SICK.COM

OPERATING INSTRUCTIONS

Flexi Compact

Safety controller

SICK Sensor Intelligence

Described product

Flexi Compact

Manufacturer

SICK AG
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Legal information

Original document

This document is an original document of SICK AG.

EtherCAT®

EtherCAT® and Safety over EtherCAT® are registered trademarks and patented technologies, licensed by Beckhoff Automation GmbH, Germany.

The backplane bus is based on EtherCAT® and Safety over EtherCAT®.

Contents

1 About this document

1.1 Purpose of this document

These operating instructions contain the information required during the life cycle of the main modules. The operating instructions contain additional information on the entire safety controller. For information on the extension modules, refer to the respective operating instructions of the extension modules.

Operating instructions of the safety controller must be made available to all people who work with the device.

1.2 Scope

Product

This document applies to the following products:

- Product code: Flexi Compact
- “Operating instructions” type label entry: 8024573

Document identification

Document part number:

- This document: 8024589
- Available language versions of this document: 8024573

You can find the current version of all documents at **www.sick.com**.

1.3 Target group

This document is intended for persons who project plan, install, commission, operate and maintain the product.

1.4 Further information

www.sick.com

The following information is available via the Internet:

- Data sheets and application examples
- CAD files and dimensional drawings
- Certificates (such as the EU declaration of conformity)
- Guide for Safe Machinery. Six steps to a safe machine
- Safety Designer (software for configuring safety solutions made by SICK AG)

1.5 Related applicable documents

Related applicable documents from SICK

Table 1: Related applicable documents from SICK

Document	Title	Part number
Technical information	Cybersecurity – safety controller	8031111
Operating instructions	Flexi IO XTDI1 Expansion module - IO	8024571
Operating instructions	Flexi IO XTDO1 Expansion module - IO	8024570
Operating instructions	Flexi Gateway GPNT1 Expansion module - gateway	8024567

Document	Title	Part number
Operating instructions	Flexi Gateway GETC1 Expansion module - gateway	8024566
Operating instructions	Flexi Gateway GCAN1 Expansion module - gateway	8024572

1.6 Symbols and document conventions

Warnings and other notes

DANGER
Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.

WARNING
Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.

CAUTION
Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

NOTICE
Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

NOTE
Highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

Instructions to action

→ The arrow denotes instructions to action.

1. The sequence of instructions is numbered.
2. Follow the order in which the numbered instructions are given.

✔ The tick denotes the results of an action.

2 Safety information

2.1 General safety notes

Integrating the product

DANGER
The product can not offer the expected protection if it is integrated incorrectly.

→ Plan the integration of the product in accordance with the machine requirements (project planning).
→ Implement the integration of the product in accordance with the project planning.

Mounting and electrical installation

DANGER
Death or severe injury due to electrical voltage and/or an unexpected startup of the machine

→ Make sure that the machine is (and remains) disconnected from the voltage supply during mounting and electrical installation.
→ Make sure that the dangerous state of the machine is and remains switched off.

Repairs and modifications

DANGER
Improper work on the product

A modified product may not offer the expected protection if it is integrated incorrectly.

→ Apart from the procedures described in this document, do not repair, open, manipulate or otherwise modify the product.

2.2 Intended use

The Flexi Compact safety controller is a freely programmable controller for safety applications.

Sensors and switching elements (e.g. light curtains, laser scanners, switches, sensors, encoders, emergency stop pushbuttons) are connected to the safety controller and are linked logically. The corresponding actuators of the machines or systems can be switched off safely via the switching outputs of the safety controller.

The product may be used in safety functions.

The product is only suitable for use in industrial environments.

The product must only be used within the limits of the prescribed and specified technical specifications and operating conditions at all times.

Incorrect use, improper modification or manipulation of the product will invalidate any warranty from SICK; in addition, any responsibility and liability of SICK for damage and secondary damage caused by this is excluded.

2.3 Improper use

Impermissible use

- Access control or authorization

Impermissible ambient conditions

- Outdoors
- Underwater
- In explosion-hazardous areas
- In residential areas

2.4 Qualification of personnel

Any work on the product may only be carried out by personnel qualified and authorized to do so.

Qualified personnel are able to perform tasks assigned to them and can independently recognize and avoid any potential hazards. This requires, for example:

- technical training
- experience
- knowledge of the applicable regulations and standards

3 Cybersecurity

3.1 Comprehensive cybersecurity concept

Overview

To protect against cybersecurity threats, the operator must have a comprehensive cybersecurity concept, which must be continuously monitored and maintained. A suitable concept consists of organizational, technical, procedural, electronic, and physical levels of defense and considers suitable measures for different types of risks. The measures implemented in this product can only support protection against cybersecurity threats if the product is used as part of such a concept.

You will find further information at www.sick.com/psirt, e.g.:

- General information on cybersecurity
- Contact option for reporting vulnerabilities
- Information on known vulnerabilities (security advisories)

Further topics

- "Related applicable documents", page 6
- "Improper use", page 8
- "Network services and protocols", page 135
- "Assigning or changing passwords", page 109
- "Resetting the password", page 109
- "Configuring the security functions", page 109
- "Communication interfaces", page 128

3.2 Software from trustworthy sources

When installing software (e.g. firmware, application software), the operating entity must ensure the relevant sources are known and trustworthy.

For information on verifying downloads from the SICK website, visit **www.sick.com/verify-downloads**.

3.3 Data backup

To enable the operating entity of a product to prove at a later time what configuration was used during commissioning and that the configuration has not changed, certain data needs to be saved.

The following data must be retained by the operating entity in a protected manner for a period of at least 5 years from commissioning:

- Backup copy of the configuration that was created as a project file in the configuration software (e.g. Safety Designer) and used in the product
- Report on the verified configuration

4 Product description

4.1 Scope of delivery

- Main module
- Housing end cap
- 2 front connectors
- SmartPlug
- Safety note
- Operating instructions for download: **www.sick.com**

4.2 Product identification

4.2.1 Product identification via the SICK product ID

SICK product ID

The SICK product ID uniquely identifies the product. It also serves as the address of the web page with information on the product.

The SICK product ID comprises the host name pid.sick.com, the part number (P/N), and the serial number (S/N), each separated by a forward slash.

For many products, the SICK product ID is displayed as text and QR code on the type label and/or on the packaging.

Figure 1: SICK product ID

4.3 Overview of the module

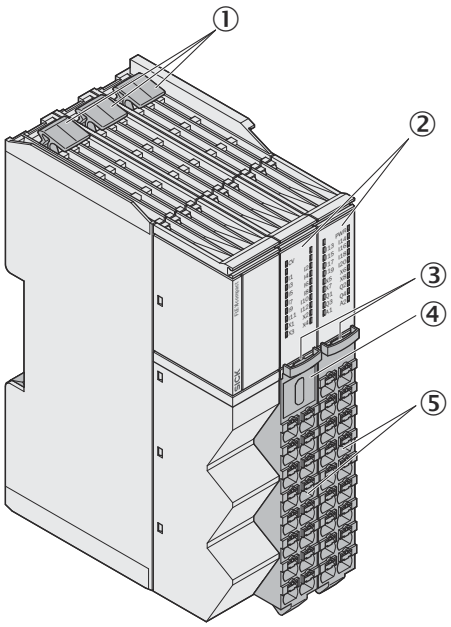


Figure 2: FLX3-CPUC1 module

① Release elements of the module

② Status indicators (LEDs)

③ Release elements of the front connector

④ SmartPlug with USB connection

⑤ Front connector with terminals (spring type)

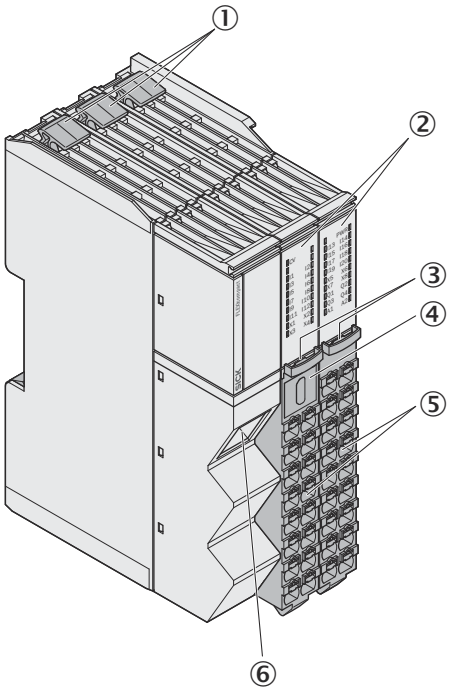


Figure 3: FLX3-CPUC2 module

① Release elements of the module
② Display elements (LEDs)
③ Release elements of the front connector
④ SmartPlug with USB connection
⑤ Front connector with terminals (spring balancer)
⑥ RJ45 socket (Ethernet)

4.4 Product characteristics

4.4.1 Configuration of the safety controller

Configuration of the safety controller

A safety controller comprises the following components:

- A main module
- Up to 12 optional expansion modules (excluding maximum 1 gateway)

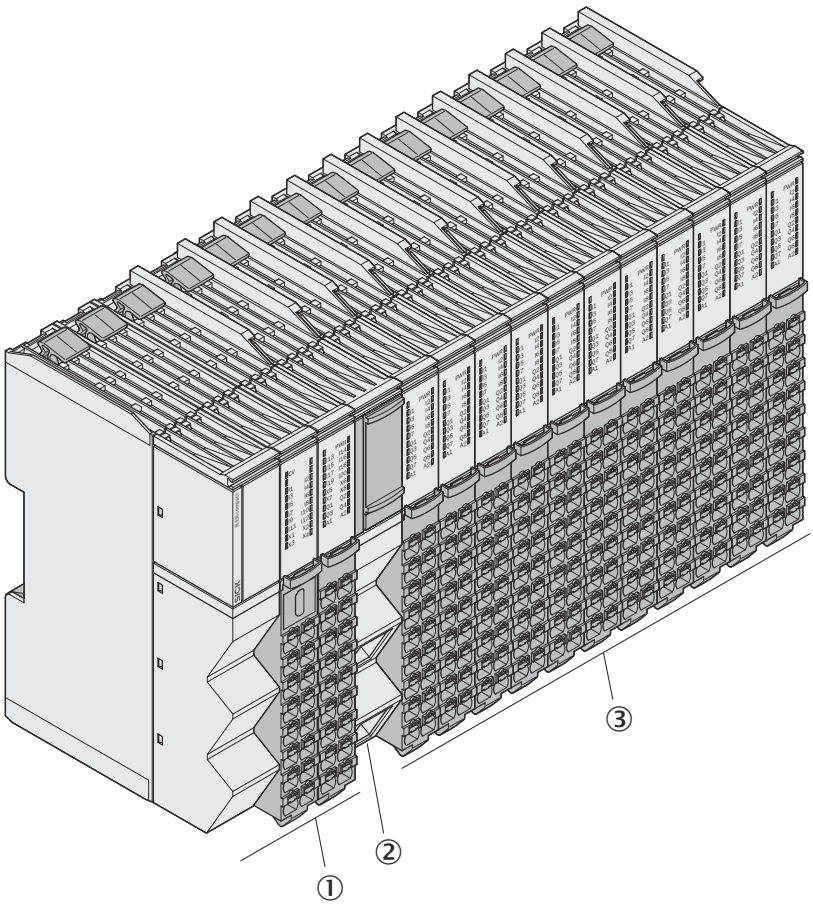


Figure 4: Example maximum configuration

① Main module

② Expansion module - gateway

③ IO expansion module

Complementary information

- The gateway and IO expansion modules can be arranged arbitrarily.

4.4.2 Structure and function of the main module

Configuration

Table 2: Interfaces of the main module

Description	Quantity
Safety capable inputs	20
Safety capable outputs	4
Test outputs [1]	8
Ethernet, Modbus® TCP, SLMP (RJ45 female connector)	CPUc1: 0 CPUc2: 1
SmartPlug	1

[1] The test outputs can also be used to switch non-safety elements (e.g., lamps).

Function

The main module is the central processor unit of the modular safety controller. The incoming signals from the entire safety controller, including all optional extension modules, are monitored and logically processed in the main module. The outputs are switched based on this processing.

If the main module is used in conjunction with expansion modules, the communication with the expansion modules is via the backplane bus.

The module offers the following functions:

- Monitoring of the connected safety devices
- Switching of the connected safety devices
- Testing of the connected safety devices and the wiring (short-circuit detection)
- Switching of non-safety devices via test outputs
- Programmable logic (binary logic, integer processing, application-specific function blocks)
- CPUc2: Ethernet interface as a TCP/IP configuration interface and data exchange via Modbus® TCP and SLMP
- IO special functions (e.g., Fast Shut Off)
- Flexi Loop safe series connection

Complementary information

- Each test output has an independent test pulse generator. This enables different test pulse parameters to be selected and short-circuits in the wiring to be detected.
- The element connected to the output during hardware configuration determines how the test output will be used. If the test output is used for a non-safety element (e.g., a lamp), then the test pulse is switched off for the output.
- Safety outputs have optional test pulses for detecting short-circuits in the wiring.

4.4.3 Version, compatibility and features

Overview

There are different functional scopes, each identified with a version.

- Functional scope of the configuration in the device
- Functional scope of the configuration in the project

Functional scope of the device (Step)

Refers to the functional scope of the hardware of an individual module in the safety controller.

The range of functions of the device (Step) is identified by a three-digit version number. The version is specified in the following places:

- Type label entry “Step”
- In Safety Designer > Main navigation **Overview** (only with connected safety controller)
- In Safety Designer > Main navigation **Configuration** > **Hardware configuration** (only with connected safety controller)
- In Safety Designer > Main navigation **Report**

The version of the functional scope of the device (Step) must be greater than or equal to the functional scope of the configuration in the device.

Functional scope of the configuration in the project

The current **functional scope of the configuration in the project** shows the minimum **functional scope of the device (Step)** required to support all functions that can be configured in the Safety Designer project.

The functional scope of the configuration in the project is specified in the following places:

- In Safety Designer > Main navigation **Overview**
- In Safety Designer > Main navigation **Configuration** > **Device identification**
- In Safety Designer > **Report**

Functional scope of the configuration in the device

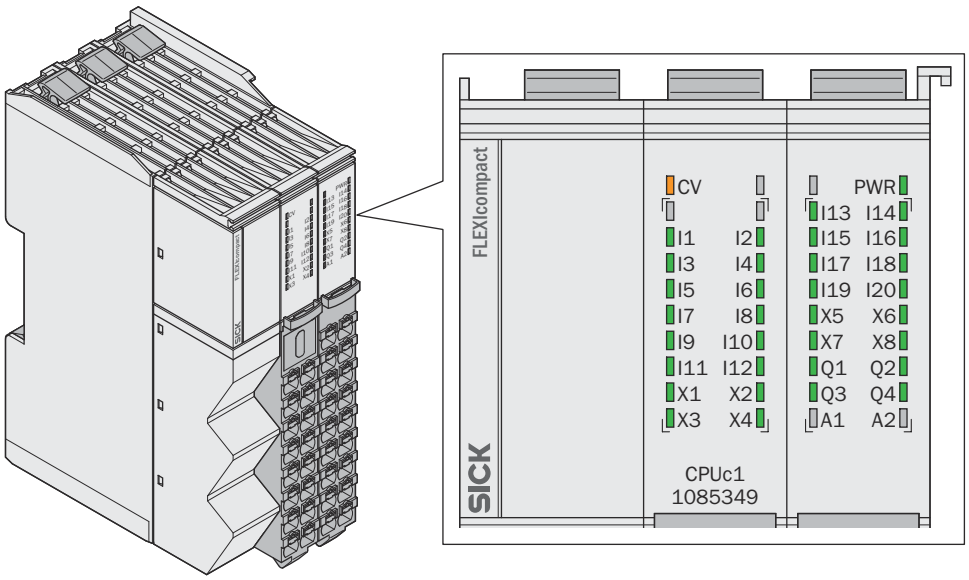
The **functional scope of the configuration in the device** indicates the minimum **functional scope of the configuration in the project** that must be supported by the Safety Designer version used so that all functions provided by the device can be configured.

The functional scope of the configuration in the device is specified in the following places:

- In Safety Designer > Device tile, behind the type code (only for configuration in the safety controller)
- In Safety Designer > Main navigation **Overview** (only with connected safety controller)
- In Safety Designer > Main navigation **Configuration** > **Device identification** (only with connected safety controller)

4.4.4 Status indicators

Status indicators



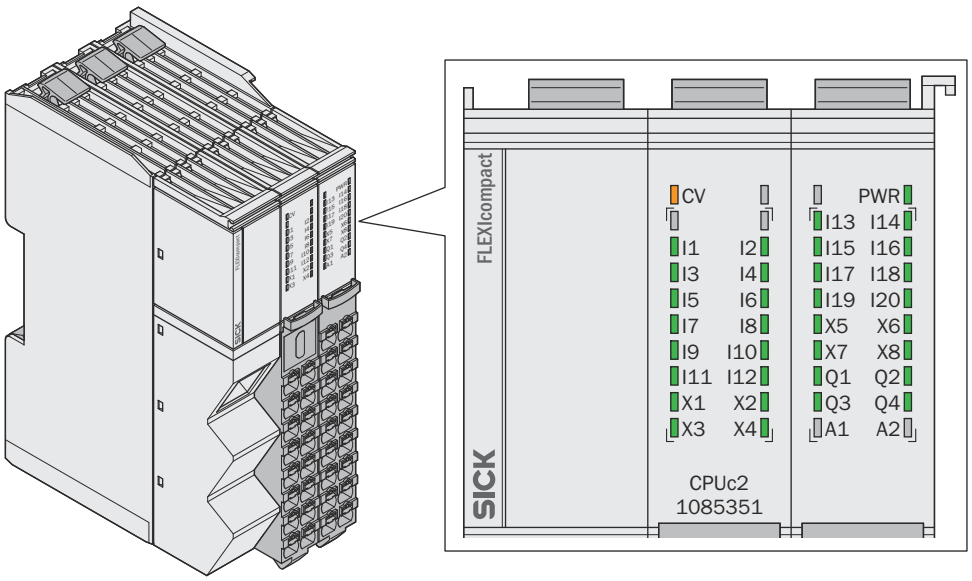


Figure 5: LEDs for indicating the status

The arrangement of the display elements corresponds to the arrangement of the terminals.

Status indicator

Table 3: Status indicator

Labeling	Color	Function
PWR (power)	Green/Red	Device status
CV (configuration valid)	Yellow	Device configuration status
Link/Act ETH1	Green	Network activity
I1 ... I20	Green	Safety input 1 ... 20
X1 ... X8	Green	Test output 1 ... 8
Q1 ... Q4	Green	Safety output 1 ... 4

Further topics

- "Status indicators", page 116
- "Troubleshooting", page 116

4.4.5 SmartPlug

SmartPlug

The SmartPlug is the system memory plug of the safety controller.

When installed, the SmartPlug is located behind the front connector of the main module. The front connector with the SmartPlug must only be removed when there is no power to the system. The safety controller stops program execution immediately if the front connector with the SmartPlug is removed.

The SmartPlug has a USB connection for configuration and diagnostics of the safety controller via a computer. The USB connection may only be used locally, temporarily and only for configuration and diagnostics.

The safety controller can only be operated when a SmartPlug is plugged in.

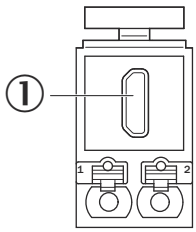


Figure 6: SmartPlug

① Micro-USB connection

The SmartPlug performs the following functions:

- Permanently saving the configuration data in the SmartPlug.
- The main module and configuration software can read the configuration data from the SmartPlug.
- When the module is replaced, the safety controller needs to be reconfigured.
- The stored data are also retained in the event of an interruption to the voltage supply.

Complementary information

If you use a display (e.g., on a gateway) to configure settings on the safety controller that can also be configured using the configuration software, the configuration in the SmartPlug is updated accordingly.

Further topics

- "Mounting the SmartPlug", page 27
- "Accessories", page 147

5 Project planning

5.1 Manufacturer of the machine

The manufacturer of the machinery must carry out a risk assessment and apply appropriate protective measures. Further protective measures may be required in addition to the product.

The product must not be tampered with or changed, except for the procedures described in this document.

The product must only be repaired by the manufacturer of the product or by someone authorized by the manufacturer. Improper repair can result in the product not providing the expected protection.

5.2 Operating entity of the machine

Changes to the electrical integration of the product in the machine controller and changes to the mechanical mounting of the product necessitate a new risk assessment. The results of this risk assessment may require the entity operating the machine to meet the obligations of a manufacturer.

After each change to the configuration, it is necessary to check whether the protective measure provides the necessary protection. The person making the change is responsible for ensuring that the protection measure provides the necessary protection.

The product must not be tampered with or changed, except for the procedures described in this document.

The product must only be repaired by the manufacturer of the product or by someone authorized by the manufacturer. Improper repair can result in the product not providing the expected protection.

5.3 Design

Installation site

- The safety controller must be protected against condensation and conductive contamination, e.g. in an IP54 control cabinet.
- Mounting on a 35 mm × 7.5 mm mounting rail in accordance with IEC 60715.
- The mounting rail is connected to the functional earth.
- Mounting rail is mounted on a mounting plate.
- Mounting plate is connected to functional earth.
- Mounting in a vertical orientation (on a horizontal mounting rail). figure 9
- Take suitable ESD protection measures.

Air circulation

To ensure sufficient air circulation and cooling, sufficient distance must be kept in the control cabinet above and below the module.

Provide an adequate clearance in front of the module (front side) for the connected cables.

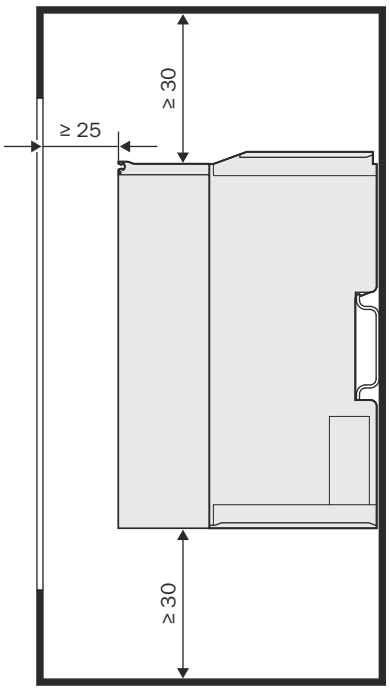


Figure 7: Clearances for adequate air circulation

Recommended distance:

- Above and below the module: ≥ 30 mm
- In front of the module: ≥ 25 mm

5.4 Electrical integration

Important information

NOTICE

Damage to the device at voltage > 36 V

If a voltage > 36 V is applied, e.g., during an insulation test, the internal protective elements may become conductive. This can damage the device.

→ Disconnect external interfaces before performing insulation tests with voltages > 36 V.

5.4.1 Internal circuitry

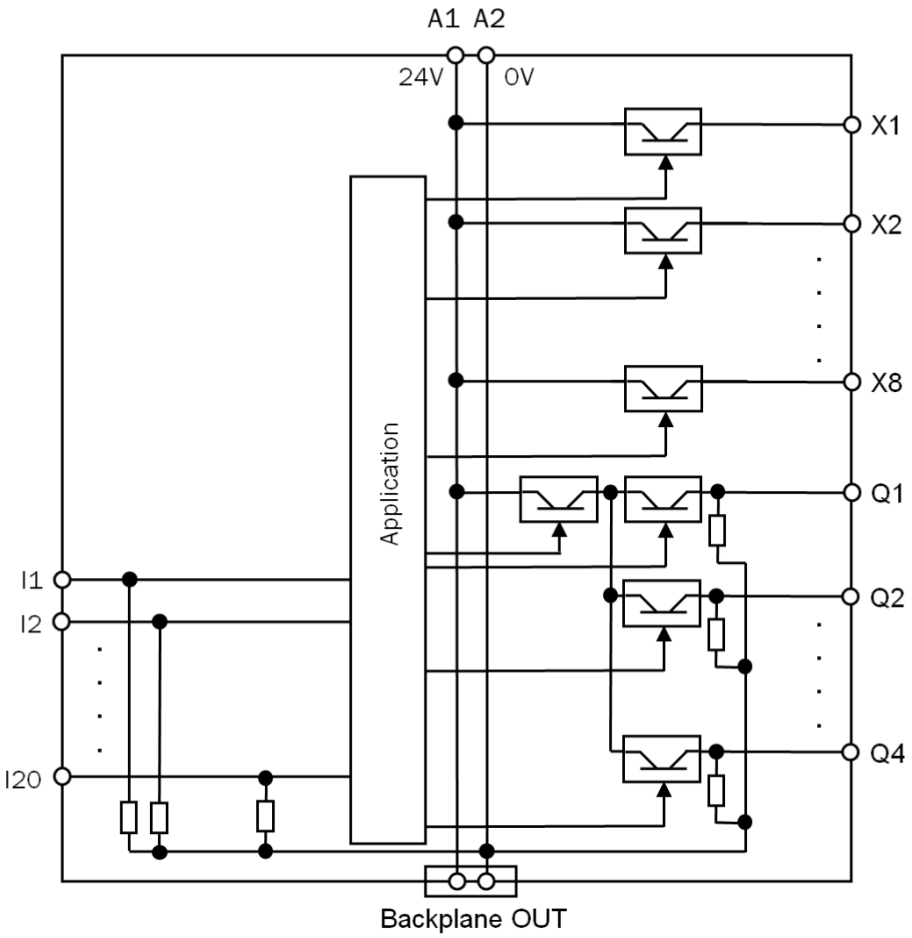


Figure 8: Internal circuitry main module

5.4.2 Fault detection using test outputs

Overview

The test outputs can be used in combination with the associated safety input. This enables a range of errors to be detected.

Important information

WARNING

Unexpected pulses or delayed falling signal edges due to a short circuit

Machine can start up unexpectedly or the dangerous state of the machine may not be stopped or not stopped in a timely manner.

→ Protect single-channel inputs against short-circuits.
→ Make sure the signal line is laid with protection (to prevent a short-circuit with other signal lines).
→ Take additional safety measures.

Prerequisites

- The test output (X) and associated safety input (I) are located on the same module.
- Use a permissible combination of safety capable inputs (I) and test outputs (X). I.e. pairings with only an even-numbered or odd-numbered index, e.g. I1 and X1, I9 and X3, I20 and X4 ...

Fault detection by testing

The following faults can be detected by testing an element:

- Faults in electronic sensors with test inputs.
- Short-circuits between any of the test outputs.

  Using a test pulse interval of ≥ 200 ms and a test pulse width of 2 ms, you can detect a short-circuit between the test outputs of 12 sequential modules.

  Using a test pulse interval of ≥ 8 ms and a test pulse width of 2 ms, you can detect a short-circuit between any two sequential test output pairs of a module.
- Short-circuits to 24 V DC (to HIGH) in the sensor wiring from the test output to the safety input, regardless of the length of the test pulse width and the test pulse interval.

The following faults cannot be detected:

- Short circuits between test outputs and the associated input.

Further topics

- "Configuring elements", page 48

5.4.3 Fault detection using safety outputs

Important information

WARNING
Ineffectiveness of the protective device

In the event of a fault, a single safety output (Q) can switch off after a delay or briefly switch to High. The error detection time and therefore the response time increases depending on the configuration of the output. The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Take the increased response time into consideration in the risk analysis.
→ Take the possible reduced safety level into consideration in the risk analysis.

Fault detection by testing

The following faults can be detected by testing an element:

- Short-circuits between any of the safety outputs.

  You can detect a cross-circuit between the safety outputs of 12 sequential modules.
- Short-circuits to 24 V DC (to High) in the wiring from the safety output to the actuator.

Further topics

- "Electrical installation", page 31
- "Configuring elements", page 48

5.4.4 Single-channel use of safety inputs

Important information

WARNING

Unexpected pulses or delayed falling signal edges due to a short-circuit to High

Machine can start up unexpectedly or the dangerous state of the machine may not be stopped or not stopped in a timely manner.

→ Protect single-channel inputs against short-circuits and cross-circuits.
→ Make sure the signal line is laid with protection (to prevent a cross-circuit with other signal lines).
→ Do not reference the test outputs.

Short-circuit to High for single-channel use of safe inputs

On a single-channel safety input with test pulses, which was previously in the low state, a short-circuit to high may be interpreted as a pulse by the logic due to the fault detection. The short-circuit to High causes the signal to switch to High and back to Low at the end of the fault detection time.

If a short-circuit to High occurs on a single-channel safety input with test pulses and this was already in the High state, the logic interprets the signal as a delayed falling signal edge (High - Low).

If a dangerous state could potentially arise because of an unexpected pulse or a delayed falling signal edge, then concrete measures must be implemented.

This is particularly important in the case of the following inputs:

- **Reset** input on the reset function block
- **Restart** input on the restart function block
- **Override** input on the muting function blocks
- **Reset to zero** input and **Set to reload value** input on a counter function block

5.5 Integration into the network

5.5.1 Network topology

The Modbus® TCP interface is suitable for the following network topologies:

- Star
- Tree

5.5.2 Integration via the fieldbus interface

Overview

You can connect the safety controller to a client as a server.

Prerequisites

- When integrating the system in Modbus® TCP: The Modbus®-TCP client can use the commands 03 (0x03) Read holding registers, 04 (0x04) Read input registers, and 16 (0x10) Write multiple registers.
- When integrating the system in SLMP: The SLMP client can use the commands 0x0613 Read memory, 0x1613 Write memory, and 0x0E30 Node search.

Parameters to be configured

Parameter:

- Unique IP address
- Port used for SLMP
- Number of possible connections via Modbus® TCP

You can configure the parameters via the following interfaces:

- Safety Designer

5.5.3 Integration via a network router

Integration via a network router is not possible with the CPUc2 main module up to firmware version 1.11.0. A GPNT1 PROFINET gateway is required for connection to a network router.

5.6 Testing plan

Testing plan

The manufacturer of the machine and the operating entity must define all required thorough checks. The definition must be based on the application conditions and the risk assessment and must be documented in a traceable manner.

→ When defining the thorough check, please note the following:

- Define the type and execution of the thorough check.
- Define the frequency of the thorough check.
- Inform and instruct the machine operators about the thorough check.

The following thorough checks are often defined in connection with a protective device:

- Thorough check during commissioning and modifications
- Regular thorough check

Thorough check during commissioning and modifications

Before commissioning the machine and after making changes, you must check whether the safety functions are fulfilling their planned purpose and whether persons are being adequately protected.

The following points are helpful when planning the thorough check:

- Does the thorough check have to be completed by qualified safety personnel?
- Can the thorough check be completed by personnel specially qualified and authorized to do so?
- Does the thorough check have to be documented in a traceable manner?
- Can the thorough check be carried out according to a check list?
- Do the machine operators know the function of the protective device?
- Have the operators of the machine been trained to work on the machine?
- Have the operators been notified about modifications to the machine?

→ Define all guidelines for the thorough check.

Regular thorough check

The following points are helpful when planning the thorough check:

- Which thorough check must be carried out and how is it carried out?
- How often does the thorough check have to be carried out?
- Do the operators of the machine have to be notified of the thorough check and do they need to be instructed accordingly?

→ Define all guidelines for the thorough check.

6 Mounting

6.1 Mounting the product

Prerequisites

- Assembly is carried out according to the project planning.
- Dangerous condition of the machine is and remains switched off during mounting.
- The outputs of the safety controller do not affect the machine during mounting.

Procedure

1. Attach main module to mounting rail.

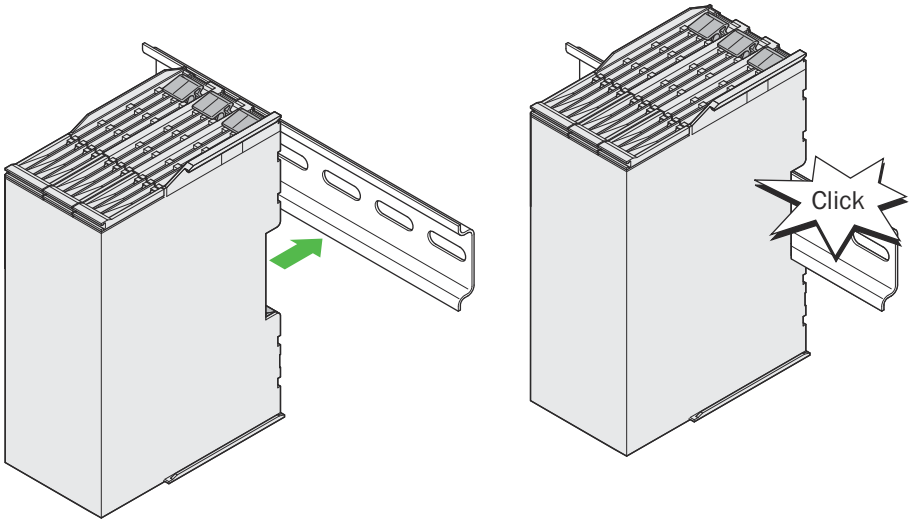


Figure 9: Main module mounting

✔ The main module engages with an audible click.

2. Attach the extension module to the mounting rail. Ensure that the side guide rails of the module intertwine.

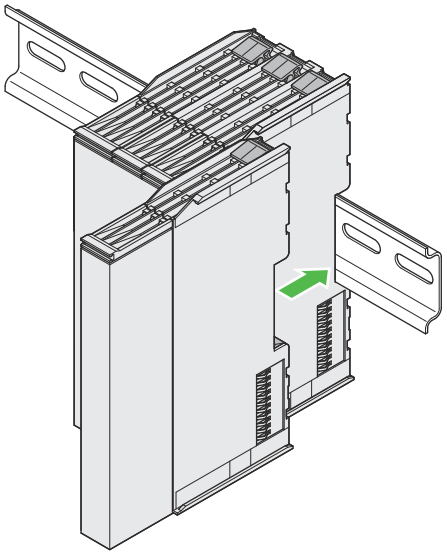
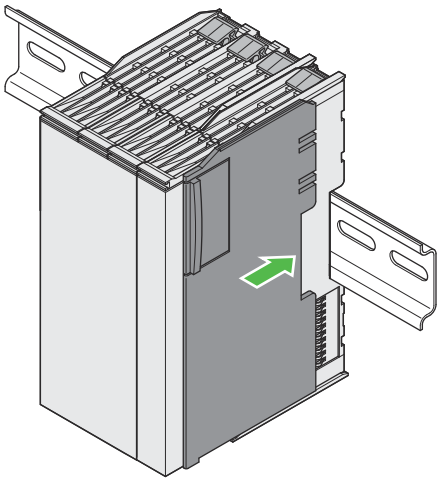


Figure 10: Expansion module mounting

✔ The module engages with an audible click.

3. Attach the housing end cap to the last module.



4. Attach the end clamps on the mounting rail on the left and right of the safety controller.

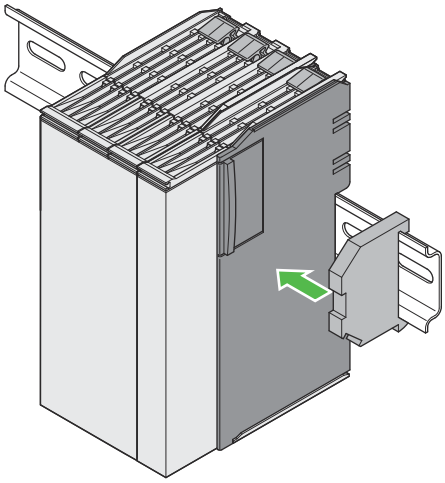


Figure 11: Housing end cap and end clamp mounting

Further topics

- "Design", page 19

6.2 Mounting the SmartPlug

Procedure

1. Disconnect the main module and the components connected to the front connection from all voltage sources.
2. Push the front connector unlocking mechanism downwards and pull out the front connector.

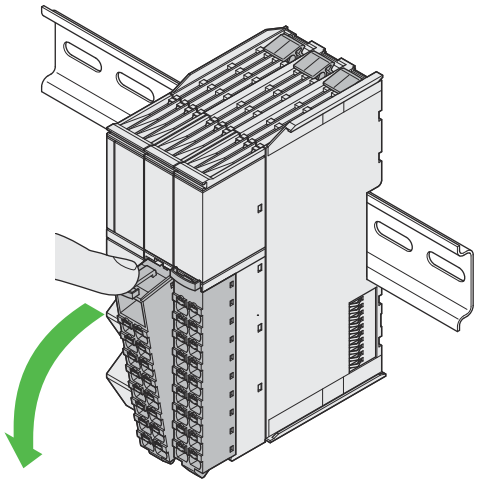
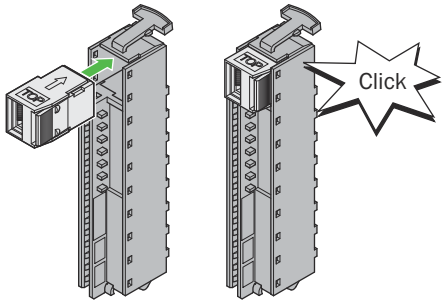


Figure 12: Pull out the front connector

3. Insert the SmartPlug into the rear side of the front connector.



4. First mount the terminal strip with bent hook in the module and then engage in the housing.

✔ The front connector engages with an audible click.

Further topics

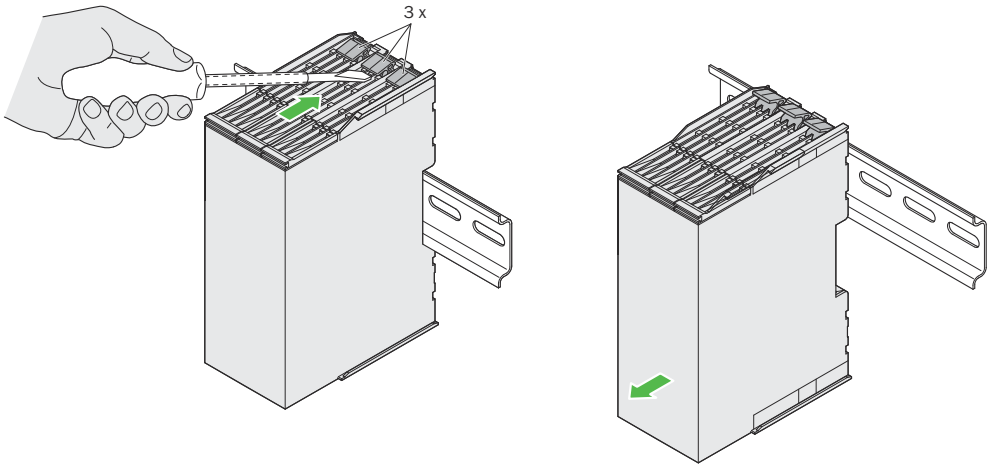
- "SmartPlug", page 17

6.3 Removing the product

Prerequisites

- Electrician screwdriver (slotted screwdriver)

Procedure



1. Disconnect the module and the connected components from all voltage sources.
2. Press the unlocking mechanism(s) on the upper side of the module towards the back using the electrician screwdriver.
3. Loosen the module from the mounting rail.

✔ The module is disassembled.

4. Press the unlocking mechanisms of the disassemlbed module forwards.

6.4 Replacing the module

Procedure

1. Disconnect module and the connected components from all voltage sources.
2. Take front connector with connected cables off the defective device: Press the unlocking mechanism of the front connector downwards and pull out the front connector.

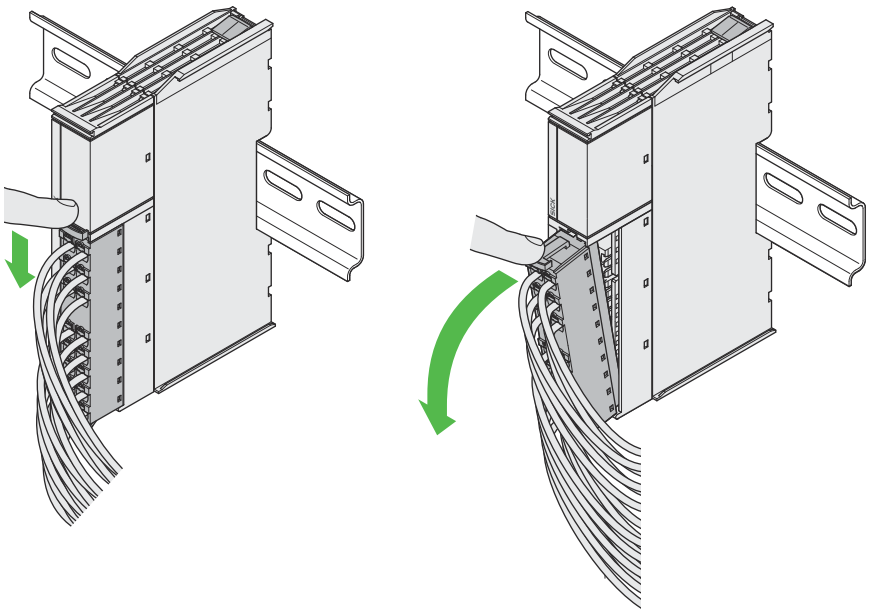


Figure 13: Removing the plug

3. Dismantle the defective module.
4. Mount new module.

5. Mount front connector with connected cables to the new module: First mount in the module with bent hook and then engage in the housing.

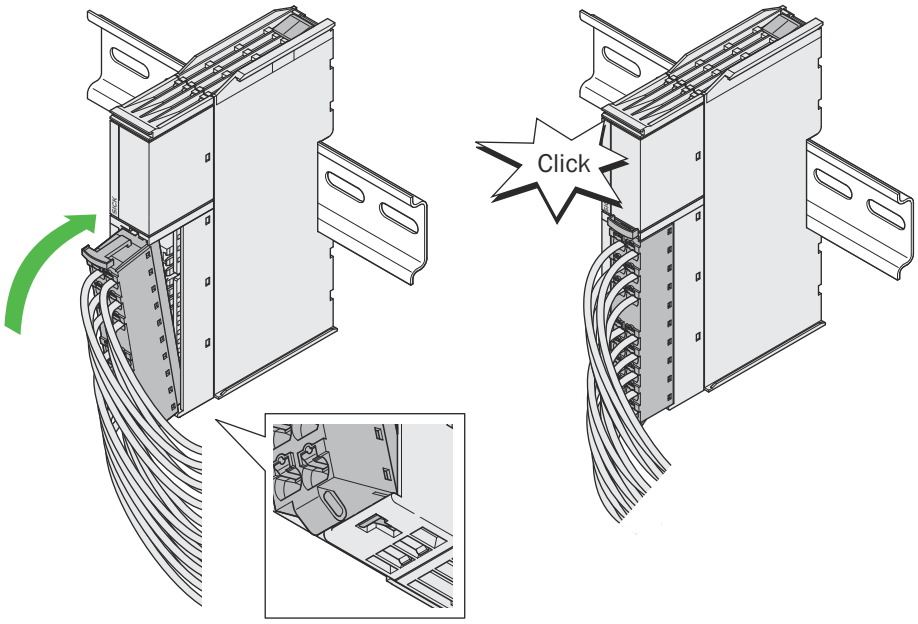


Figure 14: Mount the front connector

✔ The front connector engages with an audible click.

Further topics

- "Mounting the product", page 26
- "Removing the product", page 28
- "Offline, online and security configuration", page 37

7 Electrical installation

7.1 Connecting

Prerequisites

- Mounting is completed.
- Electrical installation is carried out according to the project planning.
- Dangerous condition of the machine is and remains off during the electrical installation.
- The outputs of the safety controller do not affect the machine during electrical installation.

7.1.1 Front connector

Important information

NOTICE

If the voltage supply (A1 and A2) is connected with reversed polarity and a parallel USB connection exists, the safety controller and the connected USB host can be damaged.

Prerequisites

Electrical connection requirement:

- Electrical installation is performed in accordance with EN 60204-1.
- The mounting rail is connected to the functional earth.
- The voltage supply and connected signals meet the requirements for extra-low voltages with safe separation (EN 60664) or NEC Class 2 (UL 1310).
- The external voltage supply must be capable of buffering brief power failures of 20 ms as specified in EN 60204-1. Suitable power supply units are available as accessories from SICK.
- Galvanically isolate the 24 V power circuit of the safety controller from the battery-operated power circuit using an encapsulated DC/DC converter in accordance with EN 1175 (e.g., when using AGVs).
- The GND of all connected devices must have the same potential as A2 of the main module.
- The GND connections of the actuators at the safety outputs must be connected in star configuration with the GND connection of the respective voltage supply.

Pin assignment

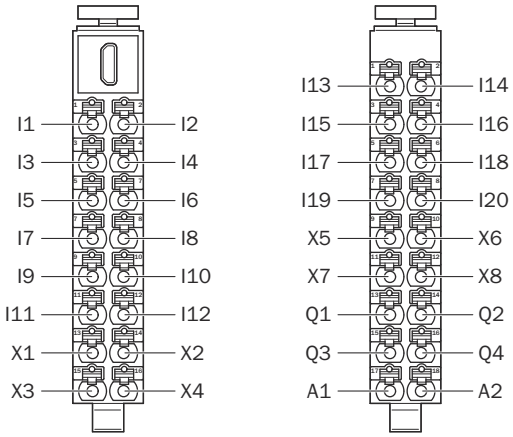


Figure 15: Terminals on front connectors

Table 4: Left front connector pin assignment

Terminal	Designation	Description
1	I1	Safety capable input
2	I2	
3	I3	
4	I4	
5	I5	
6	I6	
7	I7	
8	I8	
9	I9	
10	I10	
11	I11	
12	I12	
13	X1	Test output
14	X2	
15	X3	
16	X4	

Table 5: Right front connector pin assignment

Terminal	Designation	Description
1	I13	Safety capable input
2	I14	
3	I15	
4	I16	
5	I17	Safety capable input
6	I18	Safety capable input
7	I19	Safety capable input
8	I20	Safety capable input
9	X5	Test output
10	X6	
11	X7	
12	X8	
13	Q1	Safety output
14	Q2	
15	Q3	
16	Q4	
17	A1	24 V
18	A2	GND

Complementary information

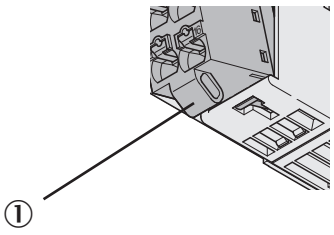


Figure 16: Eyelet on front connector

① Eyelet for cable tie

Connected cables can be fastened to the front connector eyelet using a cable tie. This relieves the strain on the cables.

Further topics

- "Electrical integration", page 20

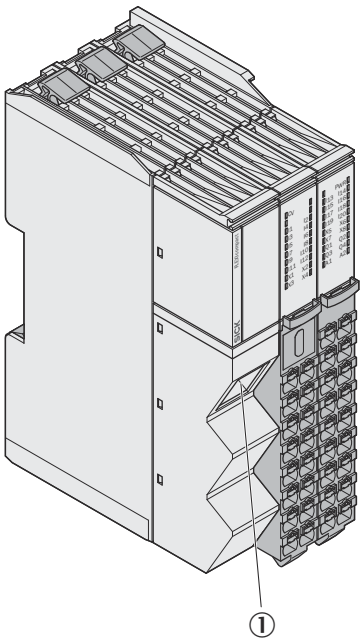
7.1.2 RJ45 socket

Prerequisites

Network cable requirement:

- Type: 100Base-TX
- Cables with RJ45 connections
- Twisted pair Ethernet cable, maximum length 100 m in accordance with EN 50173
- Use of wire pairs 1/2 and 3/6
- Shielded cables
- Cat 5 STP or higher

Connection



① RJ45 female Ethernet connector

7.2 Coding

Overview

You can code the front connector and its modules. A uniquely coded front connector only fits a uniquely coded module. Coding prevents the front connectors from getting mixed up.

Coding options

- 1-of-7 coding: 7 front connectors can be uniquely coded.

	Coding						
	1	2	3	4	5	6	7
Front connector 1	□	■	■	■	■	■	■
Front connector 2	■	□	■	■	■	■	■

...				...			
Front connector 7	■	■	■	■	■	■	□

- 2-of-7 coding: 21 front connectors can be uniquely coded.

	Coding						
	1	2	3	4	5	6	7
Front connector 1	□	□	■	■	■	■	■
Front connector 2	■	□	□	■	■	■	■
...				...			
Front connector 6	■	■	■	■	■	□	□
Front connector 7	□	■	■	■	■	■	□
...				...			

- 3-of-7 coding: 35 front connectors can be uniquely coded.

	Coding						
	1	2	3	4	5	6	7
Front connector 1	□	□	□	■	■	■	■
Front connector 2	■	□	□	□	■	■	■
...				...			
Front connector 5	■	■	■	■	□	□	□
Front connector 6	□	□	■	■	■	■	□
...				...			

7.2.1 Coding front connector and module

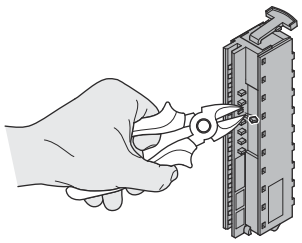
Prerequisites

- Slotted screwdriver 3.5 mm × 0.6 mm
- Diagonal cutter

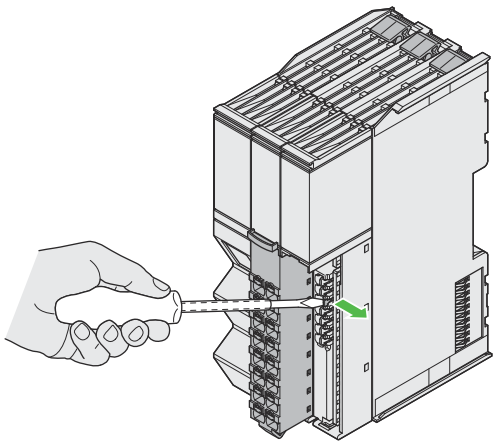
Procedure

Each front connector contains seven coding ribs. The modules have seven coding elements each for each front connector.

1. Remove the coding ribs on the front connector with wire cutters.



2. Insert the slotted screwdriver vertically on the left next to the respective coding element.



3. Tip the coding element to the right with a slotted screwdriver.
✔ The coding element engages.

Complementary information

You can not reattach a removed coding rib to the front connector.

If you turn a coding element on a module several times, it can break off. This means there is no active coding function in this case. However, you can continue to use the module.

8 Configuration

8.1 Delivery state

The device is not configured in the delivery state.

8.2 Safety Designer configuration software

The safety controller is configured using the Safety Designer configuration software.

For information on the Safety Designer, see the operating instructions for the Safety Designer item no. 8018178.

The Safety Designer operating instructions include, among other things, information on creating projects, device administration, and opening the device window.

The configuration of the device is described after the device window is opened.

8.2.1 User groups

Overview

The devices contain a hierarchy of user groups that regulate access to the devices.

For certain actions (e.g., transferring a configuration to the device), you are requested to log onto the device with the respective user group.

Important information

NOTICE

When you log into a device, the configuration software stores the password so that you do not need to re-enter it for other configuration steps.

If you do not change any other settings in the login dialog, the password is deleted as soon as you exit the configuration software, or log out in the main window or Device window.

If you enable the **Temporarily store password for login on additional devices.** function, the password will be retained even if you log out in the device window only.

If you leave the computer unattended, you must log off to prevent unwanted access to the device.

User groups

Table 6: User groups

User group		Password	Authorization
	Operator	No password required. Anyone can log on as a machine operator.	• May read configuration from the device.
	Maintenance personnel	Deactivated ex-works, i.e. it is not initially possible to log on as a maintenance technician. The user group can be activated by the user group administrator and provided with a password.	• May read configuration from the device. • May transmit verified configuration to the device. • Change own password allowed.

User group		Password	Authorization
	Authorized client	Deactivated ex-works, i.e. it is not initially possible to log on as an authorized customer. The user group can be activated by the user group administrator and provided with a password.	• May read configuration from the device. • May transmit verified and unverified configuration to the device. • May verify configuration. • Resetting the safety function and communication settings to factory defaults is allowed. • Change own password allowed. • Changing the password of the **Maintenance personnel** user group is allowed.
	Administrator	The password SICKSAFE is created at the factory. → Change this password to protect the device against unauthorized access.	• May read configuration from the device. • May transmit verified and unverified configuration to the device. • May verify configuration. • Resetting whole device to factory settings allowed. • Activating and deactivating device functions is allowed. • Activating and deactivating the **Maintenance personnel** and **Authorized client** user groups is allowed. • Change own password allowed. • Changing the passwords of the **Maintenance personnel** and **Authorized client** user groups is allowed.

Complementary information

The configuration of the safety controller is saved in the SmartPlug. This is why the passwords are retained when replacing the safety controller and continuing to use the SmartPlug.

8.2.2 Offline, online and security configuration

Overview

All configuration parameters are assigned to a configuration group. The configuration groups differ, for example, when transmitting and saving the configuration.

The following configuration groups are available

- Offline configuration
- Online configuration
- Security configuration

Offline configuration

All offline configuration parameters are written to the safety controller using the **Transfer to device** function. The offline configuration includes, for example, all parameters of the hardware configuration.

These parameters can only be configured in the configuration software.

To configure the parameters, no connection to the safety controller must exist. Only establish a connection to the safety controller when you want to transfer the configuration.

The application is stopped while the configuration is transferred to the safety controller.

The offline configuration is stored in the SmartPlug. A (defective) module can be replaced with a compatible module without having to reconfigure the device. The offline configuration must be compatible with the physical safety controller.

Within the offlline configuration, a distinction is made between the following configuration data.

Offline configuration data:

- Safety configuration

  Configuration data that affect the safety function of a device, e.g., configuration of safety capable inputs, safety outputs, logic, ...
- Standard configuration

  Configuration data that affect the non-safety function of a device, e.g., configuration of test outputs, configuration of non-safe modules.
- Non-functional configuration

  Configuration data that have no effect on the functioning of the device, e.g. tag names, comments in the logic, project information of the user

Online configuration

Each of the online configuration parameters have their own transfer option and can be individually written to the safety controller. The online configuration includes, for example, the parameters relating to the network settings.

These parameters can be configured in the configuration software or via a module with a display.

To configure the parameters using the configuration software, a connection to the safety controller must exist.

The application does not need to be stopped while the configuration is transferred to the safety controller.

The online configuration is saved in and read back from the SmartPlug using the module position and the module type. If the module position is maintained, a (defective) module can be replaced with a compatible module without the need for reconfiguration. If the module position is changed, the saved parameters will not work. If, for example, the module position of a gateway is changed, the connection parameters need to be reconfigured before a connection to the safety controller can be established. The old module positions are corrected when writing an offline configuration.

If online configuration parameters are configured without a SmartPlug inserted, these settings will only apply temporarily until the safety controller is restarted or a SmartPlug is inserted.

Security configuration

The security configuration includes the following parameters:

- Passwords for user groups
- Security settings

These parameters can only be configured in the configuration software.

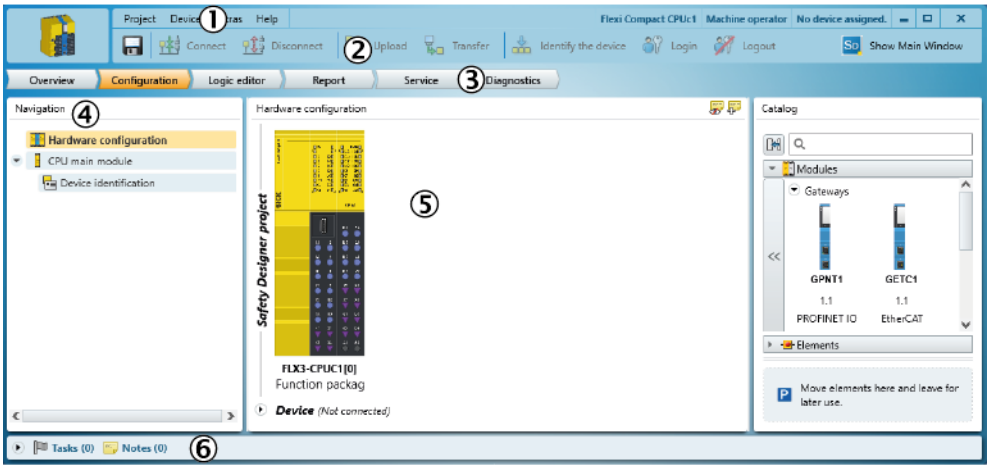
The application does not need to be stopped while the configuration is transferred to the safety controller.

The security configuration is saved in the SmartPlug. A (defective) module can be replaced with a compatible module without having to reconfigure the device.

Further topics

- "SmartPlug", page 17

8.3 Device window user interface



① Menu bar

② Toolbar

③ Main navigation

④ Navigation

⑤ Working range

⑥ Task list and notes

8.4 Overview main navigation menu

The **Overview** main navigation menu contains information about the configuration.

8.5 Configuration main navigation menu

Configuration main navigation menu

Once a main module has been selected in the configuration software, the various modules and connectable elements can be combined into a safety controller.

- **Hardware configuration**: This is where you combine the modules and elements into a safety controller.
- **Catalog**: This is where you select the modules and elements and, if necessary, configure user-defined elements.
- In the navigation, you can switch between the hardware configuration and the diagnostic bits (online only) of the modules.
- **Move elements here and leave for later use.**: Here you can create a collection of devices for a specific application and store them here temporarily.
- Modules or elements can be deleted using the trashcan.

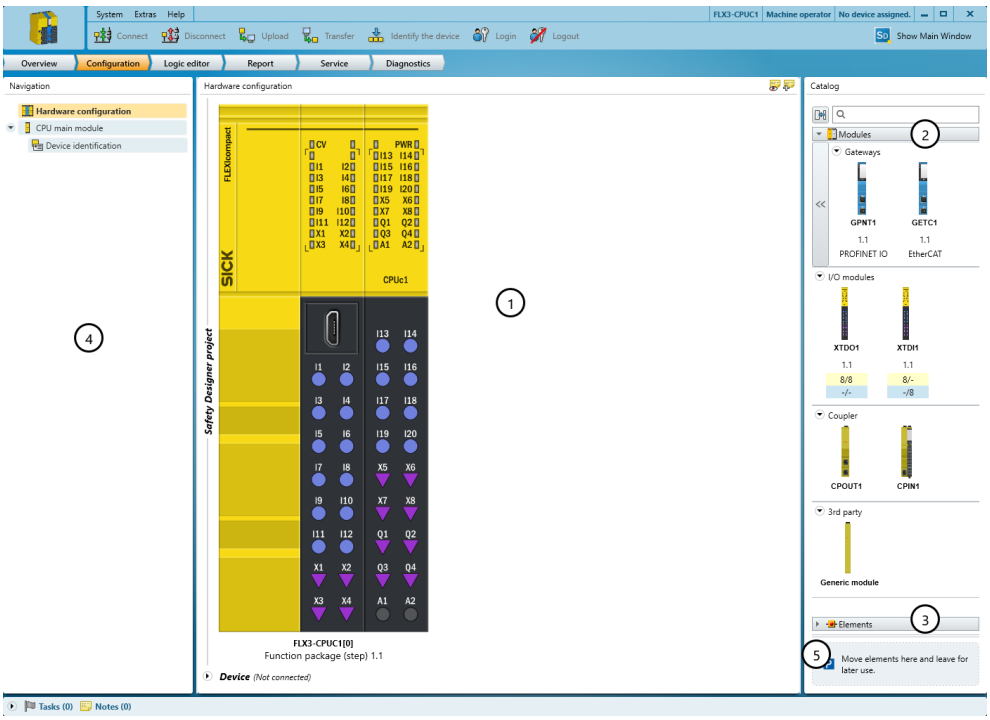


Figure 17: Configuration

① Workspace

② Module catalog

③ Element catalog

④ Navigation

⑤ Parking area

Complementary information

The **Edit mode** button is only visible if the configuration software is connected to a safety controller.

The configuration can be edited in **Edit mode** if the safety controller is online.

Figure 18: Edit mode button

8.5.1 Identification

Overview

On the **Identification** page, you can optionally enter attributes for the device. The attributes are used to identify the device or to distinguish between different devices. The attributes appear in reports and in the diagnostic data.

Device name

If a number of devices are used in an application or in a project, a unique device name helps to tell the individual devices apart.

Project name

The project name is used to identify an entire project. The same project name should be chosen for all devices in the project.

Application name

The application name can be the same for a number of devices in the project.

User name

The optional user name helps later users to find a contact for the application.

Application image

An image helps to identify the application more quickly. The Safety Designer supports the following file formats: BMP, GIF, JPG, PNG, TIF.

Description

A description makes it easier to understand an application's context more quickly.

8.5.2 Adding expansion modules

Overview

The **Catalog** shows, in the **Modules** area, all extension modules that can be added. A version can be selected for the module, if applicable.

Procedure

1. In the **Navigation pane**, click on **Hardware configuration**.
2. In the **Catalog** under **Modules**, select the version of an extension module if applicable.
3. Drag an extension module in the **Catalog** to the desired position. Alternatively, double-click on an extension module.

✔ The expansion module is added to the workspace.

8.5.3 Input elements

Table 7: Categories of input elements

Category	Safety-relevant parameters[1)]			Examples
	Mode	Test pulses	Other parameters	
Electro-mechanical switch/safety switch (EMSS) Contract based single-channel/dual-channel electro-mechanical switch/safety switch without signal processing unit	• Single-channel input • Dual-channel equivalent input • Dual-channel complementary input	• Parameter **Element is connected to a test output** is deactivated. • Parameter **Element is connected to a test output** is activated and **test pulse width** = 2 ms.		• Magnetic safety switches • Emergency stop pushbutton • Reset switch • Safety door limit switch • Two-hand control devices • Enabling pushbutton • Operating mode selector switch
Safety sensors with monitored semiconductor output (OSSD) Safety sensors with dual-channel cross-circuit monitored semi-conductor outputs	Dual-channel equivalent input	Parameter **Element is connected to a test output** is deactivated.	OSSD test pulse filter active	• Transponder safety switch e.g., Sistra • Safety light curtains, e.g. deTec4 • Safety laser scanner, e.g., microScan3, nanoScan3

Category	Safety-relevant parameters[1]			Examples
	Mode	Test pulses	Other parameters	
Safety sensors with test input Safety sensors with a test input, signal processing unit and test output	Single-channel input	Parameter **Element is connected to a test output** is activated and **test pulse width** = 4 ms.		• Type 2/4 safety light-beam sensors, e.g. L41 • Flexi Loop
Safety pressure mats [2][3]	Dual-channel input with short-circuit detection (with/without diodes)	Parameter **Element is connected to a test output** is activated and **test pulse width** = 2 ms.		• Safety pressure mats • Edges and bars

1) These parameters are also included in the report.

2) When sensor cables carry the test pulse signal of the same test output, protected or separate cabling is required. Reason: Cross-circuits between the sensor cables are not detected.

3) If you are configuring safety pressure mats (dual-channel input with short-circuit detection), the safety function must be requested at least once a year.

8.5.3.1 Configuration options for input elements

Important information

DANGER

Ineffectiveness of the protective device or reduction of the safety parameters due to a change in configuration of the element

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Take longer response times, fault detection times or reduced safety parameters into account.

WARNING

Ineffectiveness of the protective device due to longer response time with debounce filter

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Select the shortest possible debounce time.
→ Take into account the longer response time.

Configuration options for input elements

Table 8: Configuration options for input elements

Parameter	Description
Tag name	The logic editor and report display the tag name of an element.
Nr. of devices:	If multiple devices are connected in a safe series connection, you can enter the number of devices here.
Safety element	Specifies whether you can use the element for a safety function.

Parameter	Description
ON-OFF debounce filter	The ON-OFF debounce filter for falling signal edges (1 → 0) and the OFF-ON debounce filter for rising signal edges (0 → 1) prevent undesirable signal changes that arise as a result of bouncing of the contacts. When the debounce filter is active, a change in the signal is delayed by the selected debounce filter time [ms]. Take into account the longer response time.
OFF-ON debounce filter	
Debounce filter time	
Element is connected to a test output	The element is tested if the option is activated. You can configure the test pulse interval and test pulse width in the **Test outputs** tab. For dual-channel elements, these parameters can be configured individually for each channel.
test pulse interval (test pulse interval)	
test pulse width (test pulse width)	
Discrepancy time	The discrepancy time determines how long the two inputs can continue to have different values after the value of one of the two input signals changes.
OSSD test pulse filter	When this option is activated, the device filters out test pulses from safety sensors with self-testing semiconductor outputs (OSSD) that have a test pulse width of ≤ 1 ms. No lengthening of the response time needs to be taken into consideration.
Max. tolerated test pulse delay	The max. tolerated test pulse delay specifies how long safety sensors with test inputs can delay the signal of a test output (X) before the safety capable input no longer detects it. • For safety sensors with test inputs: If the configured test pulse interval is > 8 ms and a long delay time of the test signal due to the connected sensors is expected, e.g., when cascading the sensors, set this to 12 ms. See the operating instructions of the sensor • In all other cases and for all other sensors: Always use 0 ms Take into account the longer response time.

Further topics

- "Input elements with dual-channel evaluation", page 43
- "Technical data", page 123
- "Report main navigation menu", page 109

8.5.3.2 Input elements with dual-channel evaluation

Overview

The safety controller evaluates dual-channel elements using sequence monitoring and optionally with discrepancy time monitoring.

Discrepancy conditions for equivalent and complementary evaluation

Table 9: Input combination for dual-channel evaluation of the inputs

Mode	Input A	Input B	Input combination	Status of dual-channel evaluation (input in the logic editor)
Dual channel equivalent	0	0	Deactivated	0
	0	1	Discrepant	0
	1	0	Discrepant	0
	1	1	Active	1[1)]

Mode	Input A	Input B	Input combination	Status of dual-channel evaluation (input in the logic editor)
Dual channel complementary	0	1	Deactivated	0
	0	0	Discrepant	0
	1	1	Discrepant	0
	1	0	Active	1[1)]

1) If discrepancy time monitoring and sequence monitoring have been met or is deactivated.

The status of the dual-channel evaluation (i.e. the input in the logic editor) changes to 1 if the following conditions are met:

- The input combination of input A and input B is = active.
- The discrepancy time was observed (discrepancy time monitoring).
- The correct sequence was observed (sequence monitoring).

The status of the dual-channel evaluation changes to 0 if the input combination of input A and input B is inactive or discrepant.

Discrepancy time monitoring

The discrepancy time determines how long the two inputs can continue to have different values (in dual-channel equivalent mode) or the same values (in dual-channel antivalent mode). A discrepancy error occurs if the input combination is discrepant for longer than the configured discrepancy time. A discrepancy error is reset if the input combination is inactive.

Sequence monitoring

The correct sequence for sequence monitoring has been met if the input combination was first inactive before changing to active, if applicable via discrepant. This means that it is not possible to switch back to state 1 of the dual-channel evaluation through the sequence of input combinations active – discrepant – active.

Sequence monitoring is also met if the input combination is already active during the transition from the stop state to the run state of the safety controller.

If the active input combination lasts longer than 100 ms without the correct sequence having been observed beforehand (status of the dual-channel evaluation = 0), a sequence error is displayed.

A sequence error is reset if the input combination = inactive.

Complementary information

Value range: 0 ms ... 60 s, 0 = deactivated

- When **Discrepancy time** is deactivated, the value is set to infinite.
- Different propagation times of the input signals can lead to an lengthening or shortening of the discrepancy time, e.g., due to the debounce filter time or the test pulse width of the safety input used.

Further topics

- "Possible faults", page 118

8.5.3.3 Start - Automatic selection of reset mode

Overview

You can use the **Automatic selection of reset mode** input element in combination with the **Reset V1** function block to perform a restart. Connect the safety input to the **Reset** input of the function block.

Depending on the wiring of the input, the reset function goes into the corresponding operating mode when the logic program is started. This results in different behavior without changing the logic program, only by changing the hardware connection.

Operating modes:

- Mode with restart interlock: Manual reset
- Mode without restart interlock: Automatic reset

Important information

WARNING

Unexpected machine start-up due to automatic reset without restart interlock

In the case of non-compliance, it is possible that the dangerous state of the machine may not be stopped or not stopped in a timely manner.

→ Take other protective measures to make sure that there is no one inside the hazardous area.

Prerequisites

- **Reset V1** function block

Manual reset

For manual reset, a pushbutton is connected between the safety input and the supply voltage. Pressing the pushbutton manually for min. 100 ms triggers a valid reset sequence at the **Reset** input of the function block.

Automatic reset

With automatic reset, the safety input and the associated test output are connected with a wire jumper. There is no restart interlock. With a direct connection between the test output and the safety input, the input signal toggles (changes) periodically in the logic. This automatically triggers a valid reset sequence at the **Reset** input of the function block every 400 ms.

Further topics

- "Electrical installation", page 31
- "Reset V1", page 85

8.5.4 Output elements

Table 10: Categories of output elements

Category	Safety-relevant parameters[1)]			Examples
	Mode	Test pulses	Other parameters	
Actuators / safe actuators	• Single-channel output (NPN) • Single-channel output (push-pull) • Single-channel output (PNP) • Dual-channel output	• Without test pulse (deactivated) (note any further measures, if applicable) • With test pulses (note any further measures, if applicable) • Test pulses allowed	• Increased capacitive loads allowed	• Safety relay, e.g., ReLy • Safety contactors • Safety locking devices, e.g., MLP1 • Valves • Motors • Robot • Lamps

1) These parameters are also included in the report.

8.5.4.1 Configuration options for output elements

Important information

DANGER

Ineffectiveness of the protective device or reduction of the safety parameters due to a change in configuration of the element

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Take longer response times, fault detection times or reduced safety parameters into account.

WARNING

Reduced safety characteristics due to deactivation of the test pulses

In the case of non-compliance, it is possible that the dangerous state of the machine may not be stopped or not stopped in a timely manner.

→ Use protected or separate cabling.
→ Perform one of the following actions:
  - Restart the safety controller once a year.
  - Switch off all safety outputs simultaneously for min. 2 s once a year. This can be done by means of an explicit test or if this is ensured by the normal process flow. The supply voltage of the outputs must be within the operating range.

WARNING

Ineffectiveness of the protective device due to longer error detection time when the **Increased capacitive loads allowed** parameter is activated

In the case of non-compliance, it is possible that the dangerous state of the machine may not be stopped or not stopped in a timely manner.

The **Increased capacitive loads allowed** parameter results in a longer error detection time. This primarily applies to single-channel outputs.

→ Take into account the extended error detection time.

Configuration options for output elements

Table 11: Configuration options for output elements

Parameter	Description
Tag name	The logic editor and report display the tag name of an element.
Nr. of devices:	If multiple devices are connected in a safe series connection, you can enter the number of devices here.
Safety element	Specifies whether you can use the element for a safety function.
Output testing A short-circuit to HIGH (stuck-at-high) can be detected using test pulses.	**Without test pulses** When this option is selected, the test pulses for this output are deactivated.[1)] Additional measures for all safety outputs of the module may be required, see "Safety-related parameters", page 123. This option is required for connected devices that cannot tolerate a brief interruption in the voltage supply (test pulses).
	Test pulses allowed When this option is selected, the test pulses for this output are activated. This option is suitable when the test pulses have no effect on the connected device and they are not needed to achieve the required safety-related characteristics.[1)] Additional measures may be required to achieve the safety-related characteristics, see "Safety-related parameters", page 123.
	With test pulses When this option is selected, the test pulses for this output are activated. This option is required for connected devices where test pulses are essential for achieving the required safety-related characteristics, see "Safety-related parameters", page 123
Delayed error reaction The function is only available for device version 1.2 and above (functional scope, step).	Standard error response: If a short circuit to HIGH (stuck-at-high) is detected at a safety output, then all safety outputs of the module are switched off without additional delay. Delayed error response: The switch-off of all safety outputs can be delayed by the set time using the parameter **Delayed error reaction** if a short circuit to HIGH (stuck-at-high) was detected in the ON state. Prerequisite: Test pulses are active for the affected output. If the safety output goes into the OFF state before the delay time has elapsed, the standard error response takes effect. The parameter is suitable when immediate switching off of the safety outputs could cause material damage. The delay time can then be used to initiate an orderly error response via the machine controller, e.g., braking drives in an orderly manner or initiating a required shutdown sequence for the safety outputs. In the event of a short circuit to HIGH (stuck-at-high) in the OFF state, the standard error response applies: Shutdown without additional delay. The diagnostic information **Stuck at high status** is available in the logic or at the gateway (via the routing), see "Process data status bits of the individual inputs or outputs", page 106.
Increased capacitive loads allowed	This may be necessary for switching loads in cases where the voltage at the load does not drop to the Low level as quickly as expected. **Examples** • Loads with a capacitance that is higher than the standard level permitted for the output, such as the supply voltage of PLC output cards that require safety-related switching. • Inductive loads that cause an overshoot in the positive voltage range once the induction voltage has decayed. Take into account the longer response time.

Parameter	Description
Power consumption	The parameter is used to check whether the output has sufficient current carrying capacity. This is particularly relevant for elements that have no safety-related requirements and can therefore be placed on a test output or safety output.

1) The achievable safety-related characteristics, in particular the category in accordance with ISO 13894, depends on the option selected for the other safety outputs of the same module. If the "Without test pulses" option is selected for one or more outputs, the achievable safety-related characteristics for all single-channel safety outputs is reduced.

Further topics

- "Input elements with dual-channel evaluation", page 43
- "Technical data", page 123
- "Report main navigation menu", page 109

8.5.5 Adding, configuring and expanding elements

8.5.5.1 Adding elements

Overview

The **Catalog** shows under **Elements** all of the devices (e.g., sensors, actuators, encoders) that can be connected to the inputs and outputs of the safety controller.

Procedure

1. In the **Navigation pane**, click on **Hardware configuration**.
2. Drag an element from the **Catalog** into the workspace but do not release it.

✔ All suitable and free inputs and outputs are highlighted.

3. Drag the element to the desired free input or output and release it.

✔ The element is connected to the relevant input or output.

Complementary information

You can move elements from one module to another. This does not work for the following elements:

- Element with a connection to a **Fast shut off V1** function block
- Grouped elements, for example an operating mode selector switch or switch with locking device

8.5.5.2 Configuring elements

Prerequisites

- The input element or output element is connected to the safety controller in the workspace of the configuration software or is located in the parking area.

Procedure

1. Double-click on the element.

✔ The configuration dialog opens.

2. Configure the element as required.
3. Click on **OK**.

✔ The changes are applied.

Further topics

- "Configuration options for input elements", page 42
- "Expanding elements", page 49

8.5.5.3 Expanding elements

Overview

Some elements are made up of a group of two or more sub-elements. For example, a guard locking element is made up of a safety switch as the input element and a lock as the output element.

You can expand these grouped elements, i.e., split them into their individual sub-elements.

Procedure

1. Place the element in the parking area.
2. In the context menu of the element, select the **Expand** command.

✔ The element is expanded in the parking area.

3. Connect individual sub-elements to modules.

8.5.6 Creating customized elements

Overview

Customized elements allow you to create your own elements using preset configuration options (e.g., single-channel or dual-channel evaluation, discrepancy time, ON-OFF filtering, etc.).

A customized element is created from the template of an existing element.

Customized elements can also be exported and imported.

Important information

NOTE

Once an element is created, it is not possible to subsequently edit it.

→ Check all settings before saving it.
→ If a correction is required, you can use the created element as a template for a new customized element.

Prerequisites

- The **Enable customized elements** option under **General settings** is selected.

Procedure

1. In the **Navigation pane**, click on **Hardware configuration**.
2. In the **Catalog** under **Elements**, open the context menu for any element. Select an element that is similar to the element to be created.
3. In the context menu, select the **Save as customized element ...** command.

✔ The **Create personalized element template** window opens.

4. Under **Element**, specify a **Title** and a **Subtitle:** for each language.
5. Assign the element its own graphic, if applicable.
6. Under **Bill of materials information**, enter the required information about the element used.
7. Under **Editable element configuration**, edit the settings for the element.
8. Click on **OK** to save the new element and close the window.

✔ The new element is added to the **Catalog** under **Elements**.

Further topics

- "Configuration options for input elements", page 42

8.5.6.1 Exporting customized elements

Procedure

1. In the context menu of the element to be exported, select the **Export ...** command.
2. Select the destination for the element to be exported or create a new folder and click on **OK**.

✔ The customized element is saved as an XML file.

8.5.6.2 Importing customized elements

Procedure

1. In the context menu of any element in the **Catalog**, select the **Import ...** command.
2. Select the XML file with the element to be imported and click on **Open**.

✔ The customized element is imported.

8.6 Configuring the network interfaces

8.6.1 Configuring Modbus connections

Procedure

1. In the main navigation pane, click **Configuration**.
2. In the navigation pane under **Main module**, select the **Fieldbus** menu item.
3. Activate the **Modbus server** option.
4. In the **Max. number of connections** field, select the number of connections.

8.6.2 Configuring SLMP connections

Procedure

1. In the main navigation pane, click **Configuration**.
2. In the navigation pane under **Main module**, select the **Fieldbus** menu item.
3. Activate the **SLMP server** option.
4. In the **Port** field, select the port.

8.6.3 Configuring the output data (routing to CPU)

Overview

The CPUc2 main module can receive up to 50 bytes of output data from a higher-level control system.

The actual data volume and contents depends on how the output data are configured in the higher-level control system.

The configuration of the output data includes the following points:

- Defining the standard routing
- Optional: Enter the tag names for the data received from the network

Procedure

1. In the main navigation pane, click **Configuration**.
2. In the navigation pane under **CPU main module** > **Fieldbus**, select the **Fieldbus** menu item.
3. Select a routing template and drag it onto a single byte or several bytes of the output data block.

✔ The bits, bytes or data formats are available as inputs in the logic editor.
✔ Each bit, byte or data format inherits a default tag name from the routing.

4. If required, edit the default tag name in the **Properties** tab.

Complementary information

Table 12: Colors of the bytes and bits of a record

Color	Meaning
Light blue	The byte or the bit is empty.
Blue	The byte or the bit is occupied. The relevant module, input or output is configured in the hardware configuration of the safety controller.
Gray	The byte or the bit is occupied. The relevant module, input or output is not yet configured in the hardware configuration of the safety controller.

You can monitor the status of the communication with the network. A status bit for the receipt of data from the network is provided for this. If the gateway detects a fault in the communication, it sets the contents of the output records and the associated status bit to Null.

8.6.4 Configuring the input data (routing to network)

Overview

The CPUc2 main module can send up to 50 bytes of input data to a higher-level control system.

The input data can comprise the statuses of the inputs and outputs, the logic results, or diagnostic data.

Procedure

1. In the main navigation pane, click **Configuration**.
2. In the navigation pane under **CPU main module** > **Fieldbus**, select the **Routing to network** menu item.
3. Select the required input data and drag it onto a single byte or several bytes of the input data block.

   The following input data are available:
   - **Routing Templates** contains templates for the routing of data from the logic editor.
   - **Inputs** contain the input values of the modules.
   - **Outputs** contain the output values of the modules as well as the logic results from the logic editor.
   - **Diagnostics** contains the checksums and status information of the modules.

✔ The bits, bytes or data formats are available as individual outputs in the logic editor.

✔ Each bit, byte or data format inherits a default tag name from the routing.

4. If required, edit the default tag name in the **Properties** tab.

Complementary information

Table 13: Colors of the bytes and bits of a record

Color	Meaning
Light blue	The byte or the bit is empty.
Blue	The byte or the bit is occupied. The relevant module, input or output is configured in the hardware configuration of the safety controller.
Gray	The byte or the bit is occupied. The relevant module, input or output is not yet configured in the hardware configuration of the safety controller.

The status of the communication with the network can be monitored. A status bit for the sending of data to the network is provided for this. If the gateway detects a fault in the communication, it sets the contents of the input records and the associated status bit to Null. The bit also switches to Null if the gateway is not ready for operation or the safety controller was stopped via the configuration software.

8.7 Logic editor main navigation

Logic editor main navigation

The function logic is programmed in a graphical logic editor.

Complementary information

If the logic configuration contains errors, you can find an error description via the **Configuration is invalid** icon in the toolbar. Click on it to open a comprehensive error overview.

	Configuration is invalid

8.7.1 Logic programming in the logic editor

8.7.1.1 Safety

- Take into consideration that in the event of an error being detected, the associated diagnostic elements are set to 0, however the input bits and output bits could have invalid values. Evaluate the associated safe diagnostic elements (yellow), so that the affected output signals can be switched off in the event of an error.
- An error at an input can result in an unexpected rising or falling signal edge. When edge detection is activated, this can lead to undesirable switching behavior. Remember to allow for unexpected rising or falling signal edges when planning your logic.
- The function blocks are executed in a specific sequence during a logic cycle. You can recognize the sequence of execution using the function block index that is displayed at the top of each function block. If a function block uses the signal of another function block with the same or a higher function block index, a so-called reverse path is created. Reverse paths cause a delay in the response time because the output signal of the function block is only updated one logic cycle later. Please take the delayed response time into account when using reverse paths.
- For pulsed signals, a signal change may be delayed because the signal change can only be taken into consideration by the test pulse in the subsequent logic cycle. The logic execution time itself is not affected by this.

8.7.1.2 Adding an element

Procedure

→ In the **CPU logic catalog**, selected the desired element and drag it onto the worksheet using drag and drop.

8.7.1.3 Connecting elements

Procedure

1. Click and hold the blue square of an element.
2. Drag and release the mouse pointer onto another blue square of an element (left side).

✔ A connection between the input and output of the elements is indicated by a black

line.

Complementary information

- You can only connect inputs to outputs and vice versa. Inputs are the blue squares on the left side of an element. Outputs are the blue squares on the right side of an element.
- You can connect the output of a function block to multiple downstream function blocks.
- You can connect the output of a function block to multiple physical outputs (i.e. output markers of the logic).

8.7.1.4 Configuring function blocks

Procedure

1. Double-click on a function block.

✔ The configuration dialog for the function block opens.

2. Configure the desired parameters on the tabs of the configuration dialog.

Complementary information

When you click on a function block on the worksheet, the **FB group info** window displays information about the relevant function block.

Further topics

- "Function blocks", page 54
- "Boolean", page 56
- "Basic Applications", page 85

8.7.1.5 Testing the logic program

Testing the logic program

While the configuration is invalid, you will not be able to activate the simulation mode. You will also not be able to transfer the configuration to the safety controller.

Complementary information

The testing of the logic program is not a safety test.

Further topics

- "Simulation mode", page 107
- "Logic editor main navigation", page 52

8.7.2 Inputs

Input elements

The **Inputs** selection window contains the following input elements for the logic program:

- Jump addresses
- The safety controller inputs that are in use
- Bits of the output record of a gateway
- Diagnostic elements
- The **Static 0** and **Static 1** input elements
  - The output of the **Static 0** element is always 0.
  - The output of the **Static 1** element is always 1.

- The **First logic cycle** input element
  - This input element is set to 1 during the very first logic cycle that is performed after each transition from the Stop status to the Run status.
  - The input element is set to 0 throughout all other logic cycles.

  When used appropriately, the **First logic cycle** input element initiates, for example, initialization functions in the logic program.

Further topics

- "Jump addresses", page 106
- "Connecting elements", page 52

8.7.3 Outputs

Output elements

The **Outputs** selection window contains the following output elements:

- Jump addresses
- The module outputs that are in use
- Bits of the input record of a gateway
- Output bits for the logic results

  You can use logic results to forward the results of the logic program to other controllers via a network, e.g., using a gateway. You can use each output bit only once.

Further topics

- "Jump addresses", page 106
- "Connecting elements", page 52

8.7.4 Function blocks

Overview

The logic is programmed using function blocks. Function blocks have inputs, outputs and sometimes parameters. The status of the outputs depends on the status of the inputs, the parameters, and the logic of the function block.

The logic programming results from the combination of various function blocks which are connected to one another and to the inputs and outputs of the safety controller.

Function blocks

Boolean

- NOT V1
- AND V1
- OR V1
- XOR V1
- XNOR V1
- RS Flip-Flop V1
- JK Flip-Flop V1
- Multi enable V1
- Multi latch V1

Converter

- Bool to UInt8 V1
- UInt8 to Bool V1

- UInt8 to One-hot V1
- One-hot to UInt8 V1

Counter, Delay and Timer

- Event counter (up and down) V1
- Event counter (up) V1
- Event counter (down) V1
- Fixed on-delay timer V1
- Fixed off-delay timer V1
- Adjustable on-delay timer V1
- Adjustable off-delay timer V1
- Clock generator V1

Input Evaluation

- Edge detection V1
- Dual channel monitor V1
- Two hand control (2 inputs) V1
- Two hand control (4 inputs) V1

Output Control

- External device monitoring V1
- Fast shut off V1

Basic Applications

- Reset V1
- Restart V1
- Operating mode switch V1
- Multi operator V1
- Parallel muting V1
- Sequential muting V1
- Cross muting V1

Complementary information

- You can also activate additional inputs with certain function blocks.
- You can also activate additional status and diagnostic outputs with certain function blocks.
- Function blocks with configuration errors are shown in red, e.g., if not all inputs have been connected.
- Maximum number of function blocks in the logic:
  256

Further topics

- "Connecting elements", page 52
- "Configuring function blocks", page 53

8.7.4.1 Logic execution

Logic execution sequence

Each function block has a function block index. The function block index shows the execution sequence within the logic cycle. The results of a function block are updated during execution, and can then affect function blocks with a higher function block index during the same logic execution cycle.

Within a logic execution cycle, the values in and out of the logic remain unchanged.

Logic execution time

The logic execution time is the time required to execute one logic cycle.

The logic processing time primarily depends on the type and number of function blocks used. It is a multiple of 4 ms. The logic processing time can also be affected by other factors, e.g., firmware version, hardware configuration, and the input/output elements and fieldbus connections (routing) used. The number and type of safe modules can also have an influence.

The status of the safety controller outputs only changes at the end of a logic cycle. A change in the status of the safety controller inputs only becomes effective at the start of the next logic cycle.

Complementary information

- The configuration software displays both the logic processing time as well as the percentage of this time that has actually been used under **FB group info** in the logic editor. If the amount of time used exceeds 100% of the logic processing time, the logic processing time is automatically increased by 4 ms.
- The logic processing time has an accuracy of ± 500 ppm (parts per million).
- When configuring time values, these are rounded up to the nearest integer multiple of the logic cycle time.
- When muting function blocks are used, a temporal inaccuracy of 10 ms also applies. This inaccuracy is in addition to the logic processing time.

8.7.4.2 Boolean

8.7.4.2.1 NOT V1

Overview

The value at the output is the inverted value of the input.

Principle of operation

Table 14: Inputs NOT V1

Input	Description
Input	Data type: Bool

Table 15: Outputs NOT V1

Output	Description
Output	Data type: Bool The value at the output is the inverted value of the input.

8.7.4.2.2 AND V1

Overview

If all evaluated inputs = 1, the output = 1.

Principle of operation

Table 16: Inputs AND V1

Input	Description
Input 1 Input 2	Data type: Bool
Input 3 ... Input 8 (optional)	

Table 17: Outputs AND V1

Output	Description
Output	Data type: Bool If all evaluated inputs = 1, the output = 1.

Table 18: Parameter AND V1

Parameter	Description
Number of inputs required	2 ... 8
invert	You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa.

8.7.4.2.3 OR V1

Overview

If at least one of the evaluated inputs = 1, the output = 1.

Principle of operation

Table 19: Inputs OR V1

Input	Description
Input 1 Input 2	Data type: Bool
Input 3 ... Input 8 (optional)	

Table 20: Outputs OR V1

Output	Description
Output	Data type: Bool If at least one of the evaluated inputs = 1, the output = 1.

Table 21: Parameter OR V1

Parameter	Description
Number of inputs required	2 ... 8
invert	You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa.

8.7.4.2.4 XOR V1 (exclusive OR)

Overview

If both inputs are complementary, then the output = 1.

Principle of operation

Table 22: Inputs XOR V1

Input	Description
Input 1 Input 2	Data type: Bool

Table 23: Outputs XOR V1

Output	Description
Output	Data type: Bool If both inputs are complementary, then the output = 1.

8.7.4.2.5 XNOR V1 (exclusive NOR)

Overview

If both inputs are equivalent, then the output = 1.

Principle of operation

Table 24: Inputs XNOR V1

Input	Description
Input 1 Input 2	Data type: Bool

Table 25: Outputs XNOR V1

Output	Description
Output	Data type: Bool If both inputs are equivalent, then the output = 1.

8.7.4.2.6 RS Flip-Flop V1

Overview

The function block saves the most recent value for the **Set** or**Reset** inputs and is used as a simple memory cell.

Principle of operation

Table 26: Inputs RS Flip-Flop V1

Input	Description
Set	Data type: Bool
Reset	The **Reset** input has a higher priority than the **Set** input.

Table 27: Outputs RS Flip-Flop V1

Output	Description
Q	Data type: Bool see table 29, page 58
/Q	Data type: Bool The value at the output is the inverted value of the Q output.

Table 28: Parameter RS Flip-Flop V1

Parameter	Description
Inverted	You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa.

Table 29: RS Flip-Flop V1 truth table without inversion

Input Set	Input Reset	Output Q
0	0	Keeps the last value
0	1	0
1	0	1
1	1	0

8.7.4.2.7 JK Flip-Flop V1

Overview

The **J** and **K** inputs only affect the outputs if an adjustable signal edge is detected at the **Clock** input.

Principle of operation

Table 30: Inputs JK Flip-Flop V1

Input	Description
J	Data type: Bool
K	
Clock	Data type: Bool Depending on the **Inverted** parameter, a rising or falling signal edge together with the statuses of the **J** and **K** inputs affects the outputs.

Table 31: Outputs JK Flip-Flop V1

Output	Description
Q	Data type: Bool see table 33, page 59
/Q	Data type: Bool The value at the output is the inverted value of the Q output.

Table 32: Parameter JK Flip-Flop V1

Parameter	Description
Inverted	• J and K input: You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa. • Clock input: No inversion: The function block reacts to rising signal edges. With inversion: The function block reacts to falling signal edges.

Table 33: JK Flip-Flop V1 truth table without input inversion

Input J	Input K	Input Clock	Output Q
0	0	(0-1)	Keeps the last value
0	1	(0-1)	0
1	0	(0-1)	1
1	1	(0-1)	Inverts the last value
X	X	No rising signal edge	Keeps the last value

X: Value can be 0 or 1.

8.7.4.2.8 Multi enable V1

Overview

Each input of the function block is separately linked to the **Release** input via AND logic. If **Input n** and the **Release** input = 1, then **Output n** = 1.

Principle of operation

Table 34: Inputs Multi enable V1

Input	Description
Input 1	Data type: Bool
Input 2 ... Input 8 (optional)	
Release	Data type: Bool

Table 35: Outputs Multi enable V1

Output	Description
Output 1 ... Output 8	Data type: Bool If **Input n** and the **Release** input = 1[1], then **Output n** = 1

1) Applies without inversion of the inputs.

Table 36: Parameter Multi enable V1

Parameter	Description
Available Inputs	1 ... 8
Inverted	You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa.

8.7.4.2.9 Multi latch V1

Overview

Depending on the **Set** input, the status of up to 8 inputs can be forwarded or saved at the respective outputs.

Principle of operation

Table 37: Inputs Multi latch V1

Input	Description
Input 1	Data type: Bool
Input 2 ... Input 8 (optional)	
Set	Data type: Bool Triggers the memory function. 0: Do not save input values 1: Save input values see table 38, page 60

Table 38: Outputs Multi latch V1

Output	Description
Output 1 ... Output 8	Data type: Bool • If the **Set** input = 0, the function block forwards the status of the inputs to the corresponding outputs unchanged. • If the **Set** input changes from 0 → 1, the function block saves the current status of inputs 1 ... 8. The function block outputs the saved status to the outputs as long as the **Set** input = 1. The status change of inputs 1 ... 8 does not influence the outputs as long as the **Set** input = 1.

Table 39: Parameter Multi latch V1

Parameter	Description
Available Inputs	1 ... 8
Inverted	• Input 1 ... Input 8 You can individually invert any visible input. At an inverted input, a 0 works internally in the same way as a 1 and vice versa. • Set input No inversion: Saving done with rising signal edge. With inversion: Saving done with falling signal edge.

8.7.4.3 Converter

8.7.4.3.1 Bool to UInt8 V1

Overview

The function block converts up to 8 Boolean input values into a sign-free 8-bit integer value (UInt8).

Principle of operation

Table 40: Inputs Bool to UInt8 V1

Input	Description
Input 1	Data type: Bool
Input 2 ... Input 8 (optional)	

Table 41: Outputs Bool to UInt8 V1

Output	Description
Output 1	Data type: UInt8

Table 42: Truth table Bool to UInt8 V1

Input 8	Input 7	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Output 1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	1	1	3
0	0	0	0	0	1	0	0	4
...	...	...	...	...	...	...	...	...
1	1	1	1	1	1	0	1	253
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	255

8.7.4.3.2 UInt8 to Bool V1

Overview

The function block converts a sign-free 8-bit integer value (UInt8) at the input into 8 Boolean values at **Output 1 ... Output 8**.

Principle of operation

Table 43: Inputs UInt8 to Bool V1

Input	Description
Input 1	Data type: UInt8

Table 44: Outputs UInt8 to Bool V1

Output	Description
Output 1 ... Output 8	Data type: Bool

Table 45: Truth table UInt8 to Bool V1

Input 1	Output 8	Output 7	Output 6	Output 5	Output 4	Output 3	Output 2	Output 1
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	1	1
4	0	0	0	0	0	1	0	0
...	...	...	...	...	...	...	...	...
253	1	1	1	1	1	1	0	1
254	1	1	1	1	1	1	1	0
255	1	1	1	1	1	1	1	1

8.7.4.3.3 UInt8 to One-hot V1

Overview

Depending on the parameter set, the function block converts a decimal value at the input into a 1-of-N or Equal-and-Lower code.

Principle of operation

Table 46: Inputs UInt8 to One-hot V1

Input	Description
Input	Data type: UInt8

Table 47: Outputs UInt8 to One-hot V1

Output	Description
Output value 0 ... Output value 7	Data type: Bool Outputs the converted value.

Table 48: Parameter UInt8 to One-hot V1

Parameter	Description
Conversion mode	• 1-of-N Exactly 1 output = 1. Example: Decimal value = 5 and **Range offset** parameter = 0: Output 5 = 1, all other outputs = 0. • Equal-and-Lower Outputs are 1 if they correspond to the decimal value or are lower than the decimal value. Example: Decimal value 5 and **Range offset** parameter =0: Output 0 ... 5 = 1, all other outputs = 0.
Range offset	0 ... 31 A single function block covers a value range of 8 decimal places. The parameter specifies which value range the function block converts. 0: Value range 0 ... 7 1: Value range 8 ... 15 2: Value range 16 ... 23 etc. You can completely cover larger value ranges by connecting several function blocks to the same source and increasing the parameter by 1 for each function block.

8.7.4.3.4 One-hot to UInt8 V1

Overview

The function block converts a 1-of-N or Equal-and-Lower code into a decimal value.

Principle of operation

Table 49: Inputs One-hot to UInt8 V1

Input	Description
Value 0 ... Value 7 (optional)	Data type: Bool

Table 50: Outputs One-hot to UInt8 V1

Output	Description
Result	Data type: UInt8 Outputs the converted value. If the combination at the inputs is invalid, the value is always 0.

Output	Description
Status	Data type: Bool • If an invalid combination is present at the inputs, the **Status** output changes to 0 (error). • If a valid input combination is present, the function block resets the error. The **Status** output changes back to 1 in this case (no error).

Table 51: Parameter One-hot to UInt8 V1

Parameter	Description
Conversion mode	• One-hot Exactly one input = 1. If several inputs = 1 or no input = 1, this is evaluated as an invalid input combination. • Highest dominant At least one input = 1. The input with the highest value determines the decimal value at the output. If no input = 1, this is evaluated as an invalid input combination. • Lowest dominant At least one input = 1. The input with the lowest value determines the decimal value at the output. If no input = 1, this is evaluated as an invalid input combination.
Range offset	0 ... 31 A function block covers 8 decimal values. With the **Range offset** parameter, you determine which value range the function block converts.

8.7.4.4 Counter, Delay and Timer

8.7.4.4.1 Event counter (up and down) V1

Overview

The function block counts the number of rising signal edges at the inputs **Up** and **Down**.

Principle of operation

Table 52: Inputs Event counter (up and down) V1

Input	Description
Up	Data type: Bool A rising signal edge (0–1) at the **Up** input increases the value at the **Counter value** output by 1 as long as the maximum value has not been reached. [1)] If the maximum value is exceeded, the behavior depends on the **Behavior with overflow** parameter. The input is ignored when a rising signal edge occurs simultaneously at the **Reset to zero**, **Set to reload value** or **Down** input.
Down	Data type: Bool A rising signal edge (0–1) at the **Down** input reduces the value at the **Counter value** output by 1 as long as 0 has not been reached. [1)] If the value falls below 0, the behavior depends on the **Behavior with underflow** parameter. The input is ignored when a rising signal edge occurs simultaneously at the **Reset to zero**, **Set to reload value** or **Up** input.
Reset to zero	Data type: Bool A rising signal edge (0-1) at the input sets the value at the **Counter value** output to 0.[1)]

Input	Description
Set to reload value	Data type: Bool A rising signal edge (0-1) at the input sets the value at the **Counter value** output to the configured value of the Reload value parameter.[1)] The input is ignored when a rising signal edge (0-1) occurs simultaneously at the **Reset to zero** input.

1) If, during the first logic cycle, the input is already 1, then function block does not evaluate this as a rising signal edge.

Table 53: Outputs Event counter (up and down) V1

Output	Description
Counter value	Data type: UInt16 Outputs the value of the internal counter (0 ... 65,535).
Upper limit	Data type: Bool Is 1 as long as the counter = Maximum value
Lower limit	Data type: Bool Is 1 as long as the counter = 0
Overflow	Data type: Bool See the **Behavior with overflow** parameters
Underflow	Data type: Bool See the **Behavior with underflow** parameters

Table 54: Parameter Event counter (up and down) V1

Parameter	Description
Initialization value	The parameter defines the start value the **Counter value** output is set to in the first logic cycle. • Set to 0 at the start time The **Lower limit** output is immediately set to 1. • Set start to reload value at the start time If Reload value = Maximum value, the **Upper limit** output is immediately set to 1. If Reload value = 0, the **Lower limit** output is immediately set to 1. • Set to maximum value at the start time The **Upper limit** output is immediately set to 1.
Behavior with overflow	The parameter controls the behavior of the function block when the **Counter value** output has reached the maximum value and another rising signal edge subsequently occurs at the **Up** input. • No overflow function All other rising signal edges at the **Up** input are ignored. • Overflow function ○ The **Overflow** output is 1 for the duration of a logic cycle. ○ The value of the internal counter is set to 0.
Behavior with underflow	The parameter controls the behavior of the function block when the **Counter value** output has reached the value 0 and another counting pulse subsequently occurs at the **Down** input. • No underflow function All other rising signal edges at the **Down** input are ignored. • Underflow function ○ The **Underflow** output is activated for the duration of a logic cycle = 1. ○ The value of the **Counter value** out is set to the **Maximum value** parameter.
Maximum value	1 ... 65,535 The value must be greater than or equal to the **Reload value**.
Reload value	0 ... 65,535 The value must be less than or equal to the **Maximum value** parameter.

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.4.2 Event counter (up) V1

Overview

The function block counts the number of rising signal edges at the **Up** input.

Principle of operation

Table 55: Inputs Event counter (up) V1

Input	Description
Up	Data type: Bool A rising signal edge (0–1) at the **Up** input increases the value at the **Counter value** output by 1 as long as the maximum value has not been reached. [1] If the maximum value is exceeded, the behavior depends on the **Behavior with overflow** parameter.
Reset to zero	Data type: Bool A rising signal edge (0-1) at the input sets the value of the **Counter value** output to 0.

1) If, during the first logic cycle, the input is already 1, then function block does not evaluate this as a rising signal edge.

Table 56: Outputs Event counter (up) V1

Output	Description
Counter value	Data type: UInt16 Outputs the value of the internal counter (0 ... 65,535).
Upper limit	Data type: Bool Is 1 as long as the counter = Maximum value
Overflow	Data type: Bool See the **Behavior with overflow** parameters

Table 57: Parameter Event counter (up) V1

Parameter	Description
Initialization value	The start value of the **Counter value** output is set to 0 in the first logic cycle.
Behavior with overflow	The parameter controls the behavior of the function block when the **Counter value** output has reached the maximum value and another rising signal edge subsequently occurs at the **Up** input. • No overflow function All other rising signal edges at the **Up** input are ignored. • Overflow function ○ The **Overflow** output is 1 for the duration of a logic cycle. ○ The value of the **Counter value** output is set to 0.
Maximum value	1 ... 65,535

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.4.3 Event counter (down) V1

Overview

The function block counts the number of rising signal edges at the **Down** input.

Principle of operation

Table 58: Inputs Event counter (down) V1

Input	Description
Down	Data type: Bool A rising signal edge (0–1) at the **Down** input reduces the value of the **Counter value** input by 1 as long as 0 has not been reached. [1)] If the value falls below 0, the behavior depends on the **Behavior with underflow** parameter.
Set to reload value	Data type: Bool A rising signal edge (0-1) at the input sets the value of the **Counter value** output to the configured value of the Reload value parameter.[1)]

1) If, during the first logic cycle, the input is already 1, then function block does not evaluate this as a rising signal edge.

Table 59: Outputs Event counter (down) V1

Output	Description
Counter value	Data type: UInt16 Outputs the value of the internal counter (0 ... 65,535).
Lower limit	Data type: Bool Is 1 as long as the counter = 0
Underflow	Data type: Bool See the **Behavior with underflow** parameters

Table 60: Parameter Event counter (down) V1

Parameter	Description
Initialization value	The start value of the **Counter value** output is set to the value of the **Maximum value** parameter.
Behavior with underflow	The parameter controls the behavior of the function block when the **Counter value** output has reached the value 0 and another rising signal edge subsequently occurs at the **Down** input. • No underflow function All other rising signal edges at the **Down** input are ignored. • Underflow function ○ The **Underflow** output is 1 for the duration of a logic cycle. ○ The value of the **Counter value** out is set to the **Maximum value** parameter.
Maximum value	1 ... 65,535
Reload value	Corresponds to the **Maximum value** parameter.

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.4.4 Fixed on-delay timer V1

Overview

The function block delays switch-on of the **Enabled** output by a configurable period of time if a rising signal edge (0-1) is present. The output is switched off without delay time if a falling signal edge (1-0) is present.

Principle of operation

Table 61: Inputs Fixed on-delay timer V1

Input	Description
Control	Data type: Bool

Table 62: Outputs Fixed on-delay timer V1

Output	Description
Enabled	Data type: Bool • The switch-on delay time begins with a rising signal edge (0-1) at the **Control** input. If, after expiration of the switch-on delay time, the **Control** input is still 1, the **Enabled** output = 1. 1 in the first logic cycle is evaluated as a rising signal edge (0-1). • If the **Control** input returns to 0 before expiration of the configured switch-on delay time, the **Enabled** output remains = 0. The timer for the switch-on delay time is reset to 0.

Table 63: Parameter Fixed on-delay timer V1

Parameter	Description
Switch-on delay time	0 ... 300 s in 1-ms increments

Complementary information

If the configured delay time is less than or not a multiple of the logic execution time, then the delay time extends to the next logic cycle.

8.7.4.4.5 Fixed off-delay timer V1

Overview

The function block delays switch-off of the **Enabled** output by a configurable period of time if a falling signal edge (0-1) is present. The output is switched on without delay time if a rising signal edge is present.

Principle of operation

Table 64: Inputs Fixed off-delay timer V1

Input	Description
Control	Data type: Bool

Table 65: Outputs Fixed off-delay timer V1

Output	Description
Enabled	Data type: Bool Depending on the **Switch-off delay time** parameter. • The switch-off delay time begins with a falling signal edge at the **Control** input. If, after expiration of the configured switch-off delay time, the **Control** input is still 0, the **Enabled** output = 0. • If the **Control** input returns to 1 before expiration of the configured switch-on delay time, the **Enabled** output remains = 1. The timer for the switch-off delay time is reset to 0.

Table 66: Parameter Fixed off-delay timer V1

Parameter	Description
Switch-off delay time	0 ... 300 s in 1-ms steps [1]

[1] 0 = No delay

Sequence/timing diagram

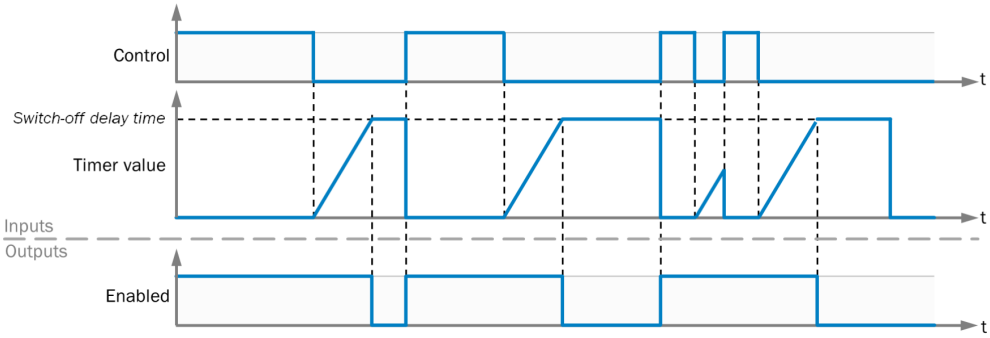


Figure 19: Sequence/timing diagram Fixed off-delay timer V1

Complementary information

If the configured delay time is less than or not a multiple of the logic execution time, then the delay time extends to the next logic cycle.

If, during the first logic cycle, the **Control** input = 0, the **Enabled** output = 0. The **Enabled** output remains 0 until the **Control** input = 1.

If, during the first logic cycle, the **Control** input = 1, the **Enabled** output = 1. The **Enabled** output remains 1 until the **Control** input = 0 and the configured switch-off delay time then expires.

8.7.4.4.6 Adjustable on-delay timer V1

Overview

The function block delays switch-on of the **Enabled** output by a certain period of time if a rising signal edge (0-1) is present. The duration is determined by the signals at the inputs. The output is switched off without delay time if a falling signal edge (1-0) is present.

Principle of operation

Table 67: Inputs Adjustable on-delay timer V1

Input	Description
Control	Data type: Bool
Delay 1 ... Delay 4 (optional)	Data type: Bool An input is only available if a delay time > 0 has been configured for the relevant parameter.

Table 68: Outputs Adjustable on-delay timer V1

Output	Description
Enabled	Data type: Bool The output outputs a rising signal edge (0-1) at the **Control** input after a delay once the selected delay time has elapsed. The output is set to 1 if the **Control** input remains 1 for the selected delay time. If the **Control** input returns to 0 before the selected delay time expires, the **Enabled** output remains = 0. The internal timer for the delay time is reset to 0.
Time changed	Data type: Bool If the resultant delay time is changed while the **Control** input is being output after a delay (i.e., the timer is still running at the moment the time is changed), then the **Time changed** output = 1. The previously set delay time continues to apply. The new delay time only becomes active at the next delay cycle.

Table 69: Parameter Adjustable on-delay timer V1

Parameter	Description
Delay 1 ... Delay 4	0 ... 600 s in 1 ms increments

Sequence/timing diagram

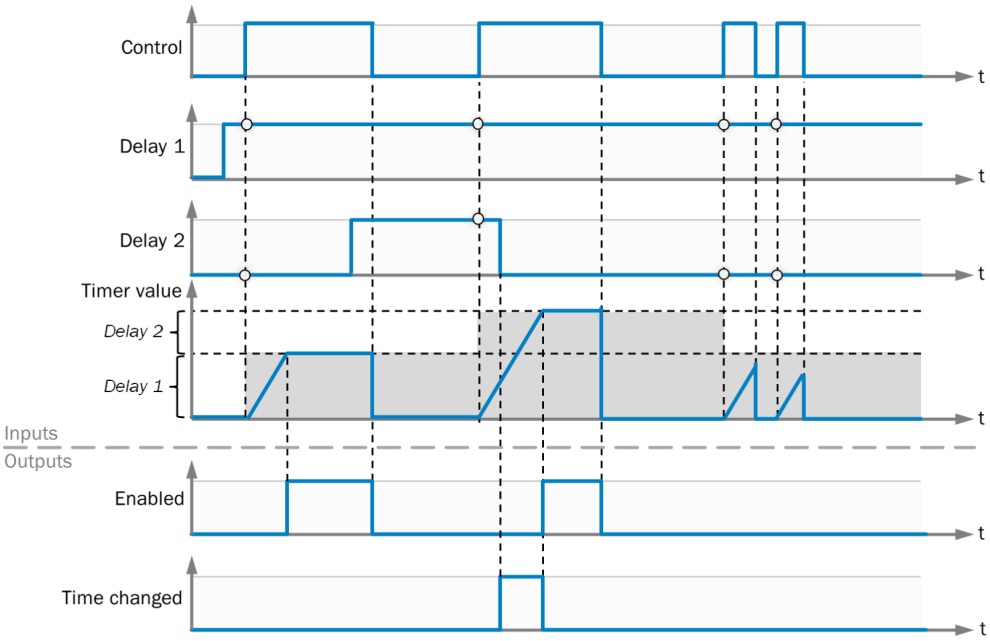


Figure 20: Sequence/timing diagram Adjustable on-delay timer V1

Complementary information

If the delay time selected using the **Delay 1 ... Delay 4** inputs is not a multiple of the logic execution time, the delay time is extended to the next logic cycle.

If, during the first logic cycle, the **Control** input = 0, the **Enabled** output = 0.

If, during the first logic cycle, the **Control** input = 1 and no delay time is configured, the **Enabled** output = 1.

If, during the first logic cycle, the **Control** input = 1 and a delay time > 0 is configured, the function block sets the **Enabled** output to 1 after the total delay time has elapsed.

8.7.4.4.7 Adjustable off-delay timer V1

Overview

The function block delays switch-off of the **Enabled** output by a certain period of time if a falling signal edge (1-0) is present. The duration is determined by the signals at the inputs.

Principle of operation

Table 70: Inputs Adjustable off-delay timer V1

Input	Description
Control	Data type: Bool

Input	Description
Delay 1 ... Delay 4 (optional)	Data type: Bool If the resultant delay time is changed while the **Control** input is being output after a delay (i.e., the timer is still running at the moment the time is changed), then the **Time changed** output = 1. The previously set delay time continues to apply. The new delay time only becomes active at the next delay cycle. An input is only available if a delay time > 0 has been configured for the relevant parameter.

Table 71: Outputs Adjustable off-delay timer V1

Output	Description
Enabled	Data type: Bool • The switch-off delay time begins with a falling signal edge at the **Control** input. If, after expiration of the configured switch-off delay time, the **Control** input is still 0, the **Enabled** output = 0. • If the **Control** input returns to 1 before expiration of the configured switch-on delay time, the **Enabled** output remains = 1. The timer for the switch-off delay time is reset to 0.
Time changed	Data type: Bool

Table 72: Parameter Adjustable off-delay timer V1

Parameter	Description
Delay 1 ... Delay 4	0 ... 600 s in 1 ms increments

Sequence/timing diagram

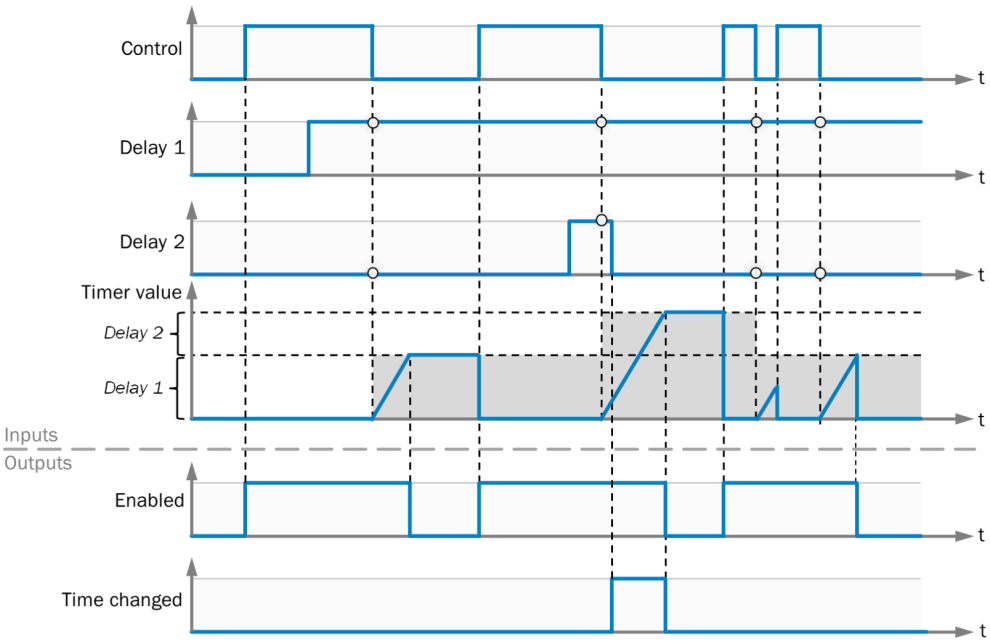


Figure 21: Sequence/timing diagram Adjustable off-delay timer V1

Complementary information

If the delay time selected using the **Delay 1 ... Delay 4** inputs is not a multiple of the logic execution time, the delay time is extended to the next logic cycle.

If, during the first logic cycle, the **Control** input = 0, the **Enabled** output = 0.

If, during the first logic cycle, the **Control** input = 1 and no delay time is configured, the **Enabled** output = 1.

If, during the first logic cycle, the **Control** input = 1 and a delay time > 0 is configured, the function block sets the **Enabled** output to 1 after the total delay time has elapsed.

8.7.4.4.8 Clock generator V1

Overview

The function block generates a pulsed signal. The elementary period and pulse duration are configurable.

Principle of operation

Table 73: Inputs Clock generator V1

Input	Description
Enable	Data type: Bool

Table 74: Outputs Clock generator V1

Output	Description
Clock	Data type: Bool • If the **Enable** input = 1, the **Clock** output pulses. • If the **Enable** input = 0, the **Clock** output is set to 0.

Table 75: Parameter Clock generator V1

Parameter	Description
Rounding mode	The input values of the **Clock period** and **Pulse time** parameters are rounded in such a way that a separation of at least one logic execution time to one another and to 0 is maintained. This parameters specifies whether to round up or round down. The parameter setting is ignored if the rounding violates the permissible limit values.
Stop mode	Determines the end of the pulsed signal. • Immediate If the **Enable** input changes from 1 to 0, the **Clock** output immediately changes to 0. • After last clock pulse If the **Enable** input changes from 0 to 1, the function block will complete the current elementary period.
Function block deactivated	Clock period and Pulse time = 0. **Clock** output = **Enable** input
Clock period	An elementary period begins with the pulse duration. This is followed by a pause, the **Clock** output = 0. The next elementary period then begins. see figure 22 The duration of the elementary period should be longer than the sum of the pulse duration and logic execution time. The parameter has an input value and an effective value. The configuration software corrects the input value to the correct effective value based on the **Rounding mode** and **Pulse time** parameters.
Pulse time	The pulse duration must be shorter than the elementary period. see figure 22 The pulse duration can be shorter than the logic execution time. The parameter has an input value and an effective value. The configuration software corrects the input value to the correct effective value based on the **Rounding mode** and **Clock period** parameters.

Sequence/timing diagram

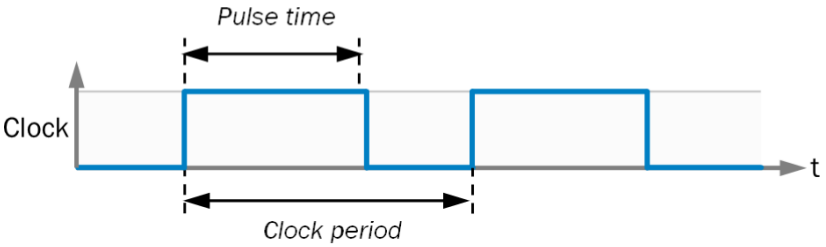


Figure 22: Parameter diagram

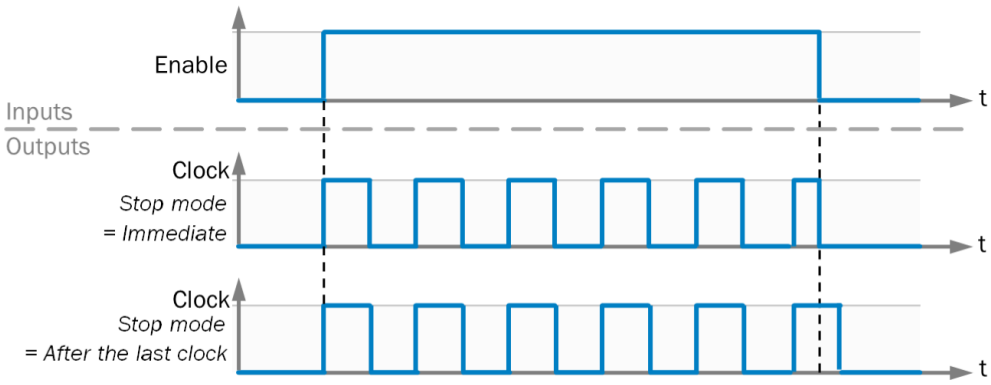


Figure 23: Sequence/timing diagram Clock generator V1

8.7.4.5 Input Evaluation

8.7.4.5.1 Edge detection V1

Overview

This function block detects rising and/or falling signal edges at the input depending on the set parameter.

Principle of operation

Table 76: Inputs Edge detection V1

Input	Description
Input	Data type: Bool

Table 77: Outputs Edge detection V1

Output	Description
Edge detected	Data type: Bool When the function block detects the relevant type of signal edge, the function block sets the **Edge detected** output to 1 for a logic cycle.

Table 78: Parameter Edge detection V1

Parameter	Description
Edge detection	• Positive (rising signal edges) • Negative (falling signal edges) • Positive and negative (rising and falling signal edges)

Sequence/timing diagram

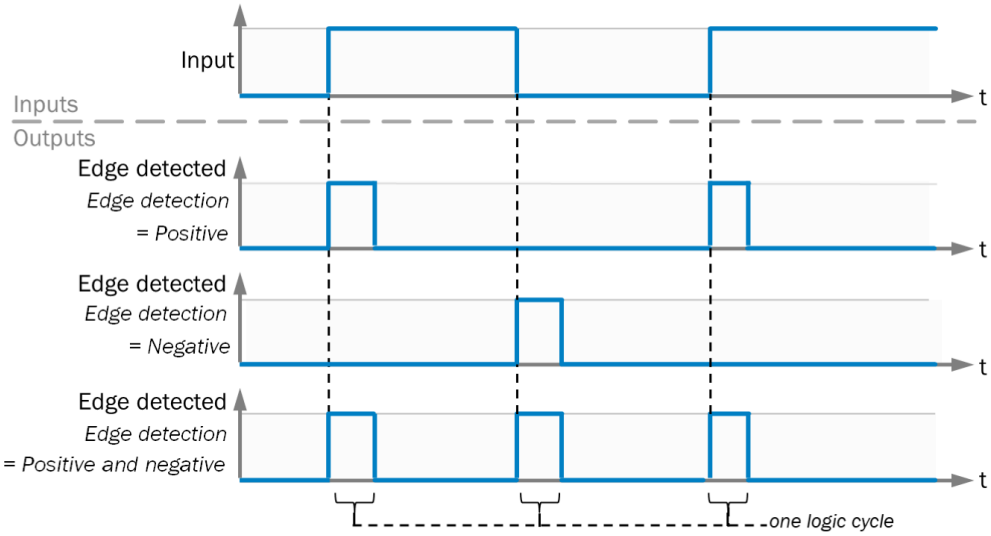


Figure 24: Sequence/timing diagram Edge detection V1

Complementary information

- If the input is already 1 during the first logic cycle, the function block does not evaluate this as a positive edge.
- If the input is already 0 during the first logic cycle, the function block does not evaluate this as a negative edge.

8.7.4.5.2 Two hand control (2 inputs) V1

Overview

The function block checks the sequence and discrepancy of two inputs.

Principle of operation

Table 79: Inputs Two hand control (2 inputs) V1

Input	Description
1A (NO) 2A (NO)	Data type: Bool

Table 80: Outputs Two hand control (2 inputs) V1

Output	Description The
Enabled	Data type: Bool • 0: Not enabled • 1: Enabled The **Enabled** output is set to 1 if all of the following conditions are met: ○ The **1A (NO)** and **2A (NO)** inputs = active. ○ The synchronization time was observed (synchronization time monitoring). ○ The correct sequence was observed (sequence monitoring). The output is 0 if the input combination of the inputs is inactive or discrepant.
Synchronization status	Data type: Bool • 0: Error Synchronization time exceeded. • 1: No error or unknown

Table 81: Input combination for dual-channel evaluation of the inputs

Input 1A	Input 1B	Input combination	Status of dual-channel evaluation (Enabled output)
0	0	Deactivated	0
0	1	Discrepant	0
1	0	Discrepant	0
1	1	Active	1[1)]

1) If synchronization time monitoring and sequence monitoring have been met.

Synchronization time monitoring

The synchronization time is the amount of time for which the two inputs are allowed to have different values.

Fixed value: 500 ms according to ISO 13851

The internally used value is reduced by the logic processing time so that the specified time value is maintained. This means that a shorter synchronization time must be adhered to in order to reliably meet these requirements. A synchronization error is present if the input combination is discrepant for longer than the synchronization time used. A synchronization error is reset if the input combination is inactive.

Different propagation times of the input signals can lead to an lengthening or shortening of the synchronization time, e.g., due to the debounce filter time or the test pulse width of the safety input used.

Sequence monitoring

The correct sequence for sequence monitoring has been met if the input combination was first inactive before changing to active, if applicable via discrepant. This means that it is not possible to switch back to state 1 of the dual-channel evaluation through the sequence of input combinations active - discrepant - active.

The active input combination is not a correct sequence in the first logic cycle

A sequence error is reset if the input combination = inactive.

Complementary information

Different propagation times of the input signals can lead to a lengthening or shortening of the synchronization time.

Further topics

- "Configuration options for input elements", page 42

8.7.4.5.3 Two hand control (4 inputs) V1

Overview

The function block checks the sequence and discrepancy of 2 input pairs.

Principle of operation

Table 82: Inputs Two hand control (4 inputs) V1

Input	Description
1A (NO) 1B (NC) 2A (NO) 2B (NC)	Data type: Bool • Input pair 1: 1A (NO), 1B (NC) • Input pair 2: 2A (NO), 2B (NC)

Table 83: Outputs Two hand control (4 inputs) V1

Output	Description
Enabled	Data type: Bool • 0: Not enabled • 1: Enabled The output is set to 1 if all of the following conditions are met: ○ The input combination of both input pairs = active ○ The discrepancy time for each input pair was observed (discrepancy time monitoring). ○ The correct sequence was observed for each input pair (sequence monitoring of each input pair). ○ The correct sequence was observed between the input pairs (sequence monitoring of the two input pairs). ○ The synchronization time was observed (synchronization time monitoring). Output is set to 0 if the input combination of at least one input pair is inactive or discrepant.
Status of input pair 1 Status of input pair 2	Data type: Bool • 0: Error Input pair has discrepancy time or sequence error. • 1: No error or unknown
Synchronization status	Data type: Bool • 0: Error Synchronization error or sequence error between the two input pairs • 1: No error or unknown

Table 84: Parameter Two hand control (4 inputs) V1

Parameter	Description
Discrepancy time (pair 1) Discrepancy time (pair 2)	The discrepancy time defines how long the two inputs can continue to have discrepant values after a change in either of the input signals without this being regarded as an error. 0 ... 30 s, where 0 = deactivated see "Discrepancy time monitoring", page 75 If set to 0, discrepancy monitoring is deactivated. The effective value is the input value rounded up to the next multiple of the logic processing time. The effective discrepancy time must be = 0 or ≥ the logic processing time.

Table 85: Input combination for dual-channel evaluation of the inputs

Mode	Input 1A or 2A	Input 1B or 2B	Input combination	Status of dual-channel evaluation
Dual channel complementary	0	1	Deactivated	0
	0	0	Discrepant	0
	1	1	Discrepant	0
	1	0	Active	1[1)]

1) If the discrepancy time monitoring and the sequence monitoring have been met.

Discrepancy time monitoring

The discrepancy time determines how long the 2 inputs of an input pair are allowed to have the same values. A discrepancy error is present if the input combination is discrepant for longer than the configured discrepancy time.

A discrepancy error is reset if the input combination of the input pair becomes inactive.

Different propagation times of the input signals can lead to an lengthening or shortening of the discrepancy time, e.g., due to the debounce filter time or the test pulse width of the safety input used.

Sequence monitoring per input pair

Sequence monitoring applies individually to each of the two input pairs. The correct sequence for this sequence monitoring has been met if the input combination was first inactive before changing to active, if applicable via discrepant. This means that it is not possible to switch back to state 1 of the dual-channel evaluation through the sequence of input combinations active - discrepant - active.

The active input combination is not a correct sequence in the first logic cycle.

A sequence error is reset if the input combination is inactive.

Synchronization time monitoring

This monitoring applies to the status of the two dual-channel evaluations in relation to each other. The synchronization time determines how long the two dual-channel evaluations are allowed to have different values.

Fixed value: 500 ms according to ISO 13851

The value used internally by the function block is reduced by the logic processing time so that the specified time value is maintained. This means that a shorter synchronization time must be adhered to in order to reliably meet these requirements. A synchronization error is present if the two dual-channel evaluations have different values for longer than the synchronization time used.

A synchronization error is reset if one of the input combinations is inactive.

Sequence monitoring for both input pairs

This monitoring applies to the status of the two dual-channel evaluations in relation to each other. The correct sequence for this sequence monitoring has been met if both dual-channel evaluations first had a status of 0 before changing to 1. This means that after one of the two dual-channel evaluations changes to 0, it is not possible to change it back to 1 unless the other dual-channel evaluation was also 0 at the same time. A sequence error is reset if the status of both dual-channel evaluations is 0.

Sequence/timing diagram

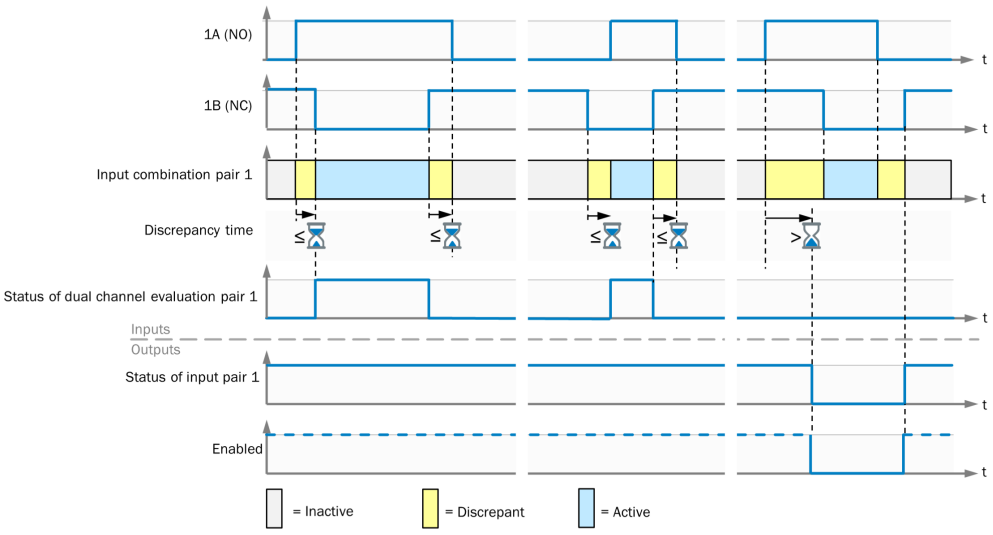


Figure 25: Sequence/timing diagram for the discrepancy time

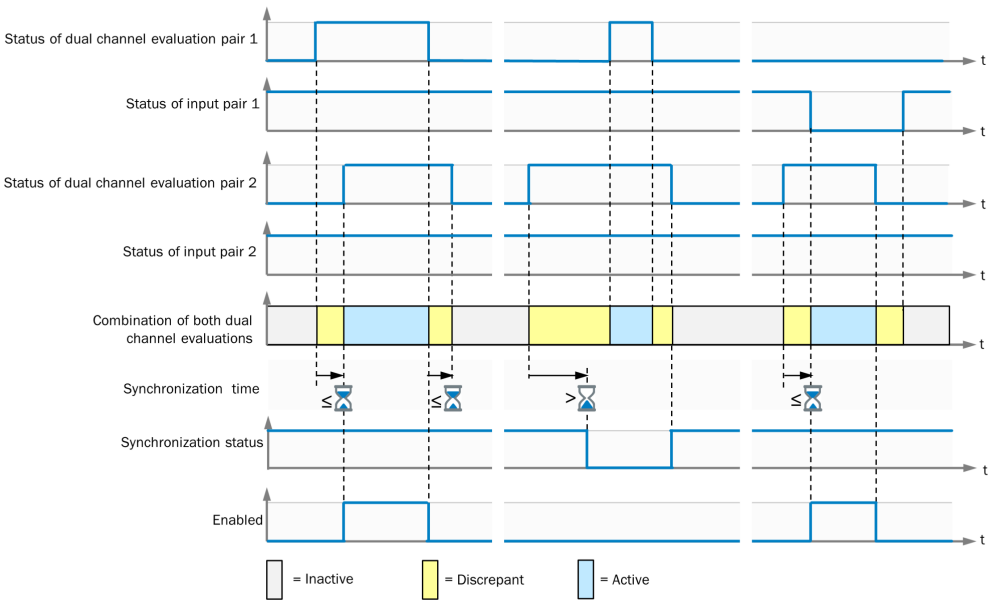


Figure 26: Sequence/timing diagram for the synchronization time

Further topics

- "Configuration options for input elements", page 42

8.7.4.5.4 Dual channel monitor V1

Overview

The function block checks the sequence and discrepancy of two inputs.

Principle of operation

Table 86: Inputs Dual channel monitor V1

Input	Description
Input A	Data type: Bool
Input B	

Table 87: Outputs Dual channel monitor V1

Output	Description
Enabled	Data type: Bool The output changes to 1 if all of the following conditions are met: • The input combination of the two inputs is active. • The discrepancy time was observed (discrepancy time monitoring). • The correct sequence was observed (sequence monitoring). Output changes to 0 if the input combination of both inputs is inactive or discrepant.
Status	Data type: Bool • 0: Error Discrepancy error or sequence error • 1: No error

Table 88: Parameter Dual channel monitor V1

Parameter	Description
Input mode	• Equivalent • Complementary

Parameter	Description
Deactivating discrepancy monitoring	• Active Discrepancy time monitoring deactivated An infinitely long discrepancy time is allowed. • Inactive (discrepancy time monitoring activated) You can configure a maximum allowed **Discrepancy time**.
Discrepancy time	0 ... 30 s see "Discrepancy time monitoring", page 78
Safe start	This parameter determines the behavior of the function block during the first logic cycle.

Table 89: Input combinations for Dual channel monitor V1

Input mode	Input A	Input B	Input combination	Output Enabled
Equivalent	0	0	Deactivated	0
	0	1	Discrepant	0
	1	0	Discrepant	0
	1	1	Active	1[1)]
Complementary	0	1	Deactivated	0
	0	0	Discrepant	0
	1	1	Discrepant	0
	1	0	Active	1[1)]

1) If discrepancy time monitoring and sequence monitoring have been met or is deactivated.

Discrepancy time monitoring

The discrepancy time determines how long the two inputs can continue to have different values (in dual-channel equivalent mode) or the same values (in dual-channel antivalent mode). A discrepancy error is present if the input combination is discrepant for longer than the configured discrepancy time.

If the parameterized discrepancy time is 0, both inputs must switch during the same logic cycle. A discrepancy error is reset if the input combination is inactive.

Different propagation times of the input signals can lead to an lengthening or shortening of the discrepancy time, e.g., due to the debounce filter time or the test pulse width of the safety input used.

Sequence monitoring

The correct sequence for sequence monitoring has been met if the input combination was first inactive before changing to active, if applicable via discrepant. This means that it is not possible to switch back to state 1 of the dual-channel evaluation through the sequence of input combinations active - discrepant - active.

If the **Safe start** parameter is activated, the active input combination is not a correct sequence in the first logic cycle.

If the **Safe start** parameter is deactivated, the active input combination is a correct sequence in the first logic cycle, i.e., an enable in the first logic cycle is therefore possible.

If the active input combination lasts longer than 100 ms without the correct sequence having been observed beforehand (**Enabled** output = 0), a sequence error is displayed. A sequence error is reset if the input combination is inactive.

Sequence/timing diagram

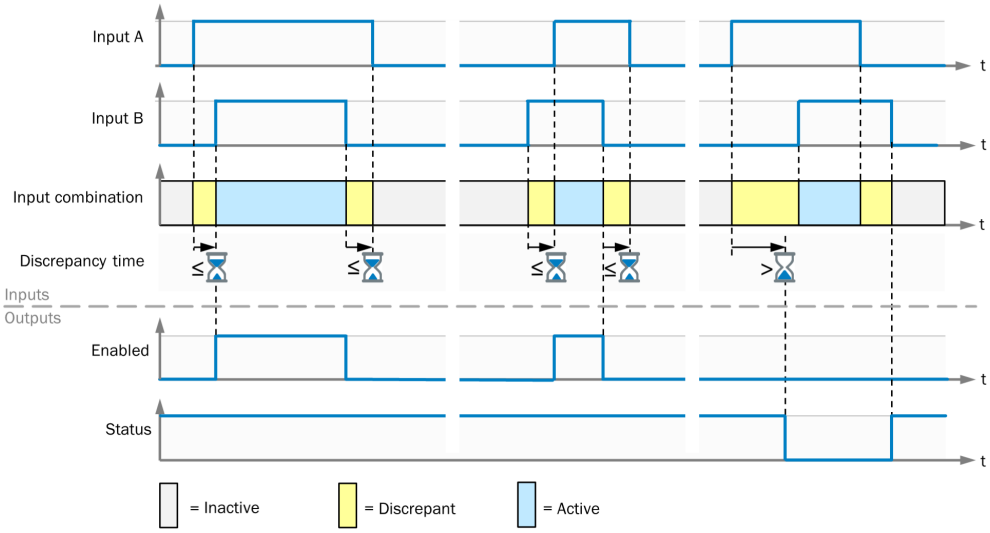


Figure 27: Sequence/timing diagram Dual channel monitor V1

Further topics

- "Configuration options for input elements", page 42

8.7.4.6 Output Control

8.7.4.6.1 External device monitoring V1

Overview

The function block monitors a switching amplifier with a feedback channel (e.g., a contactor with positively guided contacts) connected to the **Enabled** output. The function block checks whether the feedback signal connected to the **EDM feedback signal** input switches as expected.

Important information

NOTE

If an ON-OFF filter or a discrepancy time, for example, is configured for the input signals in the hardware configuration, the statuses of the **Control input** input and the **EDM feedback signal** input may differ over time. This can result in an error.

→ Avoid time differences in the signals.
→ Configure the **Max. feedback delay** parameter.

Principle of operation

Table 90: Inputs External device monitoring V1

Input	Description
Control input	Data type: Bool The input must be connected to the logic signal that represents the desired status for the external device. If the input in the first logic cycle = 1, then this is evaluated as a rising edge.

Input	Description
EDM feedback signal	Data type: Bool The input is connected to the feedback signal of the external switching amplifier. The general expectation is that the EDM feedback signal will assume the inverted value of the **Control input** input within the maximum feedback delay time that has been configured.

Table 91: Outputs External device monitoring V1

Output	Description
Enabled	Data type: Bool The output controls the external switching amplifier. • If the **Control input** input = 0 or the **Status** output = 0, then the **Enabled** output = 0. • If the **Control input** input = 1 and the **Status** output = 1, then the **Enabled** output = 1.
Status	Data type: Bool The output indicates whether the **EDM feedback signal** input has switched correctly after a change in the **Enabled** output. • If an error occurs, the **Status** output = 0 • If a valid reset condition is present, the **Status** output = 1.

Table 92: Parameter External device monitoring V1

Parameter	Description
Max. feedback delay	1 ms ... 60 s Values that are not a multiple of the logic execution time are rounded to the nearest multiple of the logic execution time.
EDM operating mode	• **Switch-on monitoring** If a rising signal edge (0-1) of the **Enabled** output is present, the function block monitors whether the **EDM feedback signal** input switches to 0 within the configured **Max. feedback delay**. • **Switch-on and switch-off monitoring** In addition to operating mode **Switch-on monitoring**: If a falling signal edge (1-0) of the **Enabled** output is present, the function block monitors whether the **EDM feedback signal** input switches to 1 within the configured **Max. feedback delay**.
Permanent monitoring of the feedback signal	When this option is selected, the function block monitors whether the **EDM feedback signal** input has assumed the expected value after the **Max. feedback delay** parameter has elapsed and also whether the value has changed again after the **Max. feedback delay** has elapsed. This enables undesired signal changes of the connected device to be identified even if the device already switched correctly. **Monitoring depending on the EDM operating mode parameter:** • **Switch-on monitoring** A rising signal edge at the **EDM feedback signal** input is not allowed after the **Max. feedback delay** has elapsed while the **Control input** input = 1. • **Switch-on and switch-off monitoring** In addition to operating mode **Switch-on monitoring**: A falling signal edge at the **EDM feedback signal** input is not allowed after the **Max. feedback delay** has elapsed while the **Control input** input = 0. If an undesired signal change occurs, the **Status** output switches to 0. The same reset conditions apply as for errors during the configured **Max. feedback delay**.

Errors and reset conditions

Table 93: Errors and reset conditions

Applies to EDM operating mode		Error	Reset condition
Switch-on monitoring	**Switch-on and switch-off monitoring**		
Yes	Yes	The **EDM feedback signal** input ≠ 1 while the **Control input** input is set to 1.	The **Control input** input = 0 or **EDM feedback signal** input = 1
Yes	Yes	After the **Control input** input = 1, the **EDM feedback signal** input does not switch to 0 within the configured **Max. feedback delay**.	**Control input** input = 0
No	Yes	After the **Control input** input = 0, the **EDM feedback signal** input does not switch to 1 within the configured **Max. feedback delay**.	The **EDM feedback signal** input = 1 for the duration of the configured feedback time, and the **Control input** input must be = 0 at the latest by expiry of the feedback delay time.

Sequence/timing diagram

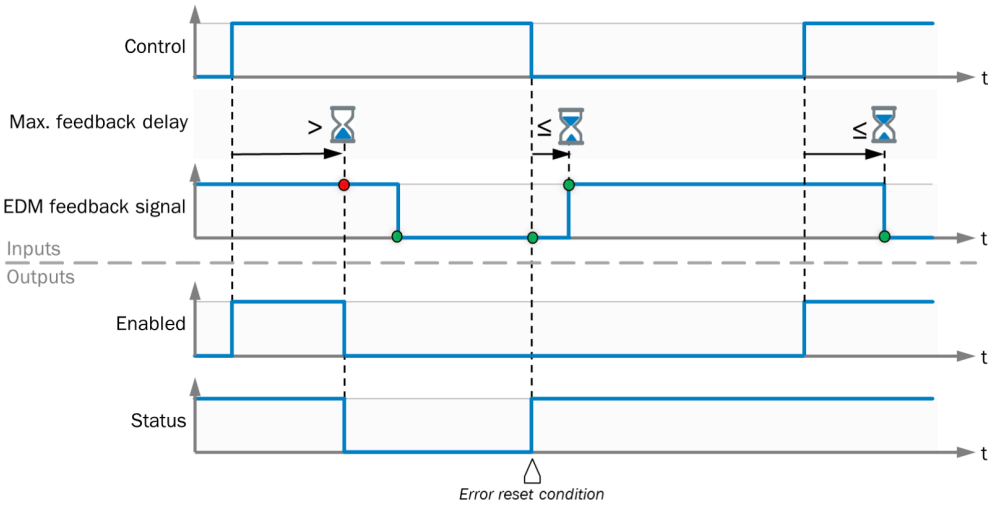


Figure 28: Sequence/timing diagram **External device monitoring V1** for incorrect feedback when switching on

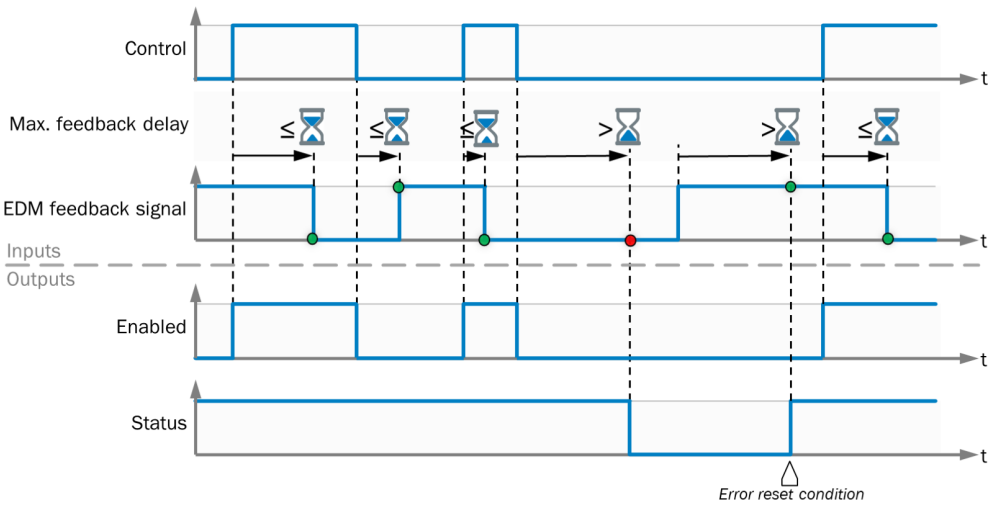


Figure 29: Sequence/timing diagram **External device monitoring V1** for incorrect feedback when switching off

Complementary information

The total delay time of the feedback signal is determined by the:

- Signal propagation time between the **Enabled** output and the physical input of the external device
- Switching time of the external device
- Signal propagation time of the external device and the **EDM feedback signal** input

If you need the signal at the **Enabled** output to be delayed, you must implement this delay time by using another function block that is located upstream of the **External device monitoring V1** function block. Otherwise, errors may result.

8.7.4.6.2 Fast shut off V1

Overview

The function block minimizes the switch-off time of a safety switching path. The switch-off time depends on the logic execution time. The switching on again of the output depends on the logic execution time.

You can implement a simple logic within the function block. The function block also provides the option to implement a bypass to bridge the fast shut off function.

Important information

WARNING
Restricted safety with bypass

In the case of non-compliance, it is possible that the dangerous state of the machine may not be stopped or not stopped in a timely manner.

→ Make sure that the system or machine is in a safe status when using the Bypass function.
→ Ensure the mandatory use of other protective measures while the Bypass function is active, e.g., that the machine is in safe setup mode so that it cannot endanger people or parts of the system while the bypass is active.
→ Take into account the longer response time when the bypass is deactivated when planning the application.

Prerequisites

- All relevant input elements and output elements for the **Fast shut off V1** function block are connected to the same module.
- Relevant input elements are connected directly to the inputs 1 ... 8 of the function block. There must be no logic between the input elements and the inputs of the function block.
- The outputs of the function block must have a direct switch-off effect on the output element. The downstream logic must not contain any **OR V1** function block.

Principle of operation

Table 94: Inputs Fast shut off V1

Input	Description
Input 1	Data type: Bool
Input 2 ... Input 8 (optional)	
Bypass (optional)	Data type: Bool

Table 95: Outputs Fast shut off V1

Output	Description
Output	Data type: Bool You need to first connect the associated inputs to the input elements before the output can be configured.

Table 96: Parameter Fast shut off V1

Parameter	Description
(**I/O settings** tab)	
Number of inputs	1 ... 8
Bypass	Bypass bridges the fast shut off function with the help of the **Bypass** input. If the **Bypass** input = 1, the **Output** remains = 1 and the physical output = HIGH.
(**Parameter** tab)	
Internal logic	see "Configuring the internal logic", page 83

Configuring the internal logic

The function block has an internal logic that comprises two AND gates (enable condition A and B) and an OR gate. The associated output is set to 1 if all conditions for A or B are met:

Conditions for A

- At least one input is activated for **Release Condition A**.
- All activated inputs of **Release Condition A** = 1.

Conditions for B

- At least one input is activated for **Release Condition B**.
- All activated inputs of **Release Condition B** = 1.

The output element for the Fast shut off output must also be selected. This is only possible if at least one input element is connected to the function block.

Example of two alternative enable conditions

A safety light curtain with presence detection is protecting the work cell of a robot. The movement of the robot is enabled as long as the safety light curtain (sensor A) is not interrupted. If the safety light curtain is interrupted, the robot movement is only enabled if the robot is located in a non-dangerous position (sensor B), e.g., in an offline position. Either sensor A or sensor B must release the robot movement.

Either sensor A or sensor B must release the robot movement.

An OR relationship of condition A and condition B can be used to configure these alternative enable conditions.

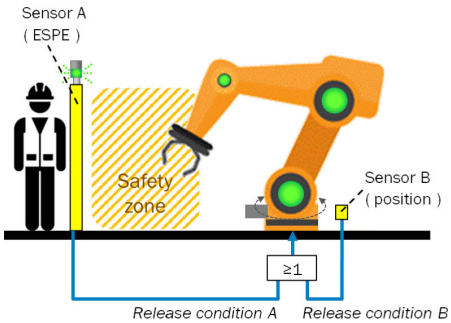


Figure 30: Release condition A is fulfilled. Robot movement is released.

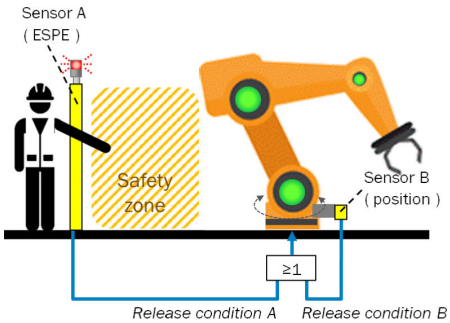


Figure 31: Release condition B is fulfilled. Robot movement is released.

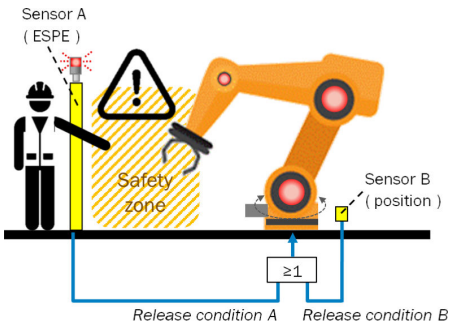


Figure 32: Release condition A and B are fulfilled. Robot movement is not released.

Examples for the use of bypass

- Operation of a machine or system in **Setup** mode (bypass is activated, for example, using an enabling pushbutton)
- Muting during the upwards movement of a press (bypass is activated with the help of a press signal)

Response time

Table 97: Response times

Input	Response time for switch-off	Response time for switch-on
Input 1 ... Input 8	Fast shut off response time	No effect on the response time → Normal response time
Bypass	No effect on the response time → Normal response time	Standard response time + switch-on delay of 2 logic cycles The switch-on delay compensates for the processing time of the logic. To bypass fast shut off, the **Bypass** input must be set to 1 at least 2 logic cycles in advance in the logic before the input signal switches to the signal level LOW on the physical input.

Complementary information

- The value of the connected output in the online monitor of the logic may deviate from the actual value of the physical output.

Further topics

- "Maximum response time", page 128

8.7.4.7 Basic Applications

8.7.4.7.1 Reset V1

Overview

You can use this function block to implement a reset function.

The function block makes it possible to acknowledge a manual safety stop and subsequently restart the application.

Important information

WARNING
Undesired reset following short-circuit to HIGH
The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Make sure the signal line is laid with protection (to prevent a cross-circuit with other signal lines).
→ No short-circuit detection, i.e., no referencing to test outputs.

Principle of operation

Table 98: Inputs Reset V1

Input	Description
Reset	Data type: Bool For connecting a reset command switch. A valid reset sequence comprises the signal sequence 0–1–0. Pulse duration: 100 ms ... 30 s, at least 2 × logic execution time
Release	Data type: Bool See **Enabled** output.

Table 99: Outputs Reset V1

Output	Description
Enabled	Data type: Bool • When the **Release** input = 1 and the function block detects a valid reset pulse on the **Reset** input, the **Enabled** output switches to 1. • If the **Release** input = 0, the **Enabled** output switches to 0.
Reset required	Data type: Bool The output pulses at 1 Hz if the output enable condition = 1 and input reset = 0. The resolution of the pulse pause and the pulse duration correspond to the logic processing time. The output is =1 if the **Reset** input = 1 and the **Ready for reset** output = 0. You can use this output to control an indicator lamp. This stops the pulsing at 1 Hz and lights up as long as the reset button is pressed.

Output	Description
Ready for reset	Data type: Bool The output switches to 1 when a valid pulse at the **Reset** input leads to activation of the **Enabled** output. The output indicates readiness, i.e., that a valid reset pulse leads to a response at the **Enabled** output. If the **Enabled** output = 1 and a rising signal edge (0-1) is present at the **Reset** input , the **Ready for reset** output switches to 0.

Sequence/timing diagram

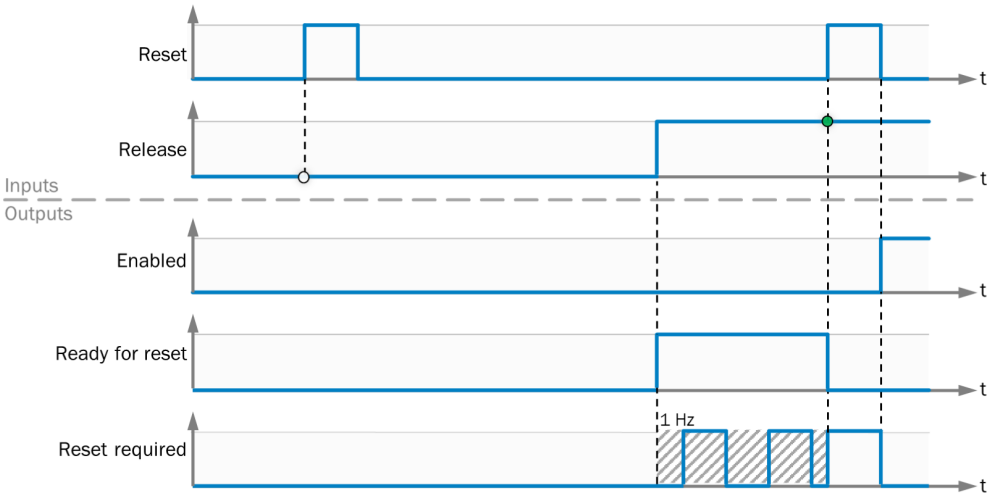


Figure 33: Sequence/timing diagram Reset V1

Complementary information

To evaluate the minimum length of the reset pulse (here: 100 ms), the reset signal must be sampled twice after the rising signal edge (0-1). The required minimum length of the reset signal is therefore extended by one logic processing time.

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.7.2 Restart V1 (Restart)

Overview

You can use this function block to implement a restart function.

The function block makes it possible to acknowledge a manual safety stop and subsequently restart the application.

Important information

WARNING
Undesired reset following short-circuit to HIGH

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Make sure the signal line is laid with protection (to prevent a cross-circuit with other signal lines).
→ No short-circuit detection, i.e., no referencing to test outputs.

Principle of operation

Table 100: Inputs Restart V1

Input	Description
Restart	Data type: Bool For connecting a restart command switch. A valid restart sequence comprises the signal sequence 0–1–0. Pulse duration: 100 ms ... 30 s, at least 2 × logic execution time
Release	Data type: Bool See **Enabled** output.

Table 101: Outputs Restart V1

Output	Description
Enabled	Data type: Bool Resets the safety device. • When the **Release** input = 1 and the function block detects a valid restart pulse on the **Restart** input, the **Enabled** output switches to 1. The resolution of the pulse pause and the pulse duration correspond to the logic processing time. • The **Enabled** output remains = 1 as long as the **Enable** input = 1.
Restart required	Data type: Bool The output pulses at 1 Hz if the **Ready for restart** output = 1 and the **Restart** input = 0. The output is = 1 if the **Restart** input = 1 and the **Ready for restart** output = 0. You can use this output to control an indicator lamp. This stops the pulsing at 1 Hz and lights up as long as the restart button is pressed.
Ready for restart	Data type: Bool The output indicates that the function block is expecting a valid restart pulse at the **Restart** input so that the **Enabled** output can switch to 1. If the **Release** input = 1 and the function block detects a rising signal edge (0-1) at the **Restart** input, the **Ready for restart** output switches permanently to 0.

Sequence/timing diagram

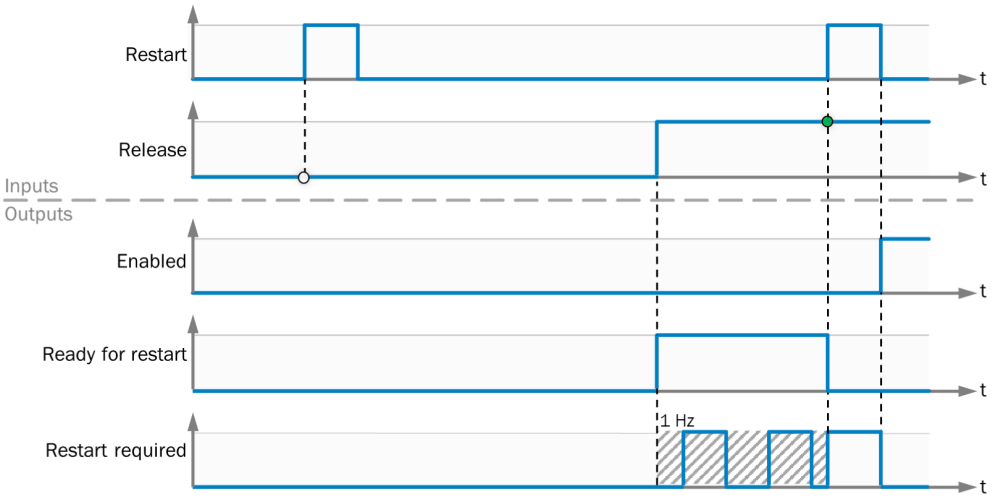


Figure 34: Sequence/timing diagram Restart V1

Complementary information

To evaluate the minimum length of the restart pulse (here: 100 ms), the restart signal must be sampled twice after a rising signal edge (0-1). The required minimum length of the restart signal is therefore extended by one logic processing time.

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.7.3 Operating mode switch V1

Overview

The function block activates exactly one output if the corresponding input = 1. It is expected that only exactly one input = 1. A discrepancy time can be configured to bridge short periods in which not exactly one input is =1.

Principle of operation

Table 102: Inputs Operating mode switch V1

Input	Description
Input 1 Input 2	Data type: Bool See Output 1 ... Output 8.
Input 3 ... Input 8 (optional)	

Table 103: Outputs Operating mode switch V1

Output	Description
Output 1 ... Output 8	Data type: Bool If exactly one input x = 1, then output x = 1. **Examples:** • Input 2 = 1 and all other inputs = 0, then output 2 = 1. • Input 5 = 1 and all other inputs = 0, then output 5 = 1. The behavior of the outputs also depends on the configured parameters.
Operating mode unchanged	Data type: Bool The output is 0 for the duration of a logic cycle if the value of at least one output changed during the last logic cycle.
Status	Data type: Bool • 0: The outputs Output 1 ... Output 8 are in the defined error output combination (**Error output combination** parameter). • 1: No error

Table 104: Parameter Operating mode switch V1

Parameter	Description
Number of inputs	2 ... 8
Discrepancy time	0 ... 10 s in 1 ms increments The discrepancy time determines how long 0, 2 or more (i.e. ≠ 1) inputs can continue to have the value 1 without this being regarded as an error.
Error output combination	Determination of the output values in the event of an error In the event of an error, activated outputs switch to 1 and deactivated outputs switch to 0. For unused inputs (**Number of inputs** parameter), the corresponding value in the error output combination is set to 0. The error is canceled as soon as a valid input combination is present again. If a faulty input combination is already present in the first logic cycle, the error output combination is activated without delay.

Sequence/timing diagram

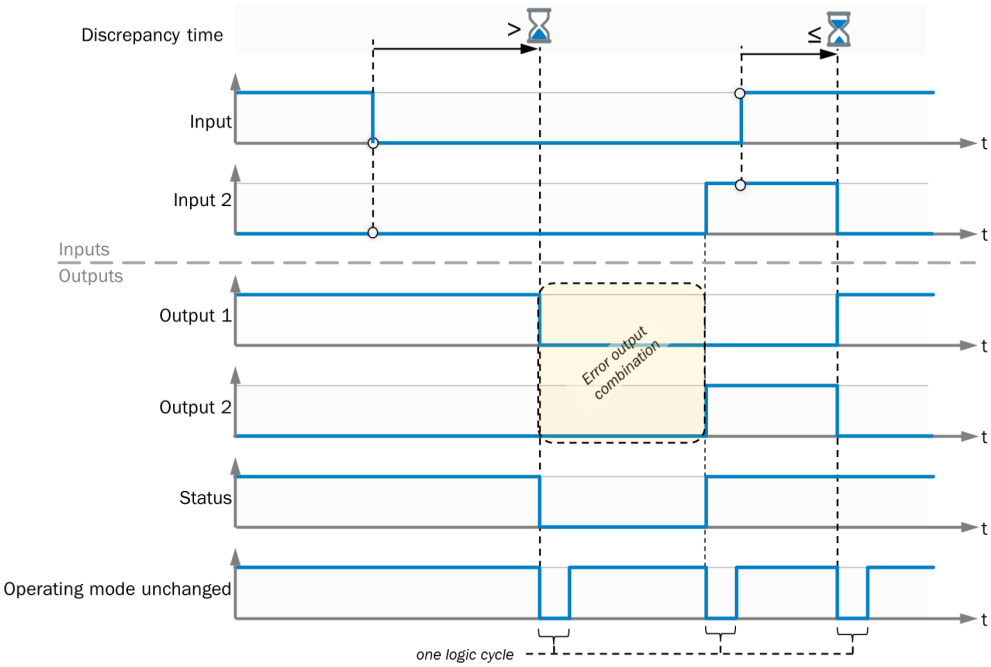


Figure 35: Sequence/timing diagram Operating mode switch V1

8.7.4.7.4 Multi operator V1

Overview

You can use this function block to operate up to three two-hand control devices at the same time (e.g., for press applications with more than one operator).

Important information

WARNING
Ineffectiveness of the protective device
The function block does not perform a dual-channel evaluation or two-hand monitoring of the inputs. The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Only connect safe signals that have undergone a preliminary evaluation to the **Operator 1 ... Operator 3** inputs. This can be, for example, the **Enabled** output of a **Two hand control (4 inputs) V1** function block.

Principle of operation

Table 105: Inputs Multi operator V1

Input	Description
Operator 1 Operator 2	Data type: Bool
Operator 3 (optional)	
Release 1 Release 2 (optional)	Data type: Bool The function block uses the inputs to check whether specific prerequisites have been met (e.g., protective device closed, safety light curtain active, etc.).

Input	Description
Cycle request	Data type: Bool A cycle request prevents one or more of the two-hand control devices from remaining permanently actuated. For this purpose, the function block requires a signal that, for example, generates a pulse during each machine cycle. Do not use this input for safety functions, but only for automation control.

Table 106: Outputs Multi operator V1

Output	Description
Enabled	Data type: Bool **The output is set to 1 if all of the following conditions are met:** • The inputs **Release 1** and **Release 2** are and remain 1 if they are used. • A rising signal edge (0-1) at all **Operator 1 ... Operator 3** inputs used. The edges do not have to occur at the same time. **The output is set to 0 if one or more of the following conditions are met:** • At least one connected **Release 1 ... Release 2** input = 0. • At least one connected **Operator 1 ... Operator 3** input = 0. • An edge is detected at the **Cycle request** input. The **Cycle request condition** parameter is used to define the type of edge. During the first logic cycle, the **Enabled** output = 0.

Table 107: Parameter Multi operator V1

Parameter	Description
Cycle request condition	• Rising signal edge • Falling signal edge
Number of operators	• 2 operators • 3 operators
Number of release inputs	0 ... 2

Sequence/timing diagram

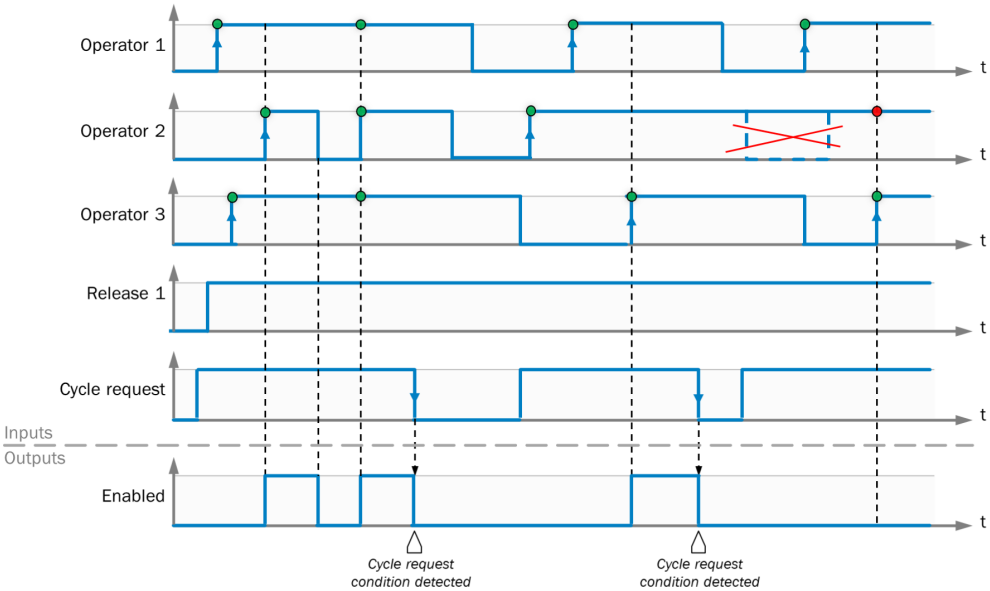


Figure 36: Sequence/timing diagram Multi operator V1

8.7.4.7.5 Function blocks for muting

Muting is an automatic process that temporarily bypasses safety functions of a control system or protective equipment. Muting allows certain objects, e.g., pallets loaded with material, to pass through electro-sensitive protective equipment (ESPE) such as a safety light curtain and into a hazardous area. During this transport operation, the muting function bridges monitoring by the electro-sensitive protective equipment.

8.7.4.7.5.1 Parallel muting V1

Overview

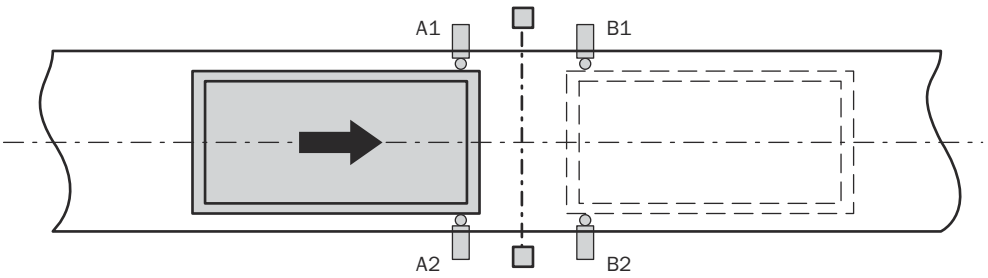


Figure 37: Muting with two sensor pairs arranged in parallel (A1 / A2 and B1 / B2)

Principle of operation

Table 108: Inputs Parallel muting V1

Input	Description
Electro-sensitive protective device	Data type: Bool The input must be connected to the electro-sensitive protective device.
A1 A2 B1 B2	Data type: Bool Signal from the muting sensor
Override (optional)	Data type: Bool "Override", page 99
Conveyor (optional)	Data type: Bool "Conveyor input", page 100
C1 (optional)	Data type: Bool This input is typically connected to the higher-level controller. The higher-level controller can confirm, via this signal, that material is being transported through the ESPE. The optional **C1** input can be used as additional protection against manipulation. If it is used, the **C1** input must have switched to 0 after a previous muting cycle, and to 1 at the latest when both muting sensor signal inputs switch to 1 at the same time. A failure to meet this condition results in a muting error, which is indicated at the **Muting error** output. The **C1** input must then switch back to 0 before the subsequent muting cycle is permitted. The **C1** input is not relevant for the duration of the muting status.

Table 109: Outputs Parallel muting V1

Output	Description
Enabled	Data type: Bool

Output	Description
Muting lamp	Data type: Bool The **Muting lamp** output can be used to indicate on a display element when an muting cycle is active. • 0: **Muting status** output = 0 • 1: **Muting status** output = 1 or **Override status** output = 1 • The **Muting lamp** output pulsates at 2 Hz if the **Override required** output = 1
Muting status	Data type: Bool The output indicates the status of the muting function. • The **Muting status** output = 0 if the muting cycle is inactive (no error) or a muting error has been detected • The **Muting status** output = 1 if the muting cycle is active (no error) or override is active (no error)
Override required	Data type: Bool • 0: Inactive • 1: Active
Muting error	Data type: Bool • 0 = No error • 1 = Error "Muting error output", page 101
Override status	Data type: Bool • 0: Inactive • 1: Active
Status	Data type: Bool • 0: Error • 1: No error The value at the output is the inverted value of the **Muting error** output.

Table 110: Parameter Parallel muting V1

Parameter	Description
Direction detection	• Disabled • Forward (A1/A2 first) (A1 / A2 first) • Backward (B1/B2 first) (B1 / B2 first) "Direction detection parameter", page 101
Condition of the other sensor pair for muting start	• Both sensors are free • At least one sensor is free "Condition of other sensor pair for muting start parameter", page 103
Condition for end of muting	• With muting sensor pair • With electro-sensitive protective equipment (ESPE) "Muting end condition parameter", page 103
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Total muting time parameter ", page 102
Concurrency monitoring time	0 = infinite, 10 ms ... 3,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. "Concurrency monitoring time parameter", page 102
Suppression of sensor signal gaps	0 = infinite, 10 ms ... 1,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. see "Parameter Suppression of sensor signal gaps", page 102
Additional muting time after the ESPE is released	0 ms, 200 ms, 500 ms, 1,000 ms "Additional muting time after the electro-sensitive protective device indicates a clear path parameter", page 102
Input C1	• Active • Deactivated

Parameter	Description
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

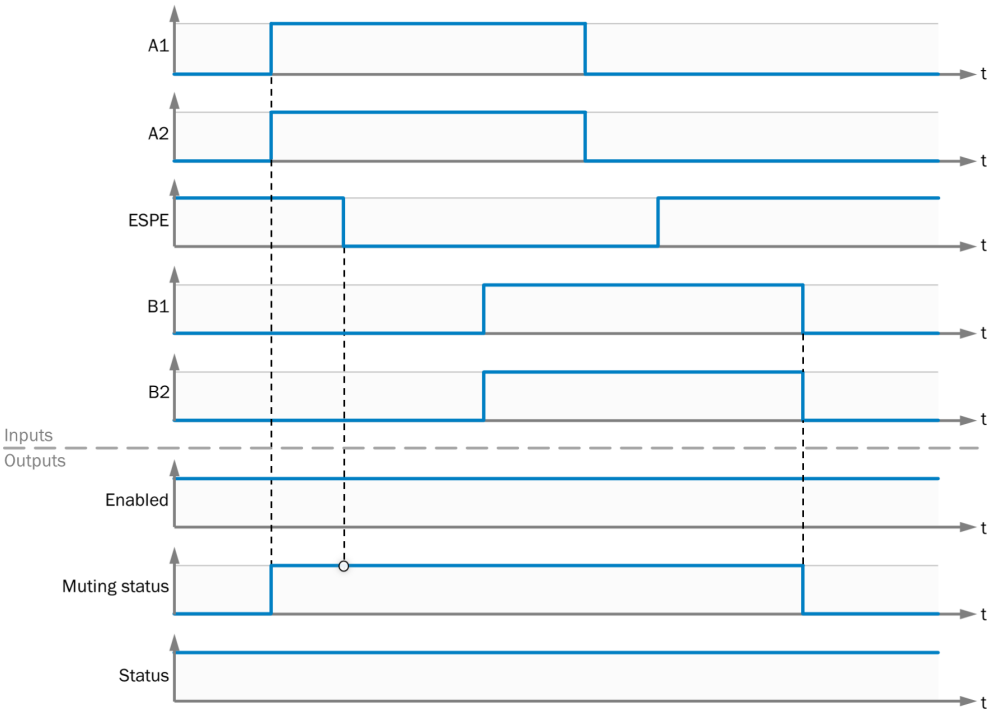


Figure 38: Sequence/timing diagram Parallel muting V1

Complementary information

- If there are objects in the area of the muting sensors during the first logic cycle and therefore one or more muting sensor signal inputs are set to 1, this generates a muting error. The signaling of the error state at the **Muting error** output is suppressed if the **BWS** input = 1. Before a new valid muting cycle can be executed, this error must be reset.
- The muting times have an accuracy of ± 10 ms (evaluation plus logic execution time).

8.7.4.7.5.2 Sequential muting V1

Overview

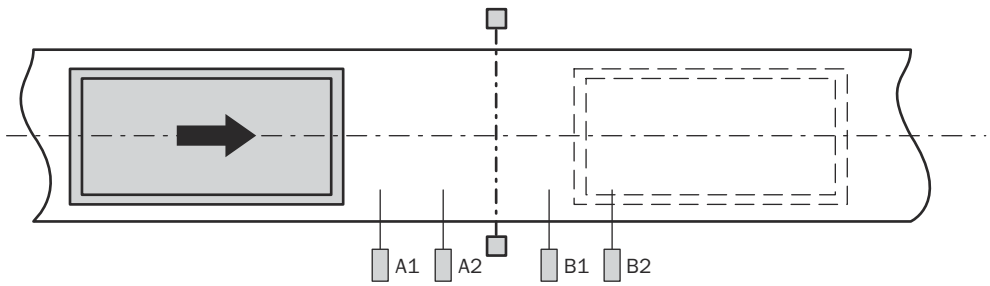


Figure 39: Muting with two sensor pairs arranged in sequence (A1 / A2 and B1 / B2)

Principle of operation

Table 111: Inputs Sequential muting V1

Input	Description
Electro-sensitive protective device	Data type: Bool The input must be connected to the electro-sensitive protective device.
A1 A2 B1 B2	Data type: Bool Signal from the muting sensor
Override (optional)	Data type: Bool "Override", page 99
Conveyor (optional)	Data type: Bool "Conveyor input", page 100
C1 (optional)	Data type: Bool The optional **C1** input can be used as additional protection against manipulation. If it is used, the **C1** input must have switched to 0 after a previous muting cycle, and to 1 at the latest when both muting sensor signal inputs switch to 1 at the same time. A failure to meet this condition results in a muting error, which is indicated at the **Muting error** output. The **C1** input must then switch back to 0 before the subsequent muting cycle is permitted. The **C1** input is not relevant for the duration of the muting status.

Table 112: Outputs Sequential muting V1

Output	Description
Enabled	Data type: Bool
Muting lamp	Data type: Bool The **Muting lamp** output can be used to indicate when a muting cycle is active. • The **Muting lamp** output = 0 if the **Muting status** output = 0 • The **Muting lamp** output = 1 if the **Muting status** output = 1 or the **Override status** output = 1 • The **Muting lamp** output pulsates at 2 Hz if the **Override required** output = 1
Muting status	Data type: Bool The output indicates the status of the muting function. • The **Muting status** output = 0 if the muting cycle is inactive (no error) or a muting error has been detected • The **Muting status** output = 1 if the muting cycle is active (no error) or override is active (no error)
Override required	Data type: Bool
Muting error	Data type: Bool "Muting error output", page 101
Override status	Data type: Bool
Status	Data type: Bool • 0: Error • 1: No error The value at the output is the inverted value of the **Muting error** output.

Table 113: Parameter Sequential muting V1

Parameter	Description
Direction detection	• Disabled • Forward (A1/A2 first) (A1/A2 first) • Backward (B1/B2 first) (B1/B2 first) "Direction detection parameter", page 101

Parameter	Description
Condition of other sensor pair for muting start	• Both sensors clear • At least one sensor clear "Condition of other sensor pair for muting start parameter", page 103
Muting end condition	• With muting sensor pair • With electro-sensitive protective device (ESPE) "Muting end condition parameter", page 103
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Total muting time parameter ", page 102
Concurrency monitoring time	0 = infinite, 10 ... 3,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. "Concurrency monitoring time parameter", page 102
Suppression of sensor signal gaps	0 = infinite, 10 ms ... 1,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. see "Parameter Suppression of sensor signal gaps", page 102 To avoid machine downtimes during sequential muting, the configured time for Suppression of sensor signal gaps should be less than the length of time between deactivation of the first sensor and deactivation of the second sensor of a muting sensor pair (e.g., A1 / A2 or B1 / B2) when the transported material leaves the range of this sensor pair. Otherwise, the signal of the first sensor is still active at the time of deactivation of the second sensor due to the Suppression of sensor signal gaps and an error occurs in the sequence monitoring.
Additional muting time after the electro-sensitive protective device indicates a clear path	0 ms, 200 ms, 500 ms, 1,000 ms "Additional muting time after the electro-sensitive protective device indicates a clear path parameter", page 102
Input C1	• Active • Deactivated
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

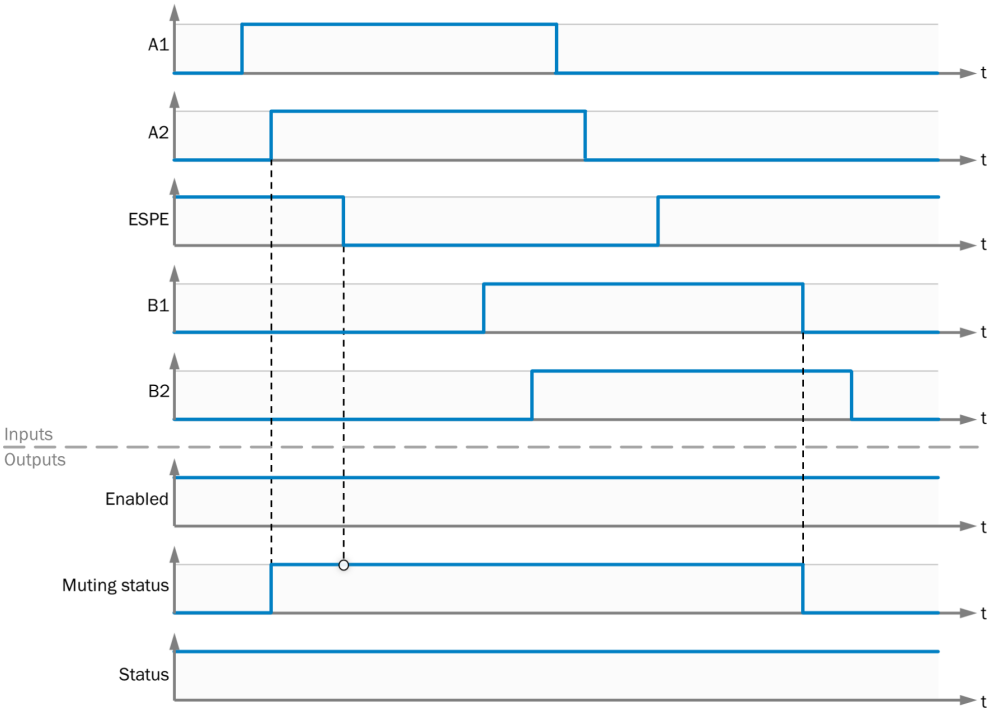


Figure 40: Sequence/timing diagram Sequential muting V1

Sequence monitoring

A sequence monitoring is performed when sequential muting is active. The prerequisite for sequence monitoring and the initiation of muting is a prescribed activation sequence of the muting sensors.

Table 114: Valid sequence for muting sensor input signals with sequence monitoring

Direction detection	Valid sequence for muting sensor input signals
Forward	A1 before A2 before B1 before B2
Backward	B2 before B1 before A2 before A1

Deviations from the sequence result in a muting error, which is indicated at the **Muting error** output. This applies both to the sequence of activation (muting sensor signal inputs switch from 0 to 1) and to deactivation (muting sensor signal inputs switch from 1 to 0).

Complementary information

- If there are objects in the area of the muting sensors during the first logic cycle and therefore one or more muting sensor signal inputs are set to 1, this generates a muting error. The signaling of the error state at the **Muting error** output is suppressed if the **BWS** input = 1. Before a new valid muting cycle can be executed, this error must be reset.
- The muting times have an accuracy of ± 10 ms (evaluation plus logic execution time).

8.7.4.7.5.3 Cross muting V1

Overview

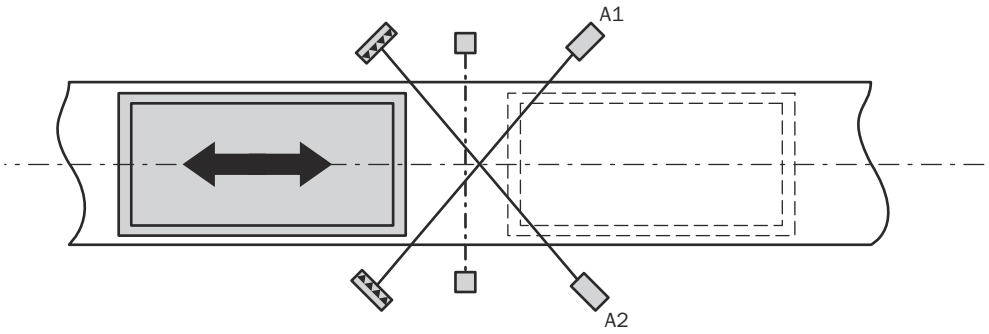


Figure 41: Muting with a sensor pair arranged crosswise (A1 / A2)

Principle of operation

Table 115: Inputs Cross muting V1

Input	Description
Electro-sensitive protective device	Data type: Bool The input must be connected to the electro-sensitive protective device.
A1 A2	Data type: Bool Signal from the muting sensor
Override (optional)	Data type: Bool "Override", page 99
Conveyor (optional)	Data type: Bool "Conveyor input", page 100
C1 (optional)	Data type: Bool The optional **C1** input can be used as additional protection against manipulation. If it is used, the **C1** input must have switched to 0 after a previous muting cycle, and to 1 at the latest when both muting sensor signal inputs switch to 1 at the same time. A failure to meet this condition results in a muting error, which is indicated at the **Muting error** output. The **C1** input must then switch back to 0 before the subsequent muting cycle is permitted. The **C1** input is not relevant for the duration of the muting status.

Table 116: Outputs Cross muting V1

Output	Description
Enabled	Data type: Bool
Muting lamp	Data type: Bool The **Muting lamp** output can be used to indicate when a muting cycle is active. • The **Muting lamp** output = 0 if the **Muting status** output = 0 • The **Muting lamp** output = 1 if the **Muting status** output = 1 or the **Override status** output = 1 • The **Muting lamp** output pulsates at 2 Hz if the **Override required** output = 1
Muting status	Data type: Bool The output indicates the status of the muting function. • The **Muting status** output = 0 if the muting cycle is inactive (no error) or a muting error has been detected • The **Muting status** output = 1 if the muting cycle is active (no error) or override is active (no error)
Override required	Data type: Bool

Output	Description
Muting error	Data type: Bool "Muting error output", page 101
Override status	Data type: Bool
Status	Data type: Bool • 0: Error • 1: No error The value at the output is the inverted value of the **Muting error** output.

Table 117: Parameter Cross muting V1

Parameter	Description
Condition of other sensor pair for muting start	• Both sensors clear • At least one sensor clear "Condition of other sensor pair for muting start parameter", page 103
Muting end condition	• With muting sensor pair • With electro-sensitive protective device (ESPE) "Muting end condition parameter", page 103
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Total muting time parameter ", page 102
Concurrency monitoring time	0 = infinite, 10 ... 3,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. "Concurrency monitoring time parameter", page 102
Suppression of sensor signal gaps	0 = infinite, 10 ms ... 1,000 ms, adjustable in 10 ms increments. If the value is not 0, it must be greater than the logic execution time. see "Parameter Suppression of sensor signal gaps", page 102
Additional muting time after the electro-sensitive protective device indicates a clear path	0 ms, 200 ms, 500 ms, 1,000 ms "Additional muting time after the electro-sensitive protective device indicates a clear path parameter", page 102
Input C1	• Active • Deactivated
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

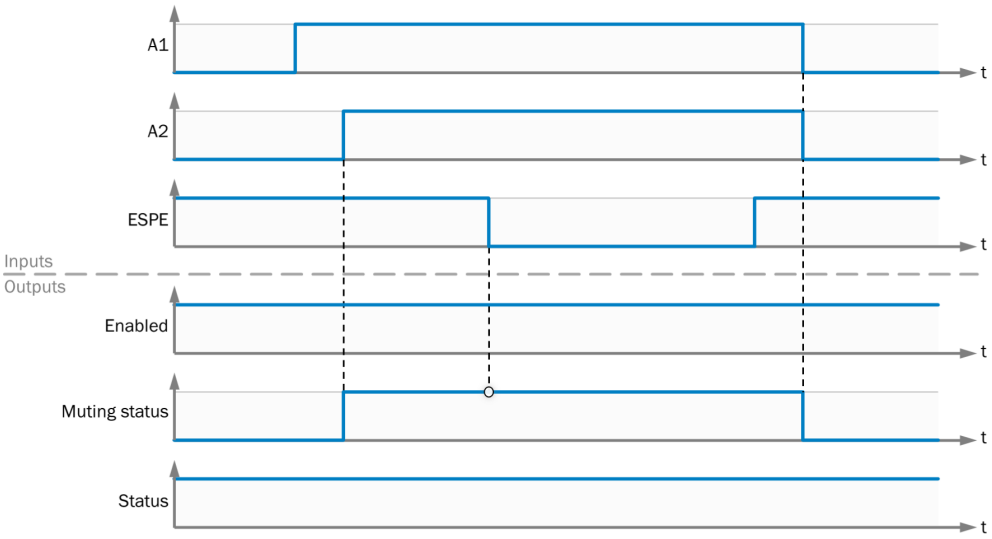


Figure 42: Sequence/timing diagram Cross muting V1

Complementary information

- If there are objects in the area of the muting sensors during the first logic cycle and therefore one or more muting sensor signal inputs are set to 1, this generates a muting error. The signaling of the error state at the **Muting error** output is suppressed if the **BWS** input = 1. Before a new valid muting cycle can be executed, this error must be reset.
- The muting times have an accuracy of ± 10 ms (evaluation plus logic execution time).

8.7.4.7.5.4 Override

Overview

An error in the muting sequence aborts muting and triggers the safety function. In this case, transported objects can remain in the protective field of the protective device. The triggering of an emergency stop or a mains voltage failure can also lead to the same condition. Depending on the application, a person must then evaluate the situation and manually override it.

The **Override** function allows you to activate the **Enabled** output of the muting function block even though no valid muting sequence has been detected.

The **Override** function includes the following inputs and outputs:

- **Override** input
- **Override required** output
- **Override status** output

Important information

WARNING
Restricted safety with Override

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Only use the override if the hazardous area has been visually checked beforehand. No person must have access to or be in the hazardous area.

Override

Conditions for override

The following conditions must all be met:

- **Muting status** output = 0
- At least one of the muting sensor signal inputs **A1**, **A2**, **B1**, **B2** = 1
- The **Electro-sensitive protective device** input = 0 (e.g., safety light curtain has been interrupted)
- **Enabled** output = 0

Signal state for override conditions are met

- **Override status** output = 1
- **Override required** output: pulsates at 2 Hz

Activate Override

- All conditions for override are met.
- Valid sequence at Override input. Valid sequence: 0–1–0, where signal state 1 must be present for a period of 100 ms ... 3 s.

If the conditions for Override are met and a valid sequence occurs at the Override input, the **Enabled** output switches to 1.

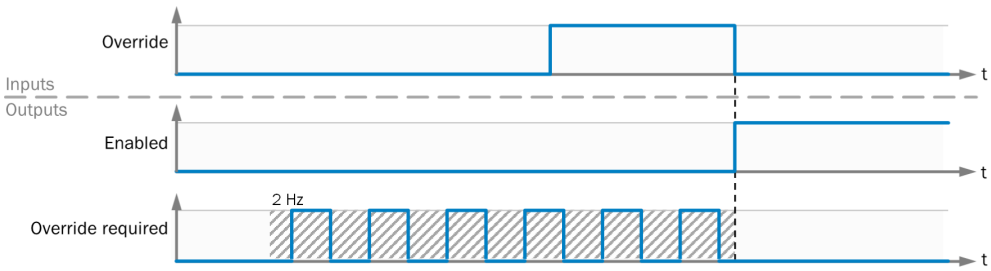


Figure 43: Sequence/timing diagram for Override and Override required

Once all the muting sensor signal inputs have switched back to 0 and the **Electro-sensitive protective device** input = 1 (e.g., protective field is clear), the next valid muting cycle is expected.

Number of permissible override cycles

To prevent excessive use of the Override function, the number of permissible override cycles is limited. The number of permissible override cycles depends on the value for the total muting time.

Table 118: Number of permissible override cycles

Total muting time	Number of permissible override cycles
5 s	360
10 s	360
20 s	180
30 s	120
1 min	60
5 min	12
15 min	5
30 min	5
60 min	5
Deactivated (0 = unlimited)	5

The number of override cycles is saved in the function block. This value is incremented whenever the **Override required** output starts pulsating or whenever the **Muting status** output switches to 1. The value is reset to 0 on completion of a valid muting cycle, after a system reset or after a transition from the Stop status to the Run status.

Complementary information

While there is a valid override status, none of the following are performed for the duration of one override cycle: direction detection, sequence monitoring (depending on function block) and concurrence monitoring.

Further topics

- "Single-channel use of safety inputs", page 23

8.7.4.7.5.5 Conveyor input

If the transported material stops moving during the muting cycle, the total muting time and other parameters that can lead to muting errors could be exceeded. This problem can be avoided by using the **Conveyor** input. This input allows you to stop the time-dependent functions associated with muting if the material being transported comes to a halt.

- **Conveyor** input is 0: Conveyor system stopped
- **Conveyor** input is 1: Conveyor system running

The following timer functions are affected by the **Conveyor** input:

Table 119: Effect of the Conveyor input

Timer function	Effect of the Conveyor input
Monitoring of the total muting time Concurrence monitoring	• The detection of a conveyor system stoppage pauses the timer functions. • When the conveyor system starts up again, the timer continues running with the value that was stored before the stoppage was detected. When this happens for the first time during the active muting cycle, a one-time increase of 5 seconds is added onto the total muting time.

Complementary information

The **Suppression of sensor signal gaps** parameter is not affected by the **Conveyor** input.

8.7.4.7.5.6 Muting error output

Muting error output

The **Muting error** output indicates when an error associated with the muting function block has been detected. The **Muting error** output = 1 if the **Electro-sensitive protective device** input = 0 and any muting error has been detected and not yet reset.

Table 120: Error statuses and reset information for muting function blocks

Error	Resetting the error status	Comments
• Total muting time monitoring error • Concurrence monitoring error • Direction detection error • Sequence monitoring error • Error during state transition in the first logic cycle: Incorrect signal state in at least one muting sensor signal input.	Before a muting error of any kind can be reset, a valid muting cycle must be performed in full. This either involves using the Override function, or all of the muting sensor signal inputs must be set to 1 and the **Electro-sensitive protective device** input must be set to 0. A valid muting sequence must follow this. When either of these conditions is met, the Muting error output returns to 0 provided that there is no other error pending.	The **Enabled** output and the **Status** output switch to 0 if the **Muting error** output is set to 1.

Complementary information

If the **Electro-sensitive protective device** input = 1, the display of muting errors at the **Muting error** output is inhibited.

8.7.4.7.5.7 Direction detection parameter

The **Direction detection** function can be used to tighten muting conditions if the material being transported is only to be moved in one particular direction. The possible movement direction depends on the order in which the muting sensors are activated.

If the **Forward (A1/A2 first)** direction is selected, the inputs for the muting sensor pairs must be activated in the order A1 / A2 before B1 / B2. Muting is not possible in the opposite direction.

If the **Backward (B1/B2 first)** direction is selected, the inputs for the muting sensor pairs must be activated in the order B1 / B2 before A1 / A2. Muting is not possible in the opposite direction.

8.7.4.7.5.8 Parameter Suppression of sensor signal gaps

Occasionally, muting sensors are affected by output signal faults that are of no significance as far as muting is concerned. The **Suppression of sensor signal gaps** function makes it possible to filter out brief faults without interrupting muting.

When the **Suppression of sensor signal gaps** parameter is active, a change of a muting sensor signal input to 0 will be ignored for the length of time that has been set for **Suppression of sensor signal gaps**. The function block continues to interpret this as an uninterrupted 1 signal provided that only one muting sensor signal input from each sensor pair (**A1**/**A2** or **B1**/**B2**) is affected by a signal gap.

8.7.4.7.5.9 Concurrency monitoring time parameter

This parameter is used to check whether the muting sensors are activated at the same time. This value relates to the two muting sensor signal inputs that are subject to dual-channel evaluation and specifies how long they are allowed to have different values without this being regarded as an error. This means that input pair **A1** and **A2** or the input pair **B1** and **B2** must assume equivalent values before the end of the concurrence monitoring time.

Concurrence monitoring starts as soon as a value of a muting sensor signal input changes for the first time. If the concurrence monitoring time expires and both inputs of an input pair still have different values, an error occurs and the muting sequence is canceled.

If the concurrence monitoring function of at least one input pair detects an error, the function block indicates this by setting the **Muting error** output to 1.

Complementary information

With the Sequential muting V1 function block, it must be taken into account that the two sensors of each pair switch at different times. The difference depends on the distance between the two sensors and on the speed of the material transport.

8.7.4.7.5.10 Total muting time parameter

This parameter is used to limit the maximum duration of the muting sequence. If the value set for the **Total muting time** parameter is exceeded, the **Muting error** output switches to 1 and the **Enabled** and **Status** outputs switch to 0.

The timer for the **Total muting time** starts running when a valid start condition for muting exists; this is indicated by the **Muting status** output transitioning to 1. The timer for the **Total muting time** stops running and is reset to 0 if the muting sequence is ended again; this is indicated by the **Muting status** output transitioning to 0.

8.7.4.7.5.11 Additional muting time after the electro-sensitive protective device indicates a clear path parameter

This parameter can be used if the **Muting end condition** parameter has been configured as **With electro-sensitive protective device**. Sometimes, irregularities in the material or transportation equipment may mean that the ESPE cannot always detect the end of muting precisely. If this happens, you can increase the availability of the machine by configuring an additional muting time of up to 1,000 ms.

In this case, the **Additional muting time after the electro-sensitive protective device indicates a clear path** parameter determines the additional muting time once the **Electro-sensitive protective device** input has switched back to 1.

If one of the muting sensors relevant for muting end frees up, the muting sequence is ended immediately, even if the time set for the **Additional muting time after the electro-sensitive protective device indicates a clear path** parameter has not yet expired.

8.7.4.7.5.12 Muting end condition parameter

This parameter determines when a valid muting status is over:

- **With muting sensor pair**: When a muting sensor signal input in the last muting sensor pair switches to 0 (sensor clear) and the sensor gap monitoring time has expired.
- **With electro-sensitive protective device**: When the **Electro-sensitive protective device** input switches to 1 and therefore indicates that the protective field is clear again.

If the **Electro-sensitive protective device** input switches to 0 at the end of muting (e.g., because the ESPE protective field has been breached) before the next valid muting sequence begins, the **Enabled** output of the function block switches to 0. In this case, the next muting cycle can only begin once the End-of-muting condition has been met.

8.7.4.7.5.13 Condition of other sensor pair for muting start parameter

This parameter determines when the next valid muting sequence can begin after a previous muting sequence.

Start conditions for muting:

- **Both inputs are clear**: All muting sensor signal inputs = 0 and the **Electro-sensitive protective device** input = 1 (i.e., the protective field is clear).
- **At least one sensor is clear**: All muting sensor signal inputs (except one) = 0, the **Electro-sensitive protective device** input = 1 (i.e., the protective field is clear) and the sensor gap monitoring time has elapsed.

If a higher throughput is required, it may be advisable to let the next muting sequence begin as soon as the transported material has traveled past the protective device and past all the muting sensors except the last one (i.e., at least one sensor is clear).

8.7.4.8 Grouping function blocks

Overview

Several function blocks can be combined into a group. This group is displayed as a single function block. A grouped function block can be instantiated multiple times like a normal function block.

This makes it easier to use the same logic groups multiple times and it reduces the number of function blocks displayed on the workspace.

Prerequisites

- The grouped function block has max. 8 inputs and 8 outputs.
- It must not contain the Fast shut off function block.
- It must not contain another grouped function block.
- It must not contain a customized function block.

Procedure

1. Drag the function blocks to be grouped onto the logic editor workspace, configure them as required, and connect them to one another.
2. Select all function blocks to be grouped (e.g., by clicking while pressing the Ctrl key).

3. Open the context menu of one of the selected function blocks and click on **Group...**.
4. Enter a name for the grouped function block.
5. To assign an icon to the grouped function block, click on **Select...**, select the desired icon, and click **OK** to confirm.
6. Click **OK** to confirm the changes and close the dialog box. The selected function blocks are grouped.

✔ The grouped function block looks like an individual function block on the workspace. The content of the grouped function block is displayed on a separate logic page and can be edited there.

8.7.4.9 Creating customized function blocks

Overview

Customized function blocks are created from grouped function blocks.

Characteristics:

- Customized function blocks are displayed in the selection list for the function blocks. Like other function blocks, they can also be used multiple times in a project.
- It is not possible to edit customized function blocks.
- Customized function blocks are available in all projects on the computer on which they were created.
- Customized function blocks can be transferred to other computers.
- Customized function blocks can be protected with a password. Without the password, it is not possible to view the configuration of this function block.

Important information

NOTICE
Loss of password

The password cannot be reset or recovered, even by the SICK service.

→ Make a note of the password and keep it safe.

NOTICE
No valid report can be created for a password protected function block.

Procedure

1. Create a grouped function block with the desired functionality.
2. On the logic page of the grouped function block. click on the **Save as CFB...** button.
3. Enter a name for the customize function block.
4. Optionally, assign an icon to the customized function block.
5. Optionally, activate password protection and enter a password.
6. Click **OK** to confirm the changes and close the dialog box.

✔ The grouped function block is converted into a user-defined function block.

Complementary information

- When calculating the total number of function blocks in a project, a customized function block is not counted as a single function block. Instead, the number of function blocks within it are counted.
- User-defined function blocks can be replaced by another user-defined function block using drag-and-drop if the number and type of inputs and outputs match.

8.7.4.9.1 Changing customized function blocks

Overview

Unlike grouped function blocks, you cannot edit customized function blocks. To change a customized function block, you must convert it back into a grouped function block again beforehand.

Procedure

1. Double-click on the customized function block and enter the password if necessary to open the logic page of the customized function block.
2. Click on **Edit ...** in the toolbar and confirm with **Yes**.

✔ The customized function block is converted back into a grouped function block, which can be edited as usual.

8.7.4.9.2 Transferring customized function blocks

Overview

You can transfer customized function blocks to another computer.

Procedure

1. Create and save a project, in which the desired customized function blocks are used.
2. Open the project on another computer. If the project contains customized function blocks which are not available on the computer, then you have two options.
   - Import the customized function blocks. These are then added to the function block selection list and are available for use in all projects on the same computer.
   - Do not import the customized function blocks. In this case, the project still opens. However, the customized function blocks included in this project are not added to the selection list of function blocks and they can only be used in the current project.

Complementary information

- User-defined function blocks can be replaced by another function block using drag-and-drop if the number and type of inputs and outputs match.

8.7.5 Diagnostics

Overview

The process data status bits can be used as input elements for the logic.

Important information

WARNING
Ineffectiveness of the protective device due to the use of non-safe diagnostic data for safety-related applications

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

→ Use non-safe process data status bits for diagnostic purposes only.

Process data status bits of the modules

Table 121: Process data status bits of the modules

Process data status bits	Value	Description
Voltage supply of outputs (for modules with safety outputs only)	0	Voltage supply of the outputs is outside the specified range, fault switch-off due to short-circuit to VCC or cross-circuit to other outputs.
	1	Voltage supply of the output is OK
Input data status	0	One or more input bits of the associated module have been set to 0 because an error has been detected (e.g., cross-circuit or communication error). I.e., the input bits may have different values than would normally be the case during error-free operation.
	1	Inputs of the associated module are OK
Output data status	0	An error has been detected at one or more outputs of the associated module (e.g., overload, short-circuit or communication error). I.e., the outputs may have different values than would normally be the case during error-free operation.
	1	Outputs of the associated module are OK

Process data status bits of the individual inputs or outputs

Table 122: Process data status bits of the individual inputs or outputs

Process data status bits	Value	Description
Fast shut off control	0	Error or timeout in fast shut-off logic
	1	Fast shut-off logic is OK
Status Ix, Iy Dual-channel evaluation	0	Error at the inputs The input value is 0, regardless of the level at the terminals.
	1	Dual-channel evaluation of Ix/Iy input is OK
Status Ix	0	Error at the input The input value is 0, regardless of the level at the terminals.
	1	Input is OK
Status Qx Short-circuit to HIGH	0	Output voltage level is HIGH instead of LOW when the output is "Off". With test pulses, also in case of short-circuits to VCC or cross-circuits to other outputs. All safety outputs of the module are “Off”, regardless of the logic result.
	1	Output is OK
Status Qx Short-circuit to LOW	0	Output voltage level is LOW instead of HIGH when the output is "On". The safety output is “Off”, regardless of the logic result.
	1	Output is OK

Further topics

- "Possible faults", page 118

8.7.6 Jump addresses

Jump addresses

Jump addresses are available as source and destination jump addresses in the logic editor. The destination jump address assumes the same value (e.g. 1 or 0) as the associated source jump address without a delay. They can be used to do the following:

- Create a reverse path.
- Connect the function blocks.
- **Delay**: The function is used to delay the jump address by one logic cycle. This can be used, among other things, to create recursions.

Complementary information

- You can use up to 256 jump addresses.
- A source jump address can have multiple target jump addresses.

8.7.7 I/O matrix

The **I/O matrix** tab in the worksheet shows which inputs affect which outputs. You can use the I/O matrix, for example, to check whether the logic program is complete.

- Green field: Input affects output.
- White field: There is no relationship between input and output.

The **I/O matrix** selection window lists all inputs and outputs in the CPU logic catalog. Activated inputs and outputs are displayed in the matrix.

8.7.8 I/O summary page

The I/O summary page summarizes all logic pages into a single overview:

- On the left, the input elements of a logic page
- In the middle, the function blocks combined into a block
- On the right, the output elements of a logic page

8.7.9 Simulation mode

In simulation mode, you can test the logic program without the configuration software being connected to the safety controller. Inputs can be set to 1 or 0 and you can observe the subsequent switching of the outputs.

8.7.9.1 Activating simulation mode

Prerequisites

- Valid configuration

Procedure

Activating simulation mode

→ Click on the  (**Start simulation mode**) button in the toolbar.

✔ The background of the logic editor turns light green and the simulation toolbar is displayed.

Deactivating simulation mode

→ To end simulation mode, click on the  (**Stop simulation mode**) button.

✔ The simulation mode is exited and the background of the logic editor changes to gray.

8.7.9.2 Starting the simulation

Overview

You can run the simulation step-by-step or in endless run mode.

Prerequisites

- Activated simulation mode

Procedure

Running simulation step-by-step

→ Click on the button with the desired time interval.
→ Or, in the input field to the right of the buttons, enter a user-defined time. The time must be a multiple of the logic execution time. Click on the blue button next to the input field.
✔ The simulation jumps forward by the corresponding time interval.
→ The timer can, if necessary, be reset by clicking the blue **Reset simulation** button.

Starting simulation in endless run mode

1. Click on the green **Start continuous run mode** button in the simulation toolbar.
✔ The simulation starts.
2. If necessary, slow down the simulation. Move the slide control on the simulation toolbar to the left.
✔ The simulation slows down.

Stopping simulation in endless run mode

1. To stop the currently running simulation, click on the red **Stop continuous run mode** button.
✔ The simulation stops.
2. The timer can, if necessary, be reset by clicking the blue **Reset simulation** button.

Complementary information

Simulation with the **External device monitoring V1** function block in endless run mode is only possible without errors with the **bypass EDM function** function. The function block then behaves in the simulation as follows:

- **Control input** input = **Enabled** output
- **EDM feedback signal** input is ignored.

8.7.9.3 Setting inputs

Overview

You can set inputs to 1 or 0 during simulation mode. This is also possible before starting the simulation.

Setting the inputs before starting the simulation allows you, for example, to switch multiple inputs at the same time without a discrepancy time.

Procedure

1. Click on an inactive input.
✔ The input is set to 1.
2. Click on an active input.
✔ The input is set to 0.

Complementary information

- An active input (1) is displayed in blue before the simulation is started.
- An active input (1) is displayed in green once the simulation is started.
- An inactive input (0) is displayed in white.

8.8 Report main navigation menu

The report summarizes all information about the configuration of the safety controller. You can select or deselect parts of the report. You can also export a parts list as a CSV file.

8.9 Service main navigation menu

Overview

You can run the following under service:

- Reboot device
- Reset the device to factory settings
- Managing passwords

Prerequisites

- Existing connection between the configuration software and device

8.9.1 Assigning or changing passwords

Procedure

1. Establish connection to the device.
2. In the device window under the main navigation **Service**, select the **User password** entry.
3. In the **User password** dialog, select the user group.
4. Enter the new password twice and use **Transmit to device** to confirm.
5. When you are prompted to log on, select your user group and enter the corresponding password.

✔ The new password is valid for the user group immediately.

8.9.2 Resetting the password

Overview

If you have forgotten the password of the Administrator user group, you can reset it with the assistance of SICK.

Procedure

Resetting the password

1. Request the form for resetting your password from SICK support.
2. Connect to the device in Safety Designer.
3. In the device window under the main navigation **Service**, select the **User password** entry.
4. In the **User password** dialog box, select the **Start password reset process** option.
5. Send the information displayed on the form to SICK support.

✔ You will then receive an activation code.

6. Enter and confirm the activation code in the field provided.

✔ The password of the **Admin** user group is reset to factory settings (SICKSAFE). The **Maintenance** and **Authorized customer** user groups are deactivated. The configuration is not changed.

8.9.3 Configuring the security functions

Overview

The configuration software can be used to activate or deactivate individual functions relating to cybersecurity.

Prerequisites

- You are logged in as administrator.

Procedure

1. In the device window under the main navigation **Service**, select the **Security Capabilities** entry.
2. Select the configuration for the relevant function:
   - **activate**
   - **deactivate**
   - **No specifications**
     The default settings of the device are used.
3. If the device does not support the **deactivate** setting for a function, specify the behavior via the drop-down menu at the bottom.
   - **Ignore setting**
   - **Device error**

8.10 Establishing a connection

Overview

To read a configuration from the device or transfer a configuration to the device, it is necessary to establish a connection between the configuration software and the safety controller.

The connection is established via the SmartPlug.

For CPUc2 only: A connection is also possible via the TCP/IP interface.

Procedure

1. Check whether the safety controller is connected correctly.
2. Click on **Connect** in the toolbar.

✔ The configuration software establishes the connection to the safety controller.

Complementary information

When a connection to the safety controller is established, the configuration software changes to online mode. In online mode, the configuration software displays individual statuses (online monitoring) in the logic editor, e.g., of the inputs and outputs.

8.11 Transferring the configuration

Important information

NOTE
When transmitting the configuration, the protective device's existing configuration may be overwritten.

Prerequisites

- Existing connection between the configuration software and device

Procedure

1. Use one of the following options to check whether a connection to the correct safety controller exists.

- Click on **Identify the device** in the toolbar. The LEDs of the main module light up sequentially.
- Compare the serial number in the configuration software with the type label of the module.

2. Click on **Transfer**.

✔ The transfer process is indicated in the configuration software and on the safety controller.

3. Verify the configuration.

Complementary information

In the configuration software, warnings and errors are displayed at the bottom left under **Tasks**. The configuration must be error-free before transferring.

Further topics

- "Verifying the configuration content and configuration transfer at the same time", page 112

8.12 Verification

Overview

The verification feature is used to confirm that the configuration corresponds to the safety function.

The following verifications are available:

- Verification of the configuration content and the configuration transfer

Important information

WARNING

Ineffectiveness of the protective device due to lack of or incorrect verification

Persons and parts of the body to be protected may not be recognized in case of non-observance.

→ While the configuration content and the configuration transfer have not yet been verified, make sure there no people in the hazardous area. If necessary, implement additional safety measures.

→ Before transferring the configuration, check whether a connection to the correct safety controller exists.

→ Check the verification report carefully before confirming.

→ If the configuration deviates from the safety function or does not fulfill the requirements in the risk assessment, **do not** confirm the verification.

→ Only operate the safety controller as a protective device if the configuration is verified.

Verification of the configuration content and the configuration transfer

This verification is used to check in one step whether the configuration is correct and whether the correct configuration record has been loaded in the device.

Complementary information

- If you change any safety-related parameters of a verified configuration, the status is reset to “Not verified”.
- A continuously lit yellow CV status indicator on the main module, and the device window of the configuration software indicate the “Verified” status.

Further topics

- "Checksums", page 112

8.12.1 Verifying the configuration content and configuration transfer at the same time

Prerequisites

- Existing connection between the configuration software and device

Procedure

1. Check whether a connection to the correct safety controller exists.
2. Click on **Verify** in the toolbar.
3. Check the verification report.
4. If the configuration content is correct, click on **Confirm**.

✔ The configuration content is verified.

Complementary information

- The configuration of connected elements is not part of the safety controller verification. Connected devices must be verified separately where applicable. For information about this, please refer to the operating instructions for the devices in question.

Further topics

- "Checksums", page 112

8.13 Checksums

Checksums

The configuration software displays various checksums in the report and under **Overview**.

Each checksum exists both within the configuration project and in the SmartPlug of the respective safety controller (device). The checksums in the SmartPlug correspond to those checksums in the project that applied when the configuration was last transferred.

Checksums:

- **Checksum of the configuration in the project (function and network)**
- **Checksum of the configuration in the device (function and network)**
  Checksums cover the security configuration and the standard configuration (for each project or device).
- **Relevant to safety**
- **Relevant to safety (device)**
  Checksums cover the security configuration (for each project or device).
- **Not relevant to safety**
- **Not relevant to safety (device)**
  Checksums cover the standard configuration (for each project or device).

Complementary information

Each checksum is 4 bytes long.

The configuration data of the safety configuration are part of the verification report and must be confirmed. Other configuration data are information-only components of the report.

Further topics

- "Offline, online and security configuration", page 37

8.14 Testing safety functions

Overview

You can use this function to test the safety functions of the application.

Prerequisites

The configuration has been transferred to the safety controller.

Procedure

1. Click on  .
✔ The safety controller starts.
2. The safety functions are tested.
3. Click on  .
✔ The safety controller stops.

Complementary information

If the configuration has not been verified, a manual start of the safety controller using the configuration software is required.

9 Commissioning

9.1 Check during commissioning and modifications

The thorough check is intended to ensure that the safety functions are fulfilling their planned purpose and whether persons are being adequately protected.

→ Carry out the checks specified in the test plan of the manufacturer of the machine and the operating entity.

10 Maintenance

10.1 Regular thorough check

The thorough check is intended to ensure that the safety functions are fulfilling their planned purpose and whether persons are being adequately protected.

→ Carry out the checks specified in the test plan of the manufacturer of the machine and the operating entity.

11 Troubleshooting

11.1 Status indicators

Possible indications

Table 123: PWR and CV indications

Display PWR	Display CV	Description	Measures
○	○	No supply voltage	→ Check terminals A1 and A2. → Switch on the supply voltage to the main module.
○	🔆 Yellow (2 Hz)	The device is being reset to factory settings. The memory of the SmartPlug is being erased.	→ Do not disconnect from the voltage supply until the device has been reset to factory settings.
🔆 Red / green (1 Hz)	🔆 Yellow (2 Hz)	Configuration is being transferred to the device. Configuration data are being saved in the SmartPlug.	→ Do not disconnect from the voltage supply until the save process has completed.
🔆 Red / green (1 Hz)	○	Self-test is in progress or the safety controller is being initializing.	
🔆 Green (1 Hz)	see table 124, page 116	Application is ready to run.	→ Press the start button in the configuration software.
🔆 Red / green (1 Hz)	see table 124, page 116	Application is running. A recoverable external error is present at this module.	→ Check the cabling of the flashing inputs and outputs. → Run diagnostics using the configuration software.
● Green	see table 124, page 116	Application is running.	
🔆 Red (1 Hz)	🔆 Yellow (lights up every 2 s)	SmartPlug not inserted or incompatible with this module.	→ Check the version and type of the SmartPlug. → Plug in the SmartPlug.
🔆 Red (1 Hz)	○	Configuration is invalid.	→ Check the module type and version. → Adjust the configuration using the configuration software. → Run diagnostics using the configuration software.
🔆 Red (2 Hz)	○	Critical error in the system, probably in this module. The application was stopped. All outputs of the safety controller are switched off.	→ Switch the supply voltage off and then on again. → Run diagnostics using the configuration software. → If the fault persists, replace the module.
● Red	○	Critical error in the system, probably in another module. The application was stopped. All outputs of the safety controller are switched off.	→ Switch the supply voltage off and then on again. → If the fault persists, replace the module where the PWR 🔆 is showing red (2 Hz). → Run diagnostics using the configuration software.

○ LED off. 🔆 LED flashes. ● LED illuminates.

Table 124: CV indications

Display CV	Description	Measures
○	see table 123, page 116	

Display CV	Description	Measures
● Yellow	Configuration is verified.	
☀ Yellow (1 Hz)	Configuration is not verified.	→ Verify the configuration using the configuration software.
☀ Yellow (2 Hz)	see table 123, page 116	
☀ Yellow (lights up every 2 s)	see table 123, page 116	

○ LED off. ☀ LED flashes. ● LED illuminates.

Table 125: I indications (safety capable input)

Display I	Description	Measures
○	Input is inactive (LOW).	
● Green	Input is active (HIGH).	
☀ Green (1 Hz) in sync with the red PWR indication	Input is inactive (LOW) and a recoverable external error is present.	→ Check cabling of the flashing inputs. A short-circuit to GND or cable break may be present.
☀ Green (1 Hz) in sync with the green PWR indication	Input is active (HIGH) and a recoverable external error is present.	→ Check cabling of the flashing inputs. A short-circuit to 24 V or a cross-circuit to another signal may be present.

○ LED off. ☀ LED flashes. ● LED illuminates.

Table 126: I indications (safety capable input) - Flexi Loop

Display I (Flexi Loop)	Description	Measures
● Green	Flexi Loop safe series connection is in operation.	
☀ Green (1 Hz) in sync with the red PWR indication	Flexi Loop safe series connection is not in operation and a recoverable external error is present.	→ Check cabling of the flashing inputs. → Check the number and type of Flexi Loop nodes. → Adjust the configuration using the configuration software. → Run diagnostics using the configuration software.
☀ Green (1 Hz) in sync with the green PWR indication	Flexi Loop safe series connection is being initialized.	

○ LED off. ☀ LED flashes. ● LED illuminates.

Table 127: Q indications (safety output)

Display Q	Description	Measures
○	Output is inactive (LOW).	
● Green	Output is active (HIGH).	
☀ Green (1 Hz) in sync with the red PWR indication	Output is inactive (LOW) and a recoverable external error is present.	→ Check cabling of the flashing outputs. A short-circuit to GND or a cross-circuit between outputs may be present. → If all indicators of the configured outputs are flashing, check the supply voltage of the A1 and A2 terminals.

Display Q	Description	Measures
☼● Green (1 Hz) in sync with the green PWR indication	Output is active (HIGH) and a recoverable external error is present.	→ Check cabling of the flashing outputs. A short-circuit to 24 V or a cross-circuit between outputs may be present.

○ LED off. ☼● LED flashes. ● LED illuminates.

Table 128: X indications (test output)

Display X	Description	Measures
○	Output is inactive (LOW).	
● Green	Output is active (HIGH).	
☼● Green (1 × flashing every 2 s)	Output is configured as a test output.	
☼● Green (2 × flashing every 2 s)	Output is configured as a Flexi Loop data output (DATA_OUT).	

○ LED off. ☼● LED flashes. ● LED illuminates.

Complementary information

The input and output indicators display the status of the terminals with a refresh rate of approx. 50 ms.

Further topics

- "Status indicators", page 16

11.2 Possible faults

Important information

NOTE
If a fault response can result in an undesired valid status, you should evaluate the associated status bits in the logic to initiate suitable measures.

Faults in the logic

Table 129: Faults in the logic

Fault	Responses	Possible causes
Voltage supply A1 / A2 of the main module is lower than the operating range	• Safety controller switches to the **No supply voltage** status • **Voltage supply** module status bit = 0 • Status indicators are off	• Fault in the voltage supply • Line break • Interruption due to a fuse
Voltage supply of the main module is higher than the operating range	• Safety controller switches to the critical error status • **Internal error** module status bit = 0	• Fault in the voltage supply • Short-circuit to other voltage-carrying line

Faults in the safety inputs (I)

Table 130: Faults in the safety inputs (I)

Fault	Responses	Possible causes
Electro-mechanical switch/safety switch (EMSS), safety sensors with test input, Flexi Loop: Safety input is LOW instead of HIGH	• Process data bit of the affected input = 0	• Short-circuit to another line e.g., GND • Error in the sensor • Line break
Electro-mechanical switch/safety switch (EMSS), safety sensors with test input, Flexi Loop: test pulses from the associated test output X are not detected correctly (short-circuit detection)	• Process data bit of the affected input = 0 • **Status Ix** process data status bit = 0 • Module status bit of the affected **Status Ix** input = 0	• Short-circuit to other voltage-carrying line • Error in the sensor (for externally tested sensors)
Dual-channel electro-mechanical safety switch (EMSS), safety sensors with monitored semiconductor outputs (OSSD): equivalent/complementary safety inputs exhibit different/the same values.	• Process data bit of the affected input = 0 • **Status Ix, Iy dual-channel evaluation** process data status bit = 0 • Module status bit of the affected **Status Ix, Iy dual-channel evaluation** input = 0	• Short-circuit to another line e.g., GND • Error in the sensor • Line break • Exceeding the discrepancy time • Sequence error
Safety pressure mats: safety input is LOW instead of test pulse signal from the associated test output X	• Process data bit of the affected input pair = 0 • **Status Ix** process data status bit = 0 • Module status bit of the affected **Status Ix** input = 0	• Line break Test output → sensor • Line break Sensor → safety input
Safety pressure mats: Only one of the two safety inputs is High instead of test pulse signal from the associated test output X	• Process data bit of the affected input = 0 • **Status Ix, Iy dual-channel evaluation** process data status bit = 0 • Module status bit of the affected **Status Ix, Iy dual-channel evaluation** input = 0	• Short-circuit to other voltage-carrying line
Internal error detected in input evaluation	• Safety controller switches to the critical error status • **Internal error** module status bit = 0	• Internal device error

Faults in the safety outputs (Q)

Table 131: Faults in the safety outputs (Q)

Fault	Responses	Possible causes
Output voltage level is LOW instead of HIGH when the output is "On", overload / overcurrent[1) 2)]	• Associated output/associated output pair is switched off • Depending on the load, the affected output may pulsate temporarily until the final switch-off • **Status Qx short-circuit to Low** process data status bit = 0 • **Status Qx short circuit to Low** module status bit = 0	• Short-circuit or resistance drop under load • Short-circuit to another line e.g., GND

Fault	Responses	Possible causes
Output voltage level is HIGH instead of LOW when the output is "Off"[3]	• All safety outputs of the module are switched off • **Output voltage supply** process data status bit = 0[4]	• Short-circuit to other voltage-carrying line
Test pulses are not detected correctly when the output is “On”[3] [5]	• **Status Qx short-circuit to High** process data status bit = 0 • **Status Qx Short circuit after High** module status bit = 0	• Short-circuit to other voltage-carrying line • Capacitive load too high
Internal error detected	• Safety controller switches to the critical error status • **Internal error** module status bit = 0	• Internal device error • Capacitive load too high

1) Depending on the voltage supply used, an overcurrent can also result in the voltage supply dropping out.

2) Resetting the error: Set the process data bit of the safety output to 0.

3) Reset of the error: the process data bits for all safety outputs of the module are simultaneously 0 and the output level is LOW.

4) In the case of a HIGH instead of a LOW on a safety output, the supply to all safety outputs is switched off internally. If the cause of a short-circuit is in the wiring to 24 V, the affected signal remains HIGH and all other signals switch to LOW.
Check if this is an undesired but valid signal value for the receiver, e.g., for the switching of the monitoring case of a SICK safety laser scanner by means of a complementary signal.

5) Depending on the size of the capacitive load, this may lead in certain cases to an incorrect interpretation as an internal error since the effect on the output voltage is only temporary.

Faults in the test outputs (X)

Table 132: Faults in the test outputs (X)

Fault	Responses	Possible causes
Voltage supply A1 / A2 for the test outputs is lower or higher than the operating range	See voltage supply A1 / A2 of the main module. The test outputs are supplied from the voltage supply of the main module.	
Output voltage level is LOW instead of HIGH when “On”, overload/overcurrent[1]	• Associated output/associated output pair are switched off temporarily (thermal overload limiting). • No status indicator or diagnostic message available for this fault.	• Short-circuit or resistance drop under load • Short-circuit to another line e.g., GND
Output voltage level is HIGH instead of LOW when “Off”	• No status indicator or diagnostic message available for this fault.	• Short-circuit to other voltage-carrying line

1) Depending on the voltage supply used, an overcurrent can also result in the voltage supply dropping out.

Critical error status

Consequences of the critical error status:

- All applications are stopped.
- All safety outputs are switched off.
- All process data = 0
- Evaluation of the process data status bits in the logic is no longer possible.
- Only limited diagnostics can be performed in the critical error status.

Alternatives to resetting the critical error status:

- Restart by switching the voltage supply off and on again
- Software reset using the configuration software

Complementary information

The status indicators and diagnostic messages may provide additional information.

Further topics

- "Status indicators", page 116
- "Input elements", page 41
- "Diagnostics using Safety Designer", page 121

11.3 Diagnostics using Safety Designer

Prerequisites

- The safety controller must be connected to Safety Designer.

Diagnostics area

The main navigation menu has a **Diagnostics** area. This area contains the following functions:

- **Diagnostic bits**: Displays all messages, information, warnings, and error messages of the safety controller.

11.3.1 Message history

Message history

Table 133: Information on the message history

Keyword	Description
Type	Error type (e.g., information, warning, recoverable error, serious error)
Occurrence	Operating time between when the main module was last switched on and when the error occurred (power-on cycles of the main module/days:hours:minutes:seconds)
Local time of occurrence	Time when the error occurred (system time of the computer). This value is not displayed for historical errors.
Site	Module position and type code of the module that detected the error
Error code	Hexadecimal error code
Support info	Internal information about the error
Message	Description of the fault that occurred
Acknowledged	The error has been marked as viewed
Reason	Detailed information on the cause of the error
Solution	Suggested solution for eliminating the error

Complementary information

Clicking an entry in the list selects that entry and displays the details of the selected message.

The diagnostic messages are also included in the report. You can use the report to save or print out the diagnostic messages.

Further topics

- "Report main navigation menu", page 109

12 Decommissioning

12.1 Disposal

Procedure

→ Always dispose of unusable devices in accordance with national waste disposal regulations.

Complementary information

SICK will be glad to help you dispose of these devices on request.

13 Technical data

13.1 Data sheet

Safety-related parameters

Table 134: Safety-related characteristic data - safety capable inputs (I)

	Safety capable inputs (I)			
	Single-channel		Dual channel	
	Without test pulses[1]	With test pulses	Without test pulses[2]	With test pulses
Safety integrity level (IEC 61508)	SIL 2	SIL 3	SIL 3	SIL 3
Safety integrity level (IEC 62061)	SIL 2	SIL 3	SIL 3	SIL 3
Cate-gory (ISO 13849)	Category 3	Category 4	Category 4	Category 4
Performance level (ISO 13849)	PL d	PL e	PL e	PL e
PFH_D (h^{-1})	1×10^{-9}	1×10^{-9}	0.5×10^{-9}	0.5×10^{-9}
PFD_{avg}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}
$MTTF_D$ (ISO 13849-1) for one channel [years]	500	500	500	500
T_M (mission time) (ISO 13849) [years]	20	20	20	20

1) If you are using single-channel safety inputs (I) without test pulses for a safety-related application, then a protected or separate cabling is required for these safety inputs in order to achieve the safety-related characteristics. Reason: Short-circuits to the supply voltage or cross-circuits are not detected.

2) If you are using dual-channel safety capable inputs (I) without test pulses, the safety function must be requested at least once a year.

Table 135: Safety-related characteristic data - CPU logic processing

	CPU logic processing
Safety integrity level (IEC 61508)	SIL 3
Safety integrity level (IEC 62061)	SIL 3
Category (ISO 13849)	Category 4
Performance level (ISO 13849)	PL e
PFH_D (h^{-1})	3×10^{-9}
PFD_{avg}	20×10^{-5}
$MTTF_D$ (ISO 13849-1) for one channel [years]	500
T_M (mission time) (ISO 13849) [years]	20

Table 136: Safety-related characteristic data - safety outputs (Q)

	Safety outputs (Q)			
	Single-channel[1]		Dual channel	
	Without test pulses[2] [3]	With test pulses	Without test pulses[2] [3]	With test pulses
Safety integrity level (IEC 61508)	SIL 3	SIL 3	SIL 3	SIL 3
Safety integrity level (IEC 62061)	SIL 3	SIL 3	SIL 3	SIL 3

	Safety outputs (Q)			
	Single-channel[1]		Dual channel	
	Without test pulses[2] [3]	With test pulses	Without test pulses[2] [3]	With test pulses
Category (ISO 13849)				
With test pulses on all safety outputs of a module		Category 4		Category 4
Without test pulses on one or more safety outputs of a module	Category 3	Category 3	Category 4	Category 4
Performance level (ISO 13849)	PL e	PL e	PL e	PL e
PFH_D (h^{-1})	5×10^{-9}	0.5×10^{-9}	5×10^{-9}	0.5×10^{-9}
PFD_{avg}	30×10^{-5}	4×10^{-5}	30×10^{-5}	4×10^{-5}
$MTTF_D$ (ISO 13849-1) for one channel [years]	500	500	500	500
T_M (mission time) (ISO 13849) [years]	20	20	20	20

1) If you are using single-channel safety outputs (Q) for a safety-related application, then a protected or separate cabling is required for these safety outputs in order to achieve the safety-related characteristics. Reason: While short-circuits to the supply voltage or cross-circuits to other outputs can be detected, no other option to switch-off the device exist.

2) If you are using single-channel or dual-channel safety outputs (Q) without test pulses, then a protected or separate cabling is required for these safety outputs in order to achieve the safety-related characteristics. Reason: Short-circuits to the supply voltage or cross-circuits to other outputs are not detected in the switched-on state without test pulses.
This also applies if an output is used for a non-safety related application. Reason: Even if an internal hardware error is detected, the switch-off capability of the other safety outputs may be impaired by reverse currents.

3) If you are using single-channel/dual-channel safety outputs (Q) without test pulses for a safety-related application, then one of the following measures is required in order to achieve the safety-related characteristics:
- Restart the safety controller once a year.
- Switch off all safety outputs simultaneously for min. 2 s once a year. This can be done by means of an explicit test or if this is ensured by the normal process flow. The supply voltage of the outputs must be within the operating range.

Ambient data

Table 137: Ambient data

Enclosure rating (IEC 60529)	IP20 [1]
Pollution degree (IEC 61010-1)	2 (IEC 61010-1)
Ambient operating temperature	
At altitudes up to 2,000 m above sea level	–25 °C ... +55 °C
At altitudes up to 2,000 m above sea level ... 3,000 m above sea level	–25 °C ... +50 °C
At altitudes 3,000 m above sea level ... 4,000 m above sea level	–25 °C ... +45 °C
Storage temperature	–25 °C ... +70 °C

Air humidity	≤ 95%, non-condensing
Operating altitude	Max. 4,000 m above sea level
Vibration resistance	5 Hz ... 200 Hz / 1 g (EN 60068-2-6)
Shock resistance, single shock	15 g, 11 ms (EN 60068-2-27)
Operating data	
Protection class (IEC 61140)	III
Immunity to interference	EN 61000-6-2
Emitted interference	EN 61000-6-4

1) Prerequisite: The front plug is mounted.

Mechanical data

Table 138: Mechanical data

Control device type	Open equipment (IEC 61010-2-201)
Weight (± 5%)	CPUc1: 277 g CPUc2: 282 g

1) Prerequisite: The front plug is mounted.

Electrical data

Table 139: Operating data

Protection class (IEC 61140)	III
Immunity to interference	EN 61000-6-2
Emitted interference	EN 61000-6-4
Connections	
Connection type	Spring terminals CPUc2: RJ45 socket
Wire cross-section	Single wire or fine-stranded wire: 0.14 mm² ... 1.5 mm² Fine-stranded wire with ferrule: a) with plastic ferrule max. 1.0 mm² b) without plastic ferrule max. 1.0 mm² AWG according to UL/CSA: 26 ... 14 For UL and CSA applications: Use copper conductors only min. rated for 85°C.
Network cable requirements	• Type: 100Base-TX • Cables with RJ45 connections • Twisted pair Ethernet cable, maximum length 100 m in accordance with EN 50173 • Use of wire pairs 1/2 and 3/6 • Shielded cables • Cat 5 STP or higher

Voltage supply (A1 / A2)

Table 140: Voltage supply

Supply voltage U_B	+24 V DC
Tolerance of supply voltage	–30% / +25% (16.8 V ... 30 V)
Type of supply voltage	PELV or SELV The supply current must be limited externally to max. 8 A – either by the voltage supply unit used, or by means of a fuse.
Power loss	CPUc1: Max. 6.2 W CPUc2: Max. 6.3 W
Current consumption at nominal voltage (without outputs)	125 mA

Short-circuit protection[1]	Max. 8 A/Min. 30 V Safety fuse with triggering characteristic: slow-blow UL/CSA applications: UL-listed fuse according to UL 248-14 required
Overvoltage category	II (EN 61131-2)
Power-up delay	20 s
Type of terminal connections	Spring terminals

1) Take into account the following when designing the voltage supply for the safety controller:
- Current consumption at nominal voltage (without outputs) of all station modules
- Peak current consumption of all electric consumers connected via the safety controller outputs

The maximum permissible supply current depends, among other things, on the ambient temperature and must not exceed the permissible value of 8 A (Ta = 55 °C).
Take into consideration the effect of lack of ventilation or the power loss in the cabling or other devices on the ambient temperature in the control cabinet.

Safety capable inputs (I)

Table 141: Technical data for the safety capable inputs (I)

Input voltage HIGH	11 V DC ... 30 V DC (according to EN 61131-2 Type 3)
Input voltage LOW	–3 V DC ... +5 V DC (according to EN 61131-2 Type 3)
Max. input voltage range [1]	–60 V DC ... +60 V DC
Input current HIGH	2.1 mA ... 6 mA
Input current LOW	≤ 1.9 mA
Reverse current at input in case of loss of ground connection[2]	≤ 100 µA
Input capacitance	15 nF
Discrepancy time	4 ms ... 30 s, configurable
Input elements **Safety sensors with monitored semiconductor output (OSSD)**	
Test pulse width	Max. 1 ms
Test pulse interval	Min. 1.5 ms

1) No damage to the input in this voltage range.
2) Do not connect any other safety capable inputs in parallel if the reverse current could lead to a High state on the other input.

Test outputs (X) used with safety capable inputs

Table 142: Technical data for the test outputs (X) when used with safety capable inputs

Type of output	Push-pull semiconductor, short-circuit protected, cross-circuit monitored
Output voltage HIGH	U_B –3 V DC ... U_B
Output voltage LOW	0 V DC ... 3 V DC
Output current HIGH	≤ 100 mA
Leakage current LOW	≤ 0.1 mA
Output resistance LOW [1]	≥ 25 Ω
Test pulse width	2 ms ... 100 ms, configurable
Test pulse interval	8 ms ... 1,000 ms, configurable
Load capacity	
@ 2 ms test pulse width	≤ 0.5 µF
@ ≥ 4 ms test pulse width	≤ 1 µF
Inductive load at nominal voltage @ 100 mA	1,000 mH

1) The output current is actively limited.

Test outputs (X) used as non-safe outputs

Table 143: Technical data when using test outputs (X) as non-safe outputs (PNP or NPN)

Type of output	Push-pull semiconductor, short-circuit protected
Output voltage HIGH	U_B –3 V DC ... U_B
Output voltage LOW	0 V DC ... 3 V DC
Maximum output current when used as a PNP output	100 mA
Maximum output current when used as a NPN output	–15 mA
Leakage current LOW	≤ 0.1 mA
Inductive load at nominal voltage [1] @ 100 mA	1,000 mH
Load capacity	1,000 µF

1) Only permissible if used as a PNP output.

Safety outputs (Q)

Table 144: Technical data for the safety outputs (Q)

Type of output	PNP semiconductor, short-circuit protected
Output voltage HIGH	U_B –3 V DC ... U_B
Output voltage LOW [1]	–50 V DC ... –30 V DC
Maximum reverse voltage at Low [2]	3 V DC
Leakage current LOW	
Normal operation	< 1 mA
Dual channel	< 2 mA
Fault [3]	< 1 mA
Output current	Max. 2 A
Sum current I_{sum}	
T_U ≤ 55 °C	4 A
Test pulse width[4]	< 650 µs or deactivated
Test pulse interval	≥ 190 ms
Cross-circuit detection using test pulses[5]	
Conductor resistance	Max. 2.5 Ω (z. B. 100 m × 1.5 mm² = 1.2 Ω)
Output current, dual-channel outputs	Max. 1 A per output
Load capacity	≤ 0.5 µF
Load capacity when connected via diode	≤ 1,000 µF
Inductive load at nominal voltage	
@2 A	100 mH
@1 A	1.6 H

@0.5 A	20 H

1) Max. –30 V DC, to avoid damaging the output.
Max. –50 V DC, for fast switch-off of inductive loads.
2) Higher voltages are evaluated as a cross-circuit fault
3) In the event of a fault (GND line open circuit) and with a load resistance of at least 2.5 kΩ, no more than the specified leakage current flows on the safety output. For lower load resistances, the leakage current may be greater however the output voltage will be < 5 V in this case. A downstream device, for example a relay or a FPLC (fail-safe programmable logic controller) must detect this state as Low.
4) When activated, the outputs are tested regularly (brief switching to Low). When selecting the downstream control elements, ensure that the test pulses with the specified parameters do not result in a switch-off, or deactivate the test pulses on the outputs yourself.
5) Safety outputs (Q) with test pulses only detect cross-circuits reliably (i.e. already in the switched-on state and not just after a switch-off) if these values for the supply cable and the connected control element are not exceeded. Otherwise further measures will be required, for example protected or separate cabling. (See also EN 60204 Electrical equipment of machines, Part 1: General requirements.)

Communication interfaces

Table 145: Communication interfaces

Physical interfaces	• USB (Micro USB) • SmartPlug • RJ45 socket (Ethernet, Modbus® TCP, SLMP) • Backplane bus (proprietary interface on the side of the module)

Network interface of the main module

Table 146: Network interface of the main module (CPUc2)

Interface	Modbus® TCP SLMP
Connection type	1 × RJ45 female connector
Transmission rate	10 Mbit/s (10 Base-T) or 100 Mbit/s (100 Base-TX), auto-sensing
Default settings for addressing	IP address: 0.0.0.0 Subnet mask: 0.0.0.0 Default gateway: 0.0.0.0 DHCP: enabled
MAC address	Printed on the type label, e.g.: 00:06:77:02:00:A7

13.2 Maximum response time

Safety controller response times

The response time of a function depends on the hardware and software configuration of the safety controller. You need to take all factors into account when calculating the response time and consider all signal paths separately.

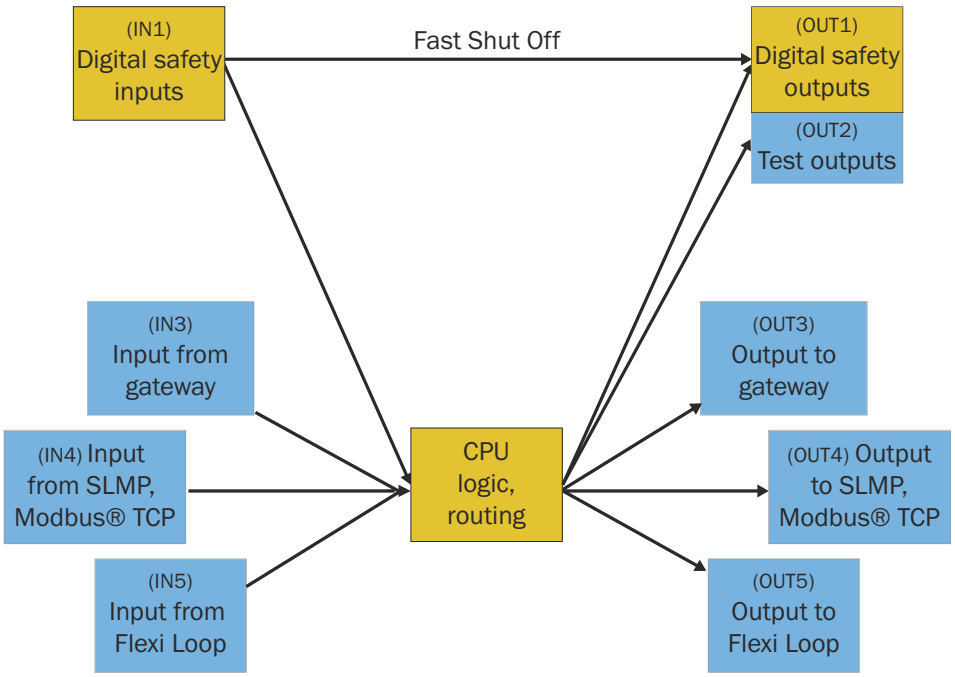


Figure 44: Safety controller response times

Complementary information

The Fast Shut Off function only has an effect on the inputs and outputs of the same module. Response times of 4.5 ms can be achieved using fast shut off.

13.2.1 Calculating the response time

Overview

Each signal path requires a separate calculation of the response time.

Important information

NOTE
The calculation applies exclusively to the safety controller. You need to separately consider the response times of sensors, actuators and communication partners via network/fieldbus.

Procedure

→ Use the following table to calculate the response time of the connected signal paths of the safety controller.

Table 147: Calculating the maximum response time

Components of the calculation	Description		Value [ms]
1. Inputs	Response time of the observed input in the signal path	IN1, IN3, IN4 or IN5 • "IN1 - Response time of safety inputs (I)", page 130 • "IN3 ... IN5 - Response time for processing of incoming process data", page 130	

Components of the calculation	Description		Value [ms]
2. Logic	a) Response time of the main module logic	2 × logic execution time Take the value from the report in the configuration software.	
		Delay time due to logic application (e.g. switch-on delay or switch-off delay function block) Take the value from the report in the configuration software.	
	b) Response time of the routing [1]	For OUT3 output to the gateway only Delay time: 8 ms	
	c) Response time of the fast shut off logic	No delay time	
3. Outputs	Response time of the observed output in the signal path	OUT1, OUT2, OUT3, OUT4 or OUT5 • "OUT1 - Response time of safety outputs (Q)", page 131 • "OUT2 - Response time of test outputs (X)", page 131 • "OUT3 ... OUT5 - Response time for processing of outgoing process data", page 131	
Total			

1) Direct routing of input data occurs in the gateway configuration under “Routing to network” on the “Input data” tab. This response time path is independent of the processing time of the main module logic.

IN1 - Response time of safety inputs (I)

Table 148: IN1 - Response time of safety inputs (I)

When relevant?	Description/Value
Always	Input processing time: 3 ms
ON-OFF debounce filter is configured.	Min. debounce filter time Take the value from the report in the configuration software.
Input element is connected to a test output (X).	Max. tolerated test pulse delay Take the value from the report in the configuration software.
Input element is connected to a test output (X).	• For safety sensors with a test input or Flexi Loop: Test pulse interval of the test output • For safety pressure mats: Longer test pulse interval of the two test outputs • For electro-mechanical switch/safety switch (EMSS): Test pulse width of the test output

IN3 ... IN5 - Response time for processing of incoming process data

Table 149: IN3 ... IN5 - Response time for processing of incoming process data

When relevant?		Description/Value
IN3	Gateway is used (excluding EtherNet/IP targets)	Response time via network [1] + 6 ms
IN3	Gateway with EtherNet/IP target is used. [2]	Response time via network [2] + 10 ms
IN4	When using Modbus® TCP or SLMP.	Response time via network [1] + 38 ms

When relevant?		Description/Value
IN5	When using Flexi Loop on the expansion module (diagnostic data).	Response time from Flexi Loop + 108 ms

1) The response time via network depends on the settings of the associated communication partner. It can be obtained from the configuration software or operating instructions of that communication partner.

2) The response time via network (RPI, number of lost packets, etc.) depends on the settings of the associated connections. If can be obtained from the connection configuration of the EtherNet/IP originator for the respective connection.

OUT1 - Response time of safety outputs (Q)

Table 150: OUT1 - Response time of safety outputs (Q)

When relevant?	Description/Value
When using single-channel safety output Q.	**Potential switch-off delay in the event of a fault** [1]**:** • **Increased capacitive loads allowed** = deactivated: 5 ms • **Increased capacitive loads allowed** = activated: 50 ms
When using dual-channel safety output Q.	**For one or both safety outputs:** • 1 ms **A potential switch-off delay in the event of a fault applies to the second safety output** [1]**:** • **Increased capacitive loads allowed** = deactivated: 5 ms • **Increased capacitive loads allowed** = activated: 50 ms
Fast shut off is used.	0.5 ms

1) If switch-off occurs, a single safety output (Q) may be switched on rather than switched off for this time in the event of an internal hardware error. An undesired switch-on can also occur in the switched off state and is limited to 5 ms by a fault switch-off. Ensure, in particular for single-channel safety outputs, that the resultant pulse does not result in a safety-critical state of the system.

OUT2 - Response time of test outputs (X)

Table 151: OUT2 - Response time of test outputs (X)

When relevant?	Description/Value
Always	1 ms

OUT3 ... OUT5 - Response time for processing of outgoing process data

Table 152: OUT3 ... OUT5 - Response time for processing of outgoing process data

When relevant?		Description/Value
OUT3	Gateway is used (excluding EtherNet/IP targets)	Response time via network [1] + 5 ms
OUT3	Gateway with EtherNet/IP target is used.	Response time via network [2] + 6 ms
OUT4	When using Modbus® TCP or SLMP.	Response time via network [2] + 37 ms

When relevant?		Description/Value
OUT5	When using Flexi Loop on the expansion module (service data).	Response time from Flexi Loop + 111 ms

1) The response time via network depends on the settings of the associated communication partner. It can be obtained from the configuration software or operating instructions of that communication partner.

2) The response time via network (RPI, number of lost packets, etc.) depends on the settings of the associated connections. If can be obtained from the connection configuration of the EtherNet/IP originator for the respective connection.

Complementary information

When muting function blocks are used, a temporal inaccuracy of 10 ms also applies. This inaccuracy is in addition to the logic processing time.

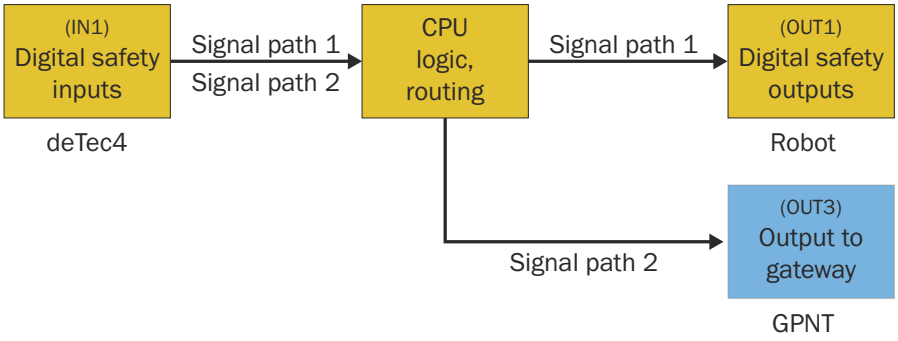
Further topics

- "Report main navigation menu", page 109
- "Input elements", page 41
- "Configuration options for input elements", page 42

13.2.2 Example response time calculation

Overview

The example calculation includes 2 signal paths. Each signal path needs to be considered separately in the calculation.



Response time of signal path 1

Table 153: IN1 – Response time of safety capable inputs (I)

When relevant?	Description	Value [ms]
Always	Input processing time	3
ON-OFF debounce filter is configured.	Min. debounce filter time Take the value from the report in the configuration software.	–
Input element is connected to a test output (X).	Max. tolerated test pulse delay Take the value from the report in the configuration software.	–
Input element is connected to a test output (X).	• For safety sensors with a test input or Flexi Loop: Test pulse interval of the test output • For safety pressure mats: Longer test pulse interval of the two test outputs • For electro-mechanical switch/safety switch (EMSS): Test pulse width of the test output	–
Total		3

Table 154: OUT1 – Response time of safety outputs (Q)

When relevant?	Description	Value [ms]
When using single-channel safety output Q.	**Potential switch-off delay in the event of a fault** [1]**:** • **Increased capacitive loads allowed** = deactivated: 5 ms • With the **Increased capacitive loads allowed** option = activated: 50 ms	–
When using dual-channel safety output Q.	**For one or both safety outputs:** • 1 ms **A potential switch-off delay in the event of a fault applies to the second safety output** [1]**:** • **Increased capacitive loads allowed** = deactivated: 5 ms • **Increased capacitive loads allowed** = activated: 50 ms	1
Fast shut off is used.	0.5 ms	–
Total		1

1) If switch-off occurs, a single safety output (Q) may be switched on rather than switched off for this time in the event of an internal hardware error. An undesired switch-on can also occur in the switched off state and is limited to 5 ms by a fault switch-off. Ensure, in particular for single-channel safety outputs, that the resultant pulse does not result in a safety-critical state of the system.

Table 155: Calculating the maximum response time – signal path 1

Components of the calculation	Description		Value [ms]
1. Inputs	Response time of the observed input in the signal path	IN1 • see table 153, page 132	3
2. Logic	a) Response time of the main module logic	2 × logic execution time Take the value from the report in the configuration software.	8
		Delay due to logic application (e.g. switch-on delay or switch-off delay function block) Take the value from the report in the configuration software.	
	b) Response time of the routing	For OUT3 output to the gateway only No delay time	0
	c) Response time of the fast shut off logic	No delay time	0
3. Outputs	Response time of the observed output in the signal path	OUT1, OUT2, OUT3, OUT4 or OUT5 • see table 154, page 133	1
Total			12

Response time of signal path 2

Table 156: IN1 – Response time of safety capable inputs (I)

When relevant?	Description	Value [ms]
Always	Input processing time	3
ON-OFF debounce filter is configured.	Min. debounce filter time Take the value from the report in the configuration software.	–
Input element is connected to a test output (X).	Max. tolerated test pulse delay Take the value from the report in the configuration software.	–

When relevant?	Description	Value [ms]
Input element is connected to a test output (X).	• For safety sensors with a test input or Flexi Loop: Test pulse interval of the test output • For safety pressure mats: Longer test pulse interval of the two test outputs • For electro-mechanical switch/safety switch (EMSS): Test pulse width of the test output	–
Total		3

Table 157: OUT3 ... OUT5 - Response time for processing of outgoing process data

When relevant?		Description	Value [ms]
OUT3	When using a gateway.	5 ms	5
OUT4	When using Modbus® TCP or SLMP.	37 ms	–
OUT5	When using Flexi Loop on the expansion module (service data).	111 ms	–
Total			5

Table 158: Calculating the maximum response time – signal path 2

Components of the calculation	Description		Value [ms]
1. Inputs	Response time of the observed input in the signal path	IN1, IN3, IN4 or IN5 • see table 156, page 133	3
2. Logic	a) Response time of the main module logic	2 × logic execution time Take the value from the report in the configuration software.	8
		Delay due to logic application (e.g. switch-on delay or switch-off delay function block) Take the value from the report in the configuration software.	
	b) Response time of the routing	For OUT3 output to the gateway only No delay time	0
	c) Response time of the fast shut off logic	No delay time	0
3. Outputs	Response time of the observed output in the signal path	OUT1, OUT2, OUT3, OUT4 or OUT5 • see table 157, page 134	5
Total			16

Further topics

- "Report main navigation menu", page 109
- "Input elements", page 41

13.3 Network services and protocols

Table 159: Network services and protocols

Service and protocol	Purpose	Communication partner	Direction	Interface	TCP or UDP	Port (product)	Port (partner)	Factory setting
CoLa 2	Configuration and diagnostics, SICK developed protocol	Client, e.g., computer with the Safety Designer configuration software	Bidirectional	RJ45 socket (Ethernet)	TCP	2122	Randomly selected	Activated
CoLa 2	Device search, SICK developed protocol	Client, e.g., computer with the Safety Designer configuration software	Bidirectional	RJ45 socket (Ethernet)	UDP	30718	Randomly selected	Activated
EtherCAT (PDO) (Master)	Communication between main module and extension module	Extension module	Bidirectional	Backplane bus (proprietary interface on the side of the module)	–	–	–	Activated
EtherCAT (SDO) (Master)	Communication between main module and extension module	Extension module	Bidirectional	Backplane bus (proprietary interface on the side of the module)	–	–	–	Activated
Modbus TCP	Exchange of process and diagnostic data	Network device, e.g. industrial PC, PLC, HMI device	Incoming	RJ45 socket (Ethernet)	TCP	502	Randomly selected	Deactivated
SLMP	Device search	Client, e.g. computer with SLMP software	Incoming	RJ45 socket (Ethernet)	UDP	45237	Randomly selected	Deactivated
SLMP	Exchange of process and diagnostic data	Network device, e.g. industrial PC, PLC, HMI device	Incoming	RJ45 socket (Ethernet)	TCP	Configurable Default setting: 3000	Randomly selected	Deactivated
SLMP	Exchange of process and diagnostic data	Network device, e.g. industrial PC, PLC, HMI device	Incoming	RJ45 socket (Ethernet)	UDP	Configurable Default setting: 3000	Randomly selected	Deactivated

The list of network services and protocols of the product is to the best of our knowledge complete. No network service or protocol has been deliberately left out.

13.4 Data exchange in the network

13.4.1 Modbus® TCP

Overview

The safety controller supports a Modbus® TCP server without a safety protocol.

Important information

NOTE

- The safety controller supports only the querying and writing of whole memory blocks. Individual items of information must be extracted from the overall information.
- The PDUs (Protocol Data Units) are limited to 256 bytes (252 bytes of user data). Large information fields, for example the safety controller configuration, are therefore spread across multiple messages.
- Modbus® TCP transmits the data in big endian format. The data is organized into 16-bit words and can only be addressed as words.
- The main module processes data internally in little endian format. The sequence of bytes may need to be adjusted when assigning the process data on a byte-wise basis.
- The consistency of the data while being processed in the logic is only ensured for Modbus® TCP input data that is transmitted to the main module together in a single request.

Supported commands

- 03 (0x03) Read holding registers
- 04 (0x04) Read input registers
- 06 (0x06) Write single holding register (for address 356 only: Find Me function can be used)
- 16 (0x10) Write multiple holding registers

Memory spaces

The safety controller provides a memory space with input registers and internal registers as an interface to external Modbus® TCP controllers.

Structure of the readable input register (Modbus® TCP input register):

- Memory space from 0 – Device Identify Information
- Memory space from 256 – Results
- Memory space from 2,000 – Status

Structure of the readable and writable register (Modbus® TCP holding register):

- Memory space from 256 – Commands

Complementary information

The main module (CPUc2) terminates the connection to the Modbus® client (higher-level controller) after 120 seconds if no data exchange takes place.

13.4.1.1 Modbus® TCP input register

13.4.1.1.1 Device

Table 160: Modbus® TCP – Device identification

Address	Contents	Data type	Size	Description
0	Manufacturer name	STRING	4 words (8 bytes)	SICK AG
(4)	Product code	STRING	4 words (8 bytes)	SICK part number
(8)	MajorMinorRevision	STRING	6 words (12 bytes)	Firmware version
(14)	Manufacturer URL	STRING	6 words (12 bytes)	www.sick.com

Address	Contents	Data type	Size	Description
(20)	Product name	STRING	16 words (32 bytes)	Product name, e.g., Flexi Compact CPUc2
(36)	Model name	STRING	9 words (18 bytes)	Type code
(45)	Serial number	STRING	4 words (8 bytes)	Serial number of the module
(49)	Application name	STRING	16 words (32 bytes)	Application name entered in the configuration software
(65)	Modbus® TCP profile version	STRING	6 words (12 bytes)	Version, e.g., 1.0.0

13.4.1.1.2 Result

Table 161: Modbus® TCP – Input data

Address	Contents	Size	Description
256	Input values	1 word (2 bytes)	Is determined by the configuration in the configuration software.
...		1 word (2 bytes)	
280		1 word (2 bytes)	

13.4.1.1.3 Status

Table 162: Modbus® TCP – Checksums, status information and metadata

Address	Contents	Data type	Size
2000	Device status see table 163, page 138	UINT	1 word (2 bytes, MSB always 0)
2001	Required user action see table 164, page 138	UINT	1 word (2 bytes)
2002	Overall checksum value	UINT	2 words (4 bytes)
2004	Safety checksum	UINT	2 words (4 bytes)
2006	Standard checksum	UINT	2 words (4 bytes)
2008	Reserved	UINT	2 words (4 bytes)
2010	Verification checksum	UINT	2 words (4 bytes)
2020	Product codes 1 x CPU 1 x SmartPlug 16 x expansion modules see table 165, page 138	UINT	36 words (72 bytes)
2300[1)]	Module status 4 x CPU status info see table 166, page 138 16 x module status info see table 167, page 139 see table 168, page 139 see table 169, page 140	BYTE	80 words (160 bytes)
3000	Device name	STRING	32 words (64 bytes)
3032	Project name	STRING	32 words (64 bytes)
3064	Application name	STRING	32 words (64 bytes)
3096	User name	STRING	32 words (64 bytes)
3128	Description	STRING	50 words (100 bytes)

1) The first 32 bytes contain the module status information of the CPU. This is followed by 8 byes each for the module status information of the expansion modules. The order depends on the hardware configuration. The content depends on the type of expansion module.

Description of the device status

Table 163: Device status

Value	Device status	Description
0	Unknown State	No supply voltage
1	Start-up	Self-test is in progress or the safety controller is being initializing.
2	Service Mode	Configuration is being transferred to the device. Configuration data are being saved in the SmartPlug.
3	Normal Operation	Application is running.
4	Suspended Operation	Application is ready to run.
6	Service Required	• SmartPlug not inserted or incompatible with this module. • Configuration is invalid.
7	Recoverable Error	Application is running. A recoverable external error is present at this module.
8	Fatal error	The application was stopped. All outputs of the safety controller are switched off.

Description of the required user actions

Table 164: Required user action

Bit	Required user action
0x00 01	Confirm configuration
0x00 02	Check configuration
0x00 08	Check application interface
0x00 10	Checking the device
0x00 20	Perform set-up procedure
0x00 40	Checking the firmware
0x00 80	Waiting

Description of the product codes

Product codes are 4-byte coded device type codes.

Table 165: Product codes

Product codes	Description
0x30 01 00 00	CPUc1 main module
0x31 01 00 00	CPUc2 main module
0x00 05 00 00	Gateway EtherCAT® extension module
0x00 06 00 00	PROFINET gateway expansion module
0x00 07 00 00	CANopen gateway expansion module
0x30 0B 00 00	XTDI IO expansion module
0x30 0C 00 00	XTDO IO expansion module
0x30 FF 00 00	SmartPlug

Module status bits for main module

Table 166: Module status bits for main module

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Reserved	Voltage supply	Configuration is valid	Reserved	External error	Internal error	operational status 1 = Run 0 = Other
Byte 1 ... 3	Reserved							

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 4	User-defined status bit 7 (CPU logic)	User-defined status bit 6 (CPU logic)	User-defined status bit 5 (CPU logic)	User-defined status bit 4 (CPU logic)	User-defined status bit 3 (CPU logic)	User-defined status bit 2 (CPU logic)	User-defined status bit 1 (CPU logic)	User-defined status bit 0 (CPU logic)
Byte 5	User-defined status bit 15 (CPU logic)	User-defined status bit 14 (CPU logic)	User-defined status bit 13 (CPU logic)	User-defined status bit 12 (CPU logic)	User-defined status bit 11 (CPU logic)	User-defined status bit 10 (CPU logic)	User-defined status bit 9 (CPU logic)	User-defined status bit 8 (CPU logic)
Byte 6 ... 7	Reserved							
Byte 8	Reserved	Fast shut off status (all grouped)	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Byte 9	Reserved	Reserved	Reserved	Reserved	Status I7, I8 Dual-channel evaluation	Status I5, I6 Dual-channel evaluation	Status I3, I4 Dual-channel evaluation	Status I1, I2 Dual-channel evaluation
Byte 10	Status I8	Status I7	Status I6	Status I5	Status I4	Status I3	Status I2	Status I1
Byte 11	Status Q4 Short-circuit to LOW	Status Q4 Short-circuit to HIGH	Status Q3 Short-circuit to LOW	Status Q3 Short-circuit to HIGH	Status Q2 Short-circuit to LOW	Status Q2 Short-circuit to HIGH	Status Q1 Short-circuit to LOW	Status Q1 Short-circuit to HIGH
Byte 12 ... 16	Reserved							
Byte 17	Reserved	Reserved	Reserved	Reserved	Status I15, I16 Dual-channel evaluation	Status I13, I14 Dual-channel evaluation	Status I11, I12 Dual-channel evaluation	Status I9, I10 Dual-channel evaluation
Byte 18	Status I16	Status I15	Status I14	Status I13	Status I12	Status I11	Status I10	Status I9
Byte 19 ... 24	Reserved							
Byte 25	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Status I19, I20 Dual-channel evaluation	Status I17, I18 Dual-channel evaluation
Byte 26	Reserved	Reserved	Reserved	Reserved	Status I20	Status I19	Status I18	Status I17
Byte 27 ... 31	Reserved							

Module status bits for XTDI

Table 167: Module status bits for XTDI

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved					External error	Reserved	
Byte 1	Reserved				Status I7, I8 Dual-channel evaluation	Status I5, I6 Dual-channel evaluation	Status I3, I4 Dual-channel evaluation	Status I1, I2 Dual-channel evaluation
Byte 2	Status I8	Status I7	Status I6	Status I5	Status I4	Status I3	Status I2	Status I1
Byte 3 ... 7	Reserved							

Module status bits for XTDO

Table 168: Module status bits for XTDO

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Fast shut off status (all grouped)	Auxiliary voltage supply	Reserved		External error	Reserved	

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Reserved				Status I7, I8 Dual-channel evaluation	Status I5, I6 Dual-channel evaluation	Status I3, I4 Dual-channel evaluation	Status I1, I2 Dual-channel evaluation
Byte 2	Status I8	Status I7	Status I6	Status I5	Status I4	Status I3	Status I2	Status I1
Byte 3	Status Q4 Short-circuit to LOW	Status Q4 Short-circuit to HIGH	Status Q3 Short-circuit to LOW	Status Q3 Short-circuit to HIGH	Status Q2 Short-circuit to LOW	Status Q2 Short-circuit to HIGH	Status Q1 Short-circuit to LOW	Status Q1 Short-circuit to HIGH
Byte 4 ... 6	Reserved							
Byte 7	Status Q8 Short-circuit to LOW	Status Q8 Short-circuit to HIGH	Status Q7 Short-circuit to LOW	Status Q7 Short-circuit to HIGH	Status Q6 Short-circuit to LOW	Status Q6 Short-circuit to HIGH	Status Q5 Short-circuit to LOW	Status Q5 Short-circuit to HIGH

Module status bits for gateway

Table 169: PROFINET gateway module status bits

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Data valid Gateway → network	Data valid Network → Gateway	Reserved		External error	Reserved	
Byte 1	Reserved	Matching submodule selection	Status of process data transmission[1]	Reserved				
Byte 2 ... 3	Reserved							
Byte 4	Reserved				Socket 4 client status	Socket 3 client status	Socket 2 client status	Socket 1 client status
Byte 5 ... 7	Reserved							

1) PROFINET: If a configured connection cannot be established after 90 s, the **Status of process data transmission** bit = 0.
TCP socket interface (gateway as client): If a configured connection cannot be established after 60 s, the **Socket X Client Status** bit = 0. The **Socket X Client Status** bit is also 0 if an already established client connection is terminated.

Table 170: EtherCAT® gateway module status bits

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Reserved	Data valid Network → Gateway	Reserved		External error	Reserved	
Byte 1 ... 7	Reserved							

Table 171: CANopen gateway module status bits

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Data valid Gateway → network [1]	Data valid Network → gateway [1]	Reserved		External error	Reserved	
Byte 1	CAN list mode status	Reserved	Status of process data transmission[2] [1]	CAN controller status	Reserved			
Byte 2	Listener status 08	Listener status 07	Listener status 06	Listener status 05	Listener status 04	Listener status 03	Listener status 02	Listener status 01
Byte 3	Listener status 16	Listener status 15	Listener status 14	Listener status 13	Listener status 12	Listener status 11	Listener status 10	Listener status 09
Byte 4 ... 7	Reserved							

1) If heartbeat or node guarding was activated via the client, the receiver indicates an error, the **Status of process data transmission** bit = 0.

2) CANopen and CAN listen mode: If a configured connection cannot be established after 90 s, the **Status of process data transmission** bit = 0.

Complementary information

- The module status bits have the following meanings:
  - 0: Error
  - 1: No error
- If a module is not present, all bits of the module are set to logical 1.
- Bits reserved for future use are always logical 1.
- The status bytes of each module are transmitted as a 32-bit word in big endian format, i.e. the most significant byte (MSB = byte 3) is transmitted first and the least significant byte (LSB = byte 0) last.

13.4.1.2 Modbus® TCP holding register

13.4.1.2.1 Commands

Commands

Table 172: Modbus® TCP – output data

Address	Contents	Size	Description
256	Output data	1 word (2 bytes)	Is specified in the higher-level controller.
...		1 word (2 bytes)	
280		1 word (2 bytes)	
356	Find me function	1 word (2 bytes, MSB always 0)	0: Standard operation of the LEDs 1: Flash mode for 30 seconds [1]

1) A change from 1 to 0 ends the flash mode.

Complementary information

- The output data is written dynamically. From address 256, a client can write up to 25 words (50 bytes) of output data. From address 257, a client can write up to 24 words (48 bytes) of output data, etc.

13.4.2 SLMP

Overview

The safety controller supports an SLMP server without a safety protocol.

SLMP (Seamless Messaging Protocol) is used for communication in CC-Link systems.

SLMP allows you to read and write data ranges completely or only up to a smaller data quantity (≤ total size).

Supported commands

Buffer memory access

- 0x0613 Read memory
- 0x1613 Write memory

Buffer memory of special functional mode (batch read)

- 0x0E30 Node search

Module control (remote control)

- 0x0101 Read processor type

The commands 1C, 2C, 3C, 4C, 1E, 3E and 4E are not supported.

13.4.2.1 SLMP input data

13.4.2.1.1 Process data to the higher-level controller

Process data to the higher-level controller

Table 173: Process data to the higher-level controller

Address	Contents	Size
0	Configured process data	25 words (50 bytes)

You configure the contents in the configuration software.

13.4.2.1.2 Checksums

Table 174: Checksums

Address	Contents	Data type	Size
150 most significant word 151 least significant word	Overall checksum value	CRC32	2 words (4 bytes)
152 most significant word 153 least significant word	Safety checksum	CRC32	2 words (4 bytes)
154 most significant word 155 least significant word	Standard checksum	CRC32	2 words (4 bytes)
156 most significant word 157 least significant word	Reserved	CRC32	2 words (4 bytes)
158 most significant word 159 least significant word	Verification checksum	CRC32	2 words (4 bytes)

Complementary information

- If the security checksum and the verification checksum are identical, the configuration of the safety controller has been verified.

13.4.2.1.3 Product codes

Table 175: Product codes

Address	Contents	Data type	Size
200	**Product codes**[1]: • Product code of the CPU (4 bytes) • Product code of the SmartPlug (4 bytes) • Product codes of the expansion modules (4 bytes each)	UINT32	100 words (200 bytes)

1) Unavailable data are padded with “0”.

13.4.2.1.4 Status

Table 176: Status

Address	Contents	Size
350	SystemStatusInfo [1]	208 words (416 bytes)

1) Unavailable data are padded with “0xFF”.

13.4.2.1.5 Device

Table 177: Device

Address	Contents	Data type	Size
714	Vendor name	ASCII STRING	4 words (8 bytes)

Address	Contents	Data type	Size
718	Product code	ASCII STRING	4 words (8 bytes)
722	Product name	ASCII STRING	16 words (32 bytes)
738	Model name	ASCII STRING	9 words (18 bytes)
747	Revision	ASCII STRING	6 words (12 bytes)
753	Serial number	ASCII STRING	12 words (24 bytes)
765	Application name	ASCII STRING	16 words (32 bytes)
781	Service number (internal use)	ASCII STRING	4 words (8 bytes)

13.4.2.1.6 Project data

Overview

Contains the project data from the configuration software of the safety controller.

Project data

Table 178: Project data

Address	Contents	Data type	Size
800	Device name	UTF8 STRING	32 words (64 bytes)
832	Project name	UTF8 STRING	32 words (64 bytes)
864	Application name	UTF8 STRING	32 words (64 bytes)
896	User name	UTF8 STRING	32 words (64 bytes)
928	Description	UTF8 STRING	50 words (100 bytes)

Complementary information

- Unused characters in the STRING are padded with blanks.
- All entries of project data are optional and can be read by the fieldbus without authentication. If the user name is used, please observe the applicable data protection policy.

13.4.2.1.7 Find me function

Table 179: Find me function

Address	Contents	Size
1000	Find me function 0: Standard operation of the LEDs 1: Flash mode for 30 seconds [1]	1 word (2 bytes)

1) A change from 1 to 0 ends the flash mode.

13.4.2.2 SLMP output data

13.4.2.2.1 Process data to the safety controller

Process data to the safety controller

Table 180: Process data to the safety controller

Address	Contents	Size
50	Process data	1 word (2 bytes)
...		1 word (2 bytes)
74		1 word (2 bytes)

Complementary information

- The process data is written and read dynamically. You can write or read up to 25 words (50 bytes) of process data at address 50. You can write or read up to 24 words (48 bytes) of process data from address 51 onwards.

13.5 Dimensional drawings

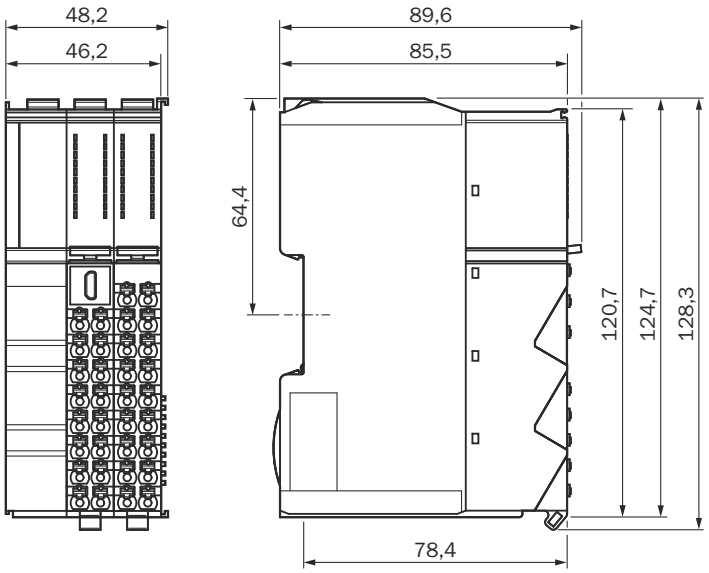


Figure 45: Dimensional drawing CPUc1

All dimensions in mm.

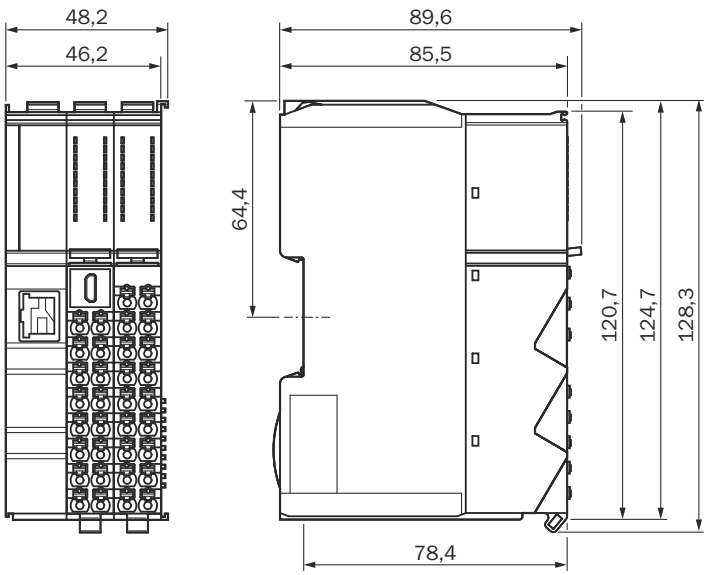


Figure 46: CPUc2 dimensional drawing

All dimensions in mm.

14 Ordering information

14.1 Ordering information for main module

Table 181: Ordering information for main module

Part	Type code	Part number
CPUc1 main module • 20 safety capable inputs • 8 test outputs • 4 safety outputs	FLX3-CPUC100	1085349
CPUc2 main module • 20 safety capable inputs • 8 test outputs • 4 safety outputs • Ethernet interface (RJ45 socket) for Modbus® TCP	FLX3-CPUC200	1085351

14.2 Ordering information for expansion module

Ordering information for IO expansion module

Table 182: Ordering information for IO expansion module

Part	Type code	Part number
Expansion module XTDI1 • 8 safety capable inputs • 8 test outputs	FLX3-XTDI100	1085353
Expansion module XTDO1 • 8 safety capable inputs • 8 safety outputs	FLX3-XTDO100	1085354

Ordering information for gateway expansion module

Table 183: Ordering information for gateway expansion module

Part	Type code	Part number
GPNT1 PROFINET-IO gateway	FLX0-GPNT100	1085356
GETC1 EtherCAT® gateway	FLX0-GETC100	1085357
The GCAN1 CANopen gateway	FLX0-GCAN100	1085363

15 Accessories

Table 184: Accessories

Part	Type code	Part number
Front connector with opening for SmartPlug • 16 spring terminals	FLX0-ACC0300	6069666
Front connector • 18 spring terminals	FLX0-ACC0200	6066285
SmartPlug	FLX3-SMPL100	2106852
Housing end cap	FLX0-ACC0400	5340579

16 Annex

16.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at **www.sick.com**. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

16.1.1 EU declaration of conformity

Excerpt

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

- ROHS DIRECTIVE 2011/65/EU
- EMC DIRECTIVE 2014/30/EU
- MACHINERY DIRECTIVE 2006/42/EC

16.1.2 UK declaration of conformity

Excerpt

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

- Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
- Electromagnetic Compatibility Regulations 2016
- Supply of Machinery (Safety) Regulations 2008

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THAT IS “SENSOR INTELLIGENCE”.

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