OPERATING INSTRUCTIONS

Flexi Compact

Safety controller

FLX3-CPUC100S14

SICK
Sensor Intelligence.

Described product

Flexi Compact

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

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 Ordering information 6
1.1 Ordering information for main module 6
1.2 Ordering information for expansion module 6

2 About this document 7
2.1 Purpose of this document 7
2.2 Scope 7
2.3 Target groups and structure of these operating instructions 7
2.4 Further information 7
2.5 Symbols and document conventions 8

3 Safety information 9
3.1 General safety notes 9
3.2 Intended use 9
3.3 Improper use 9
3.4 Requirements for the qualification of personnel 9

4 Product description 11
4.1 Configuration of the safety controller 11
4.2 Overview of the module 11
4.3 Configuration and function 11
4.4 Status indicators 12
4.5 Interfaces 13
4.5.1 SmartPlug 13

5 Project planning 14
5.1 Manufacturer of the machine 14
5.2 Operating entity of the machine 14
5.3 Design 14
5.4 Muting application 15
5.4.1 Safety notes for muting applications 15
5.4.2 Overview and general description 18
5.4.3 Notes on wiring 23
5.5 Electrical integration 24
5.5.1 Internal circuitry 24
5.5.2 Fault detection using test outputs 25
5.5.3 Safety outputs 25
5.6 Testing plan 26

6 Mounting 27
6.1 Safety 27
6.2 Mounting procedure 27
6.3 Mounting the SmartPlug in the main module 29
6.4 Disassembly 30
6.5 Module exchange 30

7 Electrical installation ... 32
7.1 Safety ... 32
7.2 Device connection ... 32
7.3 Coding ... 34
7.3.1 Coding front connector and module ... 35

8 Configuration ... 36
8.1 Safety Designer configuration software ... 36
8.1.1 User interface ... 36
8.1.2 User groups ... 36
8.2 Offline, online and security configuration ... 37
8.3 **Overview** main navigation menu ... 39
8.4 **Configuration** main navigation menu ... 39
8.4.1 Configuring the general settings ... 40
8.4.2 Specifying the device identification attributes ... 40
8.4.3 Protecting the configuration in the SmartPlug with a password ... 41
8.4.4 Adding expansion modules ... 41
8.4.5 Input elements ... 41
8.4.6 Output elements ... 44
8.4.7 Adding, configuring and expanding elements ... 46
8.4.8 Creating customized elements ... 47
8.4.9 Tag name editor ... 48
8.5 Logic editor main navigation ... 49
8.5.1 Inputs ... 50
8.5.2 Function blocks ... 50
8.5.3 Outputs ... 99
8.5.4 Diagnostics ... 100
8.5.5 Jump addresses ... 101
8.5.6 Logic programming in the logic editor ... 101
8.5.7 Logic execution time ... 103
8.5.8 I/O matrix ... 103
8.5.9 I/O summary page ... 103
8.6 Report main navigation menu ... 103
8.7 Service main navigation menu ... 103
8.8 Establishing a connection ... 104
8.9 Transferring the configuration ... 104
8.10 Verification ... 104
8.10.1 Verifying the configuration content and configuration transfer at the same time ... 105
8.11 Checksums ... 106
8.12 Testing safety functions ... 106

9 Commissioning ... 107
9.1 Check during commissioning and modifications ... 107

10 Operation 108
10.1 Regular thorough check 108

11 Maintenance 109
11.1 Regular thorough check 109

12 Troubleshooting 110
12.1 Status indicators 110
12.2 Possible faults 112
12.3 Diagnostics using Safety Designer 115
12.3.1 Error history 115

13 Decommissioning 116
13.1 Disposal 116

14 Technical data 117
14.1 Data sheet 117
14.2 Maximum response time 122
14.2.1 Calculating the response time 122
14.3 Dimensional drawings 125

