>1)</sup></b>	Ethernet connection
R911389220	RKB0021/015.0	<b>Bus cable - 15.0 m <sup>1)</sup></b>	Ethernet connection
R911389232	RKB0021/025.0	<b>Bus cable - 25.0 m <sup>1)</sup></b>	Ethernet connection
R911389239	RKB0021/050.0	<b>Bus cable - 50.0 m <sup>1)</sup></b>	Ethernet connection
R911389244	RKB0021/075.0	<b>Bus cable - 75.0 m <sup>1)</sup></b>	Ethernet connection
R911372773	RKB0061/00.25	<b>Bus cable - 0.25 m</b>	ctrlX SAFETY <sup>link</sup>
R911372772	RKB0061/00.35	<b>Bus cable - 0.35 m</b>	ctrlX SAFETY <sup>link</sup>
R911372771	RKB0061/00.55	<b>Bus cable - 0.55 m</b>	ctrlX SAFETY <sup>link</sup>
R911404765	RKB0061/00.75	<b>Bus cable - 0.75 m</b>	ctrlX SAFETY <sup>link</sup>
R911372775	RKB0062/001.0	<b>Bus cable - 1.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372776	RKB0062/002.0	<b>Bus cable - 2.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372777	RKB0062/003.0	<b>Bus cable - 3.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372779	RKB0062/004.0	<b>Bus cable - 4.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372780	RKB0062/005.0	<b>Bus cable - 5.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372781	RKB0062/006.0	<b>Bus cable - 6.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372782	RKB0062/007.0	<b>Bus cable - 7.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372783	RKB0062/008.0	<b>Bus cable - 8.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372784	RKB0062/009.0	<b>Bus cable - 9.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372785	RKB0062/010.0	<b>Bus cable - 10.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372786	RKB0062/011.0	<b>Bus cable - 11.0 m</b>	ctrlX SAFETY <sup>link</sup>

R911372787	RKB0062/012.0	<b>Bus cable - 12.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372788	RKB0062/013.0	<b>Bus cable - 13.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372789	RKB0062/014.0	<b>Bus cable - 14.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911372790	RKB0062/015.0	<b>Bus cable - 15.0 m</b>	ctrlX SAFETY <sup>link</sup>
R911170685	SUP-M01- ENDHALTER	2 quick-mount end holders, for 35 mm NS 35/7.5 or NS 35/15	DIN rail, Width: 9.5 mm
R911171035	SUP-M01- ENDHALTER/AL	2 end holders, for 35 mm NS 35/7.5 or NS 35/15, version: Aluminum	DIN rail, Width: 10 mm
R911172352	SUP-M01- ENDHALTER/PA	2 end holders, for 35 mm NS 35/7.5 or NS 35/15, version: Polyamide	DIN rail, Width: 9.5 mm

1) Other intermediate lengths of bus cables of type RKB0021 are available.

## 10 List of abbreviations

Abbreviation	Meaning	Comment
AC	Alternating Current	-
AWL (IL)	Instruction list (Anweisungsliste)	List of commands for the device
BBH	Manufacturer of devices	
CRC	Cyclic Redundancy Check	-
DC	Diagnostic Coverage	-
BG	Trade association	
Cat.	Category acc. to EN 13849-1	Architecture category
CE	Communauté Européenne	Symbol of conformity with relevant EU directives
CLK	Clock	-
CPU	Central Processing Unit	-
CXSE	ctrlX Safety Engineering	abbreviation in file name
DC	Direct Current	-
DIN	German Institute for Standardization	
[ELC]	Emergency Limit Control	Safety function
EMC	Electromagnetic compatibility	
EN	European standard (Europanorm)	
EtherCAT	EtherCAT (Name)	Data protocol
FSoE	Fail Safe over EtherCAT	Safe data transmission via the EtherCAT protocol
GND	Ground	Ground potential 0 VDC
H / HISIDE	High Side	Plus switching output 24 VDC
HW	Hardware	
I (I_A/B)	Input.	-
IO	Input Output	Digital input/output
IP	International Protection	Type of protection acc. to standard
ISO	Internationale Organisation für Normung	International Organization for Standardization
LED	Light Emitting Diode	-
LOSIDE	Low Side	GND switching output 0 VDC
O.	Output.	
[OLC]	Operational Limit Control	Safety function
PAA	Process image of the outputs	
PAE	Process image of the inputs	
.pak-file		This file is the extension of the profile file that can be imported into the CXSE
PELV	Protective Extra Low Voltage	Protection low voltage
PLC	Programmable Logic Controller	
POR	Power On Reset	Reset process
[PSC]	Position Supervision Control	Safety function
ctrlX SAFETY Engineering	Program for programming PLC	Programming interface for ctrlX SAFETY devices

Abbreviation	Meaning	Comment
SCU	Safe Control Unit	FSoE master device for processing encoder and input/output data
SDDC	Safe Device to Device Communication	-
SDU	Safe Drive Unit	FSoE slave device for detection of encoder values
SELV	Safe Extra Low Voltage	Safe (fused) low voltage
SIO	Safe IO	FSoE slave device for detection of digital inputs/outputs
SMMC	Safe Master to Master Communication	-
.splib-file		This file is the extension of the entire libraries of the CXSE
SSB	Safe Sensor Box	FSoE slave module for detection of encoder values from 6 encoders
SSI	Synchronous serial Interface	
SW	Software	
T.	Pulse output/ clock output	Pulsed signal
VDE	Association of Electrical Engineering (Verband der Elektrotechnik)	



## 11 List of images

Fig. 1: EtherCAT Network.....	18
Fig. 2: FSoE Network.....	20
Fig. 3: user interface of ctrlX SAFETY Engineering application.....	29
Fig. 4: Tab „window“, Setting the user layout via the group „tools“.....	30
Fig. 5 Docking; Personalize the application window.....	30
Fig. 6: Docking; example: properties (properties window) dropped on left side under „configuration“.....	31
Fig. 7: Example: automatic hide of an area - library.....	31
Fig. 8: context menu of application window.....	32
Fig. 9: ctrlX SAFETY Engineering, main menu: document and application functions.....	33
Fig. 10 menu of the ribbon, quick info buttons.....	35
Fig. 11 Tab „Home“ and its groups.....	35
Fig. 12 Window "Functional Output Table".....	37
Fig. 13 Window „Document properties“ - Document.....	38
Fig. 14: Window "Document properties" – Master device: application information.....	39
Fig. 15: Window "Document properties" – Master device: Connection settings.....	40
Fig. 16: Window „Signal table“.....	40
Fig. 17: view in functional scheme, all filters activated.....	41
Fig. 18: view in functional scheme,„ deactivation of filters „Axis speed“, „Group“ and „Text“.....	41
Fig. 19: Structure of status bar.....	42
Fig. 20: Inserting an output element in the functional scheme using the example of „Relay 1“.....	44
Fig. 21: Moving an element within a parent node by dragging and dropping using the „Relay 1“ example.....	45
Fig. 22: Sheet- context menu.....	46
Fig. 23: View "Terminal scheme".....	47
Fig. 24: "Select device" Window.....	47
Fig. 25: View "Wiring scheme".....	48
Fig. 26 view functional scheme, marked functional input.....	49
Fig. 27 View functional scheme, marked functional Output/ message file.....	49
Fig. 28 View terminal scheme, structured layout of the function block diagram through the use of connectors.....	50
Fig. 29 context menu of the work surface.....	51
Fig. 30 Drag to add an item from the library to the canvas.....	52
Fig. 31 Properties window, Reset value.....	53
Fig. 32 Window „Properties“ with information about the currently selected property (Example „And Block 1“).....	54
Fig. 33 Structure of Properties window.....	55
Fig. 34 Properties window with extended options.....	56
Fig. 35 Dialogue "Export properties".....	56
Fig. 36 Exported property on a master device.....	56
Fig. 37 Value of the property „Number of Input Connectors“ is not within the range.....	57
Fig. 38 Example of a value validation. After the property “maximum speed “has been changed in 5, the property “Cutoff threshold” is invalid.....	57
Fig. 39 Example of Adaption: After the property value of " Delay" has been changed in 5 ms, the value has been analyzed by the adaptation function and has been changed to 4 ms.....	58
Fig. 40 View of the message window with the "Compilation" sample output.....	59
Fig. 41 Message window with search field.....	60
Fig. 42 Message window with context menu.....	60
Fig. 43 Window „Global Search“.....	61
Fig. 44 Define search settings.....	61
Fig. 45 Tab „Print preview“.....	62
Fig. 46 Tab „General“ in the user window „Settings“.....	64
Fig. 47 Tab „User Paths“ in the user window „Settings“.....	65
Fig. 48 Tab „Library“ in the user window „Settings“.....	65
Fig. 49 Window "Auto-Recovery".....	67
Fig. 50 Information window about ctrlX SAFETY Engineering.....	68
Fig. 51 Tab "Users“ in the window „User Rights“.....	70
Fig. 52 Tab "Groups“ in the window „User Rights Dialog“.....	70

Fig. 53 Example of „Drag & Drop“ .....	71
Fig. 54 Terminal scheme – device preview .....	72
Fig. 55 Selection of an slave device.....	73
Fig. 56 Properties window of the device.....	73
Fig. 57 Confirm button with missing setting (red) .....	74
Fig. 58 Selection of input modules via the library .....	75
Fig. 59 Insert a input module.....	75
Fig. 60 Information window .....	76
Fig. 61: Example - Sketch .....	78
Fig. 62: FSoE network plan.....	79
Fig. 63: Selection of a master .....	80
Fig. 64 Selection of Axis and IO slaves.....	81
Fig. 65 One sheet per device .....	81
Fig. 66 selection of devices.....	82
Fig. 67: network selection .....	82
Fig. 68: EtherCAT network.....	83
Fig. 69 network, activation of the secondary interface .....	83
Fig. 70 FSoE option for slaves .....	84
Fig. 71 Insert I/O element.....	84
Fig. 72 Assignment to device .....	85
Fig. 73 I/O- elements inserted (Master).....	86
Fig. 74 Slave profile setting in FSoE master configuration.....	87
Fig. 75 Slave profiles in functional scheme .....	87
Fig. 76 New document, wiring scheme> IO elements inserted (Slave 1) .....	88
Fig. 77 Determining the safety functions of slave 1.....	88
Fig. 78 Creating the safe F-Bus inputs and outputs for slave 1.....	89
Fig. 79 Terminal scheme with elements.....	89
Fig. 80 View of a slave profile in a FSoE Master configuration .....	90
Fig. 81 Finished profile creation of FSoE inputs and outputs in FSoE slave document (Slave 1).....	91
Fig. 82 Slave profiles (f.l.t.r.): SAFEX-C Slave profile, SDU profile, 40 Bit In/Out profile, 2 Byte Binary-Coded SMM.....	92
Fig. 83 Safety functions.....	93
Fig. 84 Slaves: SAFEX-C.1x-Slave, IndraDrive Cx, Mx, SCU Slave, AMK ic5, AKD2G, SDC Slave (f.l. to right), view of terminal scheme.....	94
Fig. 85 Representation of the slaves in the wiring diagram.....	94
Fig. 86 Properties window of a slave device- SAFEX-C.1x Slave.....	95
Fig. 87 Axis profile in configuration .....	96
Fig. 88 Axis properties .....	96
Fig. 89 Slaves in the terminal scheme .....	97
Fig. 90 IO slave devices EL x904 in the wiring scheme .....	97
Fig. 91 Axis slave devices AX580x in the wiring scheme.....	97
Fig. 92 IO-Slave device ELx904 with terminal assignment .....	97
Fig. 93 Properties of the IO-Slave devices EL x904.....	98
Fig. 94 Properties of the Slave device IndraDrive Cx/Mx.....	99
Fig. 95 Step-by-step illustration for creating a connection between function blocks .....	101
Fig. 96 Possibilities of adding junctions.....	102
Fig. 97 Added junction in the functional scheme.....	102
Fig. 98 Added segment in the functional scheme .....	102
Fig. 99 View of a “Group” block.....	103
Fig. 100 Function blocks in Tab „groups“ .....	103
Fig. 101 Folder „groups interface“ in the library .....	104
Fig. 102 “Document properties“ window with open tab „Master device“, here SAFEX-C.12 .....	106
Fig. 103 serial number, Dialog .....	107
Fig. 104 Diagnostics window with its tabs .....	108
Fig. 105 Diagnostics window, Log Book: parameter .....	109
Fig. 106 Diagnostics procedure in the work surface (canvas).....	111
Fig. 107 Selected blocks on the work surface.....	112
Fig. 108 Diagnosis, Display of the logical state of inputs and outputs in the selected block .....	112
Fig. 109 Scope monitor areas .....	114
Fig. 110 Overview of the scrollbar for the main diagram.....	114
Fig. 111 Scaling the diagram via the slide bars.....	115

Fig. 112 Selection of an output for export .....	116
Fig. 113 Application information for validation report .....	121
Abb. 115 Applikationsinformationen für den Validierungsreport .....	121
Fig. 116 Symbols in the device interface – connected .....	126
Fig. 115 Symbols in the device interface – not connected .....	126
Fig. 117 Window „Select the action“ .....	129
Fig. 118 Replace an SMMC master by dragging it from the library and overlaying it, deactivate automatically when a master is deleted and only one master is left. ....	130
Fig. 119 View „Global network“, SMMC.SMMC network configuration .....	130
Fig. 120 Global network, SMMC line.....	131
Fig. 121 SMMC in Configuration (Browser) .....	131
Fig. 122 Properties window, Master to Master (SMMC).....	131
Fig. 123 Tab „Global Network“ .....	132
Fig. 124 Configuration, Exchange of SMMC master device.....	133
Fig. 125 SMMC Terminal Out .....	133
Fig. 126 SMMC Terminal in .....	134
Fig. 127 SMMC Status.....	134
Fig. 128 SMMC network - startup via “FlipFlop” block .....	135
Fig. 129 SMMC network - Startup via „Restart“ block.....	136
Fig. 130 Configuration (Configuration window) „Local network “ after activation of „Slave Network Interface“.....	137
Fig. 131 view in local network .....	137
Fig. 132 Fieldbus configuration in the project .....	138
Fig. 133 Network protocol type „EtherCAT“, set properties.....	139
Fig. 134 Primary interface properties, network protocol type- EtherCAT – FSoE (safe), by SAFEX-C.12 .....	139
Fig. 135 Primary/ secondary interface properties, network -protocol type EtherCAT - FSoE (safe) by SAFEX-C.15 .....	139
Fig. 136 Function block "Functional input", View in library.....	141
Fig. 137 Function Block "Functional input", view Functional scheme.....	141
Fig. 138 Example of a connected „functional input“ .....	141
Fig. 139 “functional input“ properties window.....	142
Fig. 140 Functional input: *Use top input connector-function inactive / active .....	142
Fig. 141 Functional input: *use top input connector from version 1.7.1.8179.....	142
Fig. 142 Function Block „Functional output“ , view library.....	143
Fig. 143 Function Block "Functional output“.....	143
Fig. 144 Properties window- Functional Output .....	143
Fig. 145 Functional output with 3 outputs .....	143
Fig. 146 Properties window for functional output, example with 3 outputs.....	143
Fig. 147 Functional output, Block output settings .....	144
Fig. 148 F-Bus Input: function block and properties window.....	144
Fig. 149 F-Bus Output: function block and properties window .....	144
Fig. 150 properties "primary interface", device status.....	145
Fig. 151 Use of an device reset, exampleReset from network.....	145
Fig. 152 Fast-Channel scheme .....	146
Fig. 153 library window "FastChannel" .....	147
Fig.154 ctrlX SAFETY <sup>link</sup> Block .....	147
Fig. 155 Access ID: Selection bit number marker .....	148
Fig. 156 Access ID: Selection bit number marker .....	148
Fig. 157 FastChannel function blocks in the function plan.....	149
Fig. 158 View of the library – functional scheme selected .....	150
Fig. 159 View of the library – Terminal scheme selected.....	150
Fig. 160 List of input elements .....	152
Fig. 161 Example properties of button „Confirm Button 1“ .....	153
Fig. 162 Function block with active Start test.....	155
Fig. 163 Properties of the start/reset element.....	158
Fig. 164 Example: Start-/Reset-block (element) connected with confirm button (start monitored) in wiring scheme < Version 1.7.1.8154.....	161
Fig. 165 Example: Start-/Reset-block (element) connected with confirm button (start monitored), in functional scheme >= Version 1.7.1.8154.....	161
Fig. 166 Start / Reset to save and reset errors of the SCA module via RS-FlipFlop.....	162
Fig. 167 List of output blocks .....	163
Fig. 168 Output type .....	164
Fig. 169 Listening of function blocks in the library window.....	171

Fig. 170 properties window of "AND" block.....	172
Fig. 171 Properties of "EXCLUSIVE OR" block.....	172
Fig. 172 Properties of "FLIP FLOP" block .....	173
Fig. 173 Properties of "cFLIP FLOP" block .....	173
Fig. 174 Properties of "logical 1" block.....	174
Fig. 175 Properties of "Configurable Boolean" block.....	174
Fig. 176 Properties of "NOT" block .....	174
Fig. 177 Properties of "OR" block.....	175
Fig. 178 properties of "Timers".....	175
Fig. 179 Properties of „Edge detection“ block .....	177
Fig. 180 Properties of "Restart"-Block.....	178
Fig. 181 view of "Restart" block in functional scheme .....	178
Fig. 183 Properties of "Dummy"-Block.....	179
Fig. 183 List of Safety functions in the library.....	180
Fig. 184 Properties of "FSoE Disconnect" block .....	182
Fig. 185 "FSoE Disconnect" function block in worksurface (canvas) .....	183
Fig. 186 Properties of EDM function .....	184
Fig. 187 EDM function block .....	185
Fig. 188 Trapezoidal speed profile.....	188
Fig. 189 Sigmoidal velocity profile.....	188
Fig. 190 Properties of SEL monitoring .....	189
Fig. 191 Linear calculation method for the stop distance in relation to limit position .....	190
Fig. 192 Quadratic calculation method for the stop distance in relation to the limit position.....	190
Fig. 193 Properties of SLP-function .....	193
Fig. 194 Display of the "SET/QUIT" process.....	195
Fig. 195 Properties of SCA-function.....	197
Fig. 196 The sigmoidal speed profile shows the change of speed over the time, or rather, the course of speed over the time. ....	200
Fig. 197 Monitored limit curves at a sigmoidal course of speed.....	201
Fig. 198 Properties of SSX-monitoring.....	202
Fig. 200 Properties of SLI-monitoring.....	206
Fig. 200 Activation of SLI .....	207
Fig. 201 Properties of SDI-monitoring .....	209
Fig. 202 Properties of SLS-monitoring .....	212
Fig. 203 Properties of SOS-monitoring .....	214
Fig. 204 Properties of Multiaxes position monitoring.....	217
Fig. 205 Properties of ECS function.....	219
Fig. 206 Example for the use of the ECS function .....	219
<b>Fig. 207 Function time diagram .....</b>	<b>221</b>
Fig. 208 Properties of DEM function .....	222
Fig. 209 Properties of EOS function.....	225
Fig. 210 Global network in library window.....	226
Fig. 211 SMMC Terminal Out block, from FW version 1.0.1.19 with 32 Bit.....	226
Fig. 212 SMMC Terminal In-Block .....	227
Fig. 213 SMMC Status Baustein .....	227
Fig. 214 Fieldbus network in library window.....	228
Fig. 215 Properties window of Connection „Terminal In“.....	229
Fig. 216 Properties of Terminal Out .....	230
Fig. 218 Function block group.....	230
Fig. 218 Function block in tab "Groups" .....	231
Fig. 219 Tab „Group interface“ in library .....	232
Fig. 220 Context menu, after right mouse click on the group .....	234
Fig. 221 Window "Lock", standard .....	235
Fig. 222 group locked / unlocked .....	235
Fig. 223 Window „Lock“ with selection of „Extended Property Management“ .....	236
Fig. 224 Function group, adding a "Version" block.....	237
Fig. 225 Function group, setting during group lock .....	237
Fig. 226 Functional scheme, group context menu .....	238
Fig. 227 Group, export to library .....	238
Fig. 228 Group, Export to folder.....	239
Fig. 229 Group, Exporting a group to folders via library .....	239
Fig. 230 Export of a group via context menu of the group.....	240
Fig. 231 Main menu „Import Group“ in new project.....	240

Fig. 232 Add Group output via functional scheme .....	241
Fig. 233 View functional scheme, new connection point for group output.....	241
Fig. 234 Add Group output directly from the "Group" tab.....	242
Fig. 235 View of functional scheme, new connection point for group output 3.....	242
Fig. 236 Properties of group output.....	243
Fig. 237 LED overview SAFEX-C.12 .....	246
Fig. 238: Activated LEDs at Ethernet 1 - LINK / LAN.....	248
Fig. 239: Activated LEDs at Ethernet 1 - EtherCAT L/A.....	248
Fig. 240 LED overview SAFEX-C.15 .....	251
Fig. 241 Configuration data Safe Cam (SCA) .....	265
Fig. 242 Tab "connection", lock configuration .....	271
Fig. 244 Reset timing .....	274
Fig. 245 Reset function 1: Process value (position) > no change of the output status for a reset in the alarm state .....	274
Fig. 246 Reset function 2: Process value (speed) > no change of the output status for a reset in the alarm state. ....	275
Fig. 247 Reset function 3: Time-based function > Reset of the output state, response if the limit is crossed again.....	275
Fig. 248 Activation of Additional diagnostic in device property .....	278
Fig. 249 Diagnostics window, Tab „Log Book“.....	280

## 12 Keyword Index

### A

Adaption .....	56
Automatic hide.....	29

### C

Cascading.....	174
Commissioning .....	231

### D

Device interface.....	123
devices .....	146
Docking.....	28

### F

#### Fast-Channel

Description.....	140
FastChannel Merker Input .....	143
FastChannel Merker Output .....	142
Filter.....	39

#### Function

safety-.....	173
--------------	-----

#### Function block

AND block.....	165
cFLIP FLOP block.....	166
Configurable Boolean .....	167
Dummy-Block .....	172
Edge detection.....	170
EXCLUSIVE OR block.....	165
FLIP FLOP block .....	166
Logical 1 block.....	167
NOT block.....	167
OR block.....	168
Timer .....	168

#### Function block

Restart block.....	171
--------------------	-----

#### Function blocks

logical .....	164
---------------	-----

#### Function group

creation.....	225
export/import.....	228
group interface.....	230

Function groups .....	224
Functional scheme.....	47
Functions	
Muting.....	212

### G

Global network.....	48
Groups .....	48

### H

Home .....	33
------------	----

### I

Input connection point.....	223
-----------------------------	-----

#### Input Element

Light Curtain .....	152
Limit switch .....	152
Master switch.....	152
Mode switch.....	152
Sensor .....	153
Start/Reset.....	153
two-hand-control .....	152
Confirm button .....	151
door control.....	151
Emergency stop.....	151
Input elements .....	147
Input validation.....	55

### L

Layout reset.....	28
Library window .....	50
Local network.....	48

### M

Master devices.....	146
Master to Master (SMMC).....	126
Message window .....	57
search field .....	58

#### Muting function

DEM (Dynamic Encoder Errors	
Muting).....	214
ECS (Encoder Control Supervisor)	
.....	212
EOS (External Offset Setup).....	218
ICS (Input Element Muting).....	213

### N

#### Network elements

fieldbus- .....	222
-----------------	-----

Global .....	220	<b>U</b>	User management .....	122
Networks .....	126		User Rights Dialog window .....	67
<b>O</b>		<b>V</b>		
Output blocks .....	157	Validation .....	241	
Output connection point .....	224	Validation report .....	118	
<b>Output element</b>		Value validation .....	55	
Highside semiconductor .....	160	<b>W</b>		
HiLo semiconductor .....	159	Window .....	34	
Relay .....	161	Wiring scheme .....	46	
semiconductor .....	162	Work surface	49	
<b>P</b>				
Peripheral devices .....	146			
Print .....	60			
<b>R</b>				
Reset behavior .....	251			
<b>S</b>				
<b>Safety function</b>				
EDM (External Device Monitoring)	177			
MPM (safe synchronization monitoring) .....	209			
SCA (Safe Cam) .....	189			
SDI (Safe direction Indication) .....	201			
SEL (Safe Emergency Location) ..	180			
SLI (Safe limited increment) .....	198			
SLP (Safe Limited Position) .....	185			
SLS (Safe Limited Speed control )	204			
SOS (safe operational stop) .....	206			
SSX (safe stop 1/2) .....	192			
Safety function				
FDB (FSoE Disconnect Block) .....	175			
Safety-related verification .....	249			
<b>Scope</b>				
Preparing the measurement .....	117			
Starting measurement .....	117			
Stopping a measurement / indicating data .....	117			
Scope online diagnostics .....	111			
Settings .....	62			
Slave devices .....	146			
SMMC „Terminal Input“ .....	221			
SMMC „Terminal Output“ .....	220			
Switch-on sequence .....	232			
<b>T</b>				
Terminal scheme .....	45			



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Subject to change

R911405647, DOK-XSAFE\*-SAFEX-C.1XC-PR03-EN-P, Bosch Rexroth AG, Edition 03