15 Annex 126
15.1 Compliance with EU directives 126

16 List of figures 127

17 List of tables 128

1 Ordering information

1.1 Ordering information for main module

Table 1: Ordering information for main module

Part	Type	Part number
CPUc1 main module • 20 safety capable inputs • 8 test outputs • 4 safety outputs	FLX3-CPUC100S14	1119023

1.2 Ordering information for expansion module

Ordering information for IO expansion module

Table 2: Ordering information for IO expansion module

Part	Type	Part number
Expansion module XTDI1 • 8 safety capable inputs • 8 test outputs	FLX3-XTDI100S14	1119028
Expansion module XTDO1 • 8 safety capable inputs • 8 safety outputs	FLX3-XTDO100S14	1119027

2 About this document

2.1 Purpose of this document

These operating instructions contain the information required during the life cycle of the safety controller.

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

2.2 Scope

These operating instructions apply to the Flexi Compact safety controller.

This document is included with the following SICK part numbers (this document in all available language versions):

- 8026634

2.3 Target groups and structure of these operating instructions

These operating instructions are intended for the following target groups: project developers (planners, developers, designers), installers, electricians, safety experts (such as CE authorized representatives, compliance officers, people who test and approve the application), operators, and maintenance personnel.

These operating instructions are organized by the life phases of the device: project planning, mounting, electrical installation, commissioning, operation and maintenance.

The table below shows the target groups and how – for many applications – these are typically divided up between the manufacturer and the entity operating the machine in which the device is to be integrated:

Area of responsibility	Target group	Specific chapters of these operating instructions [1]
Manufacturer	Project developers (planners, developers, designers)	Project planning, page 14 Technical data, page 117
	Installers	Mounting, page 27
	Electricians	Electrical installation, page 32
	Safety experts	Project planning, page 14 Commissioning, page 107 Technical data, page 117
Operating entity	Operators	Troubleshooting, page 110
	Maintenance staff	Troubleshooting, page 110 Ordering information, page 6

1) Chapters not listed here are intended for all target groups. All target groups must follow all of the safety and warning instructions in all chapters of the operating instructions!

In other applications, the operating organization is also the manufacturer of the equipment with the corresponding allocation of the target groups.

2.4 Further information

www.sick.com

The following information is available via the Internet:

- This document in other languages
- 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)

2.5 Symbols and document conventions

The following symbols and conventions are used in this document:

Safety notes 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
Indicates useful tips and recommendations.

Instructions to action

▶ The arrow denotes instructions to action.

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

✓ The check mark denotes the result of an instruction.

3 Safety information

3.1 General safety notes

This chapter contains general safety information about the safety controller.

Further safety information is provided in the respective chapters to cover the specific situations in which the product may be used.

DANGER
If the device is not integrated in the way intended by the manufacturer, the protective function of the device can be impaired. The dangerous state may be ended too late.

- ▶ Plan the integration of the safety component in accordance with the machine requirements, see "Project planning", page 14.

3.2 Intended use

The Flexi Compact safety controller is a freely configurable control 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.

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

The safety controller system is only suitable for use in industrial environments.

3.3 Improper use

Among others, the safety controller is not suitable for the following applications:

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

3.4 Requirements for the qualification of personnel

The protective device must be planned in, installed, connected, commissioned, and serviced by qualified safety personnel only.

Project planning

For project planning, a person is considered competent when he/she has expertise and experience in the selection and use of protective devices on machines and is familiar with the relevant technical rules and national work safety regulations.

Mechanical mounting, electrical installation, and commissioning

For the task, a person is considered qualified when he/she has the expertise and experience in the relevant field and is sufficiently familiar with the application of the protective device on the machine to be able to assess whether it is in an operationally safe state.

Operation and maintenance

For operation and maintenance, a person is considered competent when he/she has the expertise and experience in the relevant field and is sufficiently familiar with the application of the protective device on the machine and has been instructed by the machine operator in its operation.

4 Product description

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

4.2 Overview of the module

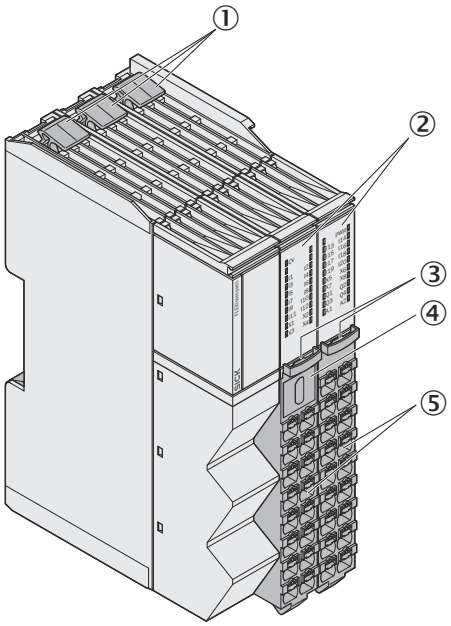


Figure 1: FLX3-CPUC1 module

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)

4.3 Configuration and function

Configuration

Table 3: Interfaces of the module

Description	Quantity
Safety capable inputs	20
Safety capable outputs	4
Test outputs [1)]	8
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 processing unit of the modular safety controller. All incoming signals 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)
- Use of the test outputs as non-safe outputs
- Programmable logic (binary logic, integer processing, application-specific function blocks)
- Special IO 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 test pulses for detecting short-circuits in the wiring.

4.4 Status indicators

Status indicators

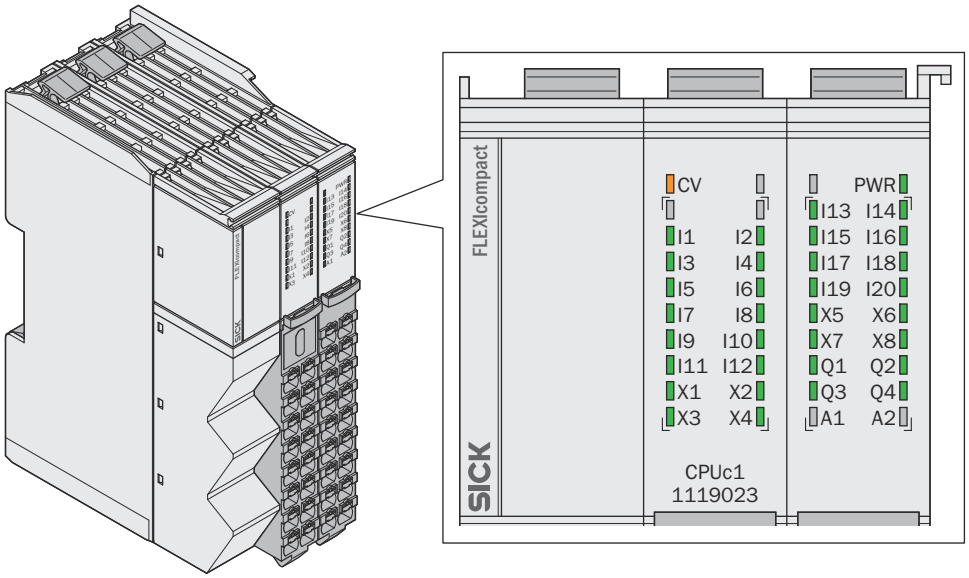


Figure 2: LEDs for indicating the status

The arrangement of the status indicators corresponds to the arrangement of the terminals.

Status indicator

Table 4: Status indicator

Labeling	Color	Function
PWR	Green/Red	Device status
CV	Yellow	Device configuration status
I1 ... I20	Green	Safety capable input 1 ... 20
X1 ... X8	Green	Test output 1 ... 8
Q1 ... Q4	Green	Safety capable output 1 ... 4

Further topics

- "Troubleshooting", page 110

4.5 Interfaces

4.5.1 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 SmartPlug has a USB connection for connecting the safety controller to a computer.

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

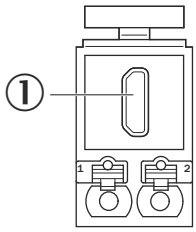


Figure 3: SmartPlug

① Micro-USB connection

The SmartPlug performs the following functions:

- Transferring the configuration from the configuration software into the system plug.
- Importing the configuration from the system plug into the configuration software.
- 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 in the main module", page 29

5 Project planning

5.1 Manufacturer of the machine

DANGER
Failure to comply with manufacturer's obligations
Hazard due to lack of effectiveness of the protective device

- ▶ Carry out a risk assessment before using the safety controller.
- ▶ Do not manipulate, open or modify the components of the safety controller.
- ▶ Make sure the safety controller is only repaired by the manufacturer or by someone authorized by the manufacturer. Improper repair can lead to a loss of the protective function.

5.2 Operating entity of the machine

DANGER
Failure to observe operator obligations
Hazard due to lack of effectiveness of the protective device

- ▶ Changes to the machine and changes to the hardware or the logic programming of the safety controller 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.
- ▶ Apart from the procedures described in this document, the components of the safety controller must not be opened or modified.
- ▶ Do not carry out any repair work on components. Improper repair of the safety controller can lead to a loss of the protective function.

5.3 Design

Mounting

- Environment meets the requirements of IP54 or higher, e.g., 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).
- 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.

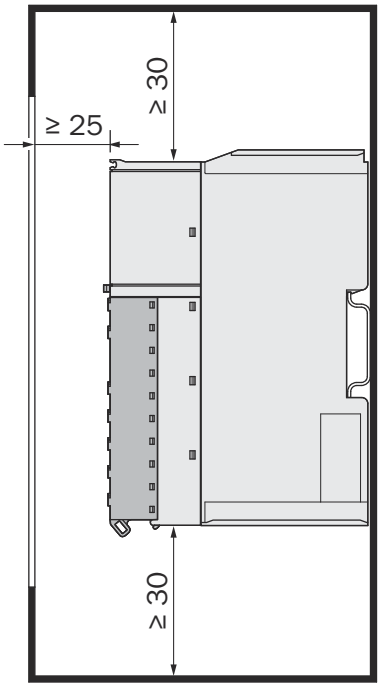


Figure 4: Clearances for adequate air circulation

Required distance:

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

5.4 Muting application

5.4.1 Safety notes for muting applications

The safety functions of a protective device are bypassed by muting.

WARNING
Restricted safety through muting

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

- ▶ Observe the general safety specifications and protective measures.
- ▶ You must always observe the following notes about how to use the muting function correctly.

General safety notes for muting

- ▶ Always observe the national, regional, and local regulations and standards that are applicable to the application.
- ▶ Make sure that the application is in line with an appropriate risk analysis and risk avoidance strategy.
- ▶ Muting must be setup to be carried out automatically but not be dependent on a single electrical signal.
- ▶ Never use muting to transport a person into the hazardous area.
- ▶ Make sure that muting is only activated for as long as access to the hazardous area remains blocked by the object responsible for triggering the muting condition.
- ▶ Make sure that the muting condition is terminated as soon as the object has finished passing through so that the protective device returns to its standard non-bypassed status (i.e., it must be reactivated).

- In the case of long muting cycles (i.e., those lasting more than 24 hours) or long machine downtimes, check the muting sensors to make sure they are functioning correctly.
- If the total muting time is set to infinite (inactive), use additional measures to prevent anyone from entering the hazardous area while muting is active.
- If safety-related information (i.e., remote safety capable input values and/or remote safety output values) is transmitted via a safety fieldbus network, always take the associated delay times into account. These delay times may influence both the system behavior and the minimum safety distance requirements associated with the response times.

Safety notes for the electro-sensitive protective equipment (ESPE)

- Access to the hazardous area must be reliably detected by the ESPE or other measures must be taken to prevent a person from bypassing, exceeding, crawling under or crossing the ESPE undetected.
- Observe the operating instructions for the electro-sensitive protective device that explain how to install and use the device correctly.
- Secure the area between the electro-sensitive protective device and the muting sensors as follows to prevent anyone standing behind:
  - With parallel muting – between the electro-sensitive protective device and sensors A1 / A2 as well as between the electro-sensitive protective device and sensors B1 / B2 (see figure 10, page 20).
  - With sequential muting – between the electro-sensitive protective device and sensor A2 as well as between the electro-sensitive protective device and sensor B1 (see figure 11, page 21).
  - With cross muting – between the electro-sensitive protective equipment and sensor A1 as well as between the electro-sensitive protective equipment and sensor A2 (see figure 12, page 22).

Safety notes for the muting sensors

- Set up muting so that it is triggered by at least two signals (e.g., from muting sensors) that are wired independently of one another and it is not fully dependent on software signals (e.g., from a PLC).
- Arrange the muting sensors so that if an intervention in the protective field occurs, the hazardous area can only be reached once the dangerous state has been eliminated. A condition for this is that the necessary minimum distances between the ESPE and the hazardous area are maintained, typically in accordance with EN ISO 13855.
- Arrange the muting sensors so that material can pass unhindered but so no one can enter the hazardous area by fulfilling the muting conditions themselves (i.e., by activating both muting sensors and thereby meeting the muting requirements).

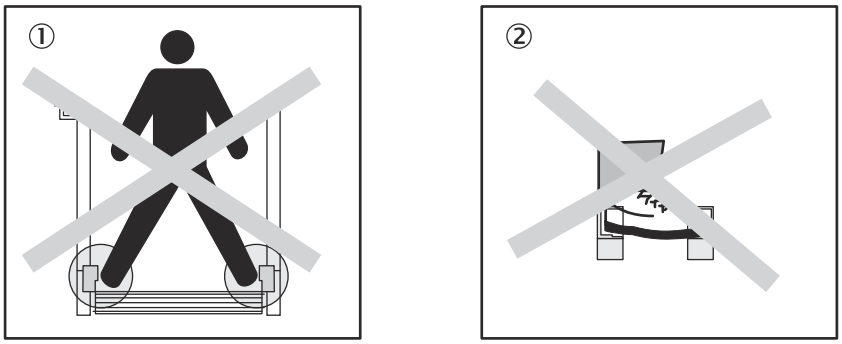


Figure 5: Safety requirements when mounting the muting sensors

① It must not be possible to activate sensors that are located opposite one another at the same time.

② It must not be possible to activate sensors that are located next to one another at the same time.

- Arrange the muting sensors so that only the moving material is detected, and not the transportation equipment (pallet or vehicle).

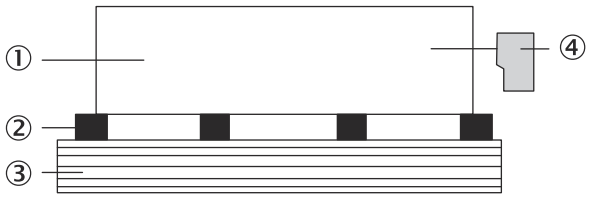


Figure 6: Detection of material during muting

① Transported material
② Transportation equipment
③ Transport level
④ Muting sensor

- Set up the muting so that the material to be transported is detected over the entire stretch. The output signals must not be interrupted.
- Arrange the muting sensors so that a minimum distance is observed in relation to the detection zone of the electro-sensitive protective equipment (e.g., in relation to the light beams of a light curtain) whenever material is detected. The minimum distance ensures the required processing time until muting is activated.

Safety notes for override

- Mount the control switches for the Override functions outside of the hazardous area so that they cannot be actuated by anyone who is located inside the hazardous area. In addition, the operator must have a complete overview of the hazardous area when actuating a control switch.
- Before activating the Override function, make sure that the equipment is in perfect working order, particularly the muting sensors (visual inspection).
- Make sure that the hazardous area is clear of people both before the Override function is activated and while it is active.
- If you have had to activate the Override function, check the functionality of the equipment and the arrangement of the muting sensors after the event.

Safety notes for the muting/override lamp

- Use a muting and/or override lamp to signal that the Muting or Override functions are active. You can either use an external muting/override lamp or one that is integrated into the electro-sensitive protective device (ESPE).
- Always attach the muting and/or override lamps so that they are clearly visible. The muting/override lamp must be visible from every side all the way around the hazardous area and must be clearly visible to the system operator.
- Depending on local, regional, and national regulations and standards, it may be necessary to monitor the muting/override lamp(s). If this is the case, implement additional measures for this purpose.

Further topics

- "Notes on wiring", page 23

5.4.2 Overview and general description

Muting is an automated 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 bypasses monitoring by the electro-sensitive protective equipment.

Three different function blocks are available for muting:

- Parallel muting

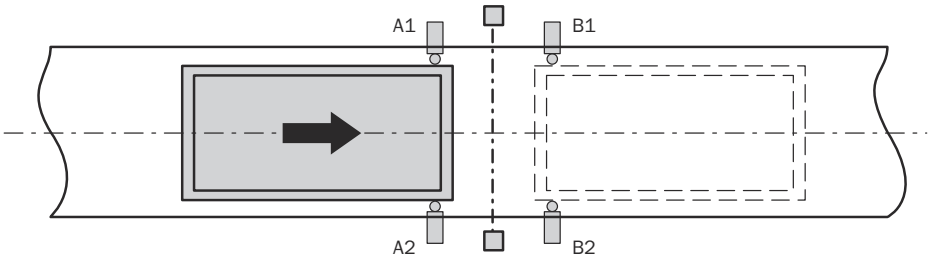


Figure 7: Muting with two sensor pairs arranged in parallel (A1 / A2 and B1 / B2)

- Sequential muting

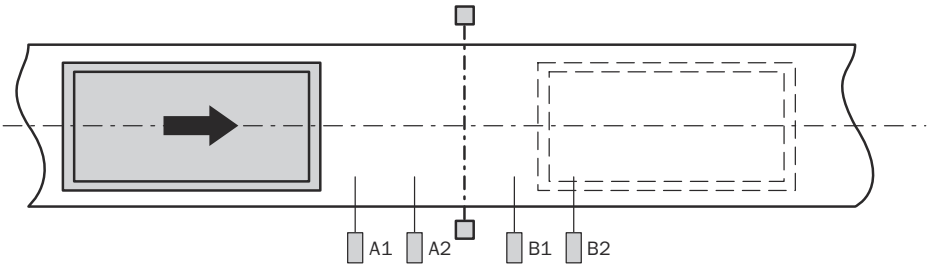


Figure 8: Muting with two sensor pairs arranged in sequence (A1 / A2 and B1 / B2)

- Cross muting

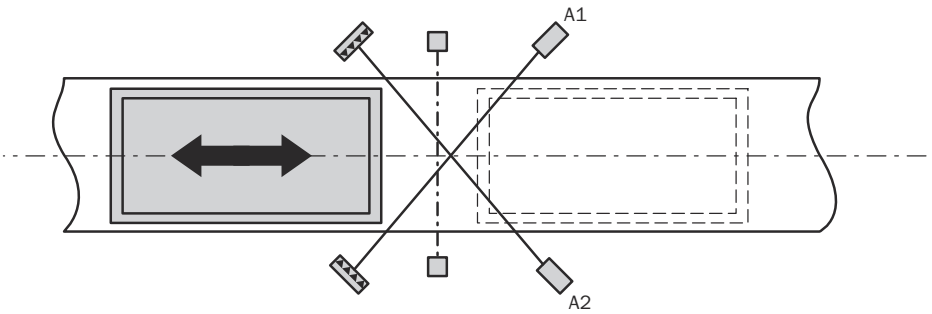


Figure 9: Muting with a sensor pair arranged crosswise (A1 / A2)

Muting sensors

Muting sensors monitor the presence of the material while it is being transported. Careful selection of the sensor type and how the sensors are arranged makes it possible to distinguish between objects and people.

In conjunction with the muting sensors and the electro-sensitive protective device, the object that is being transported generates a precisely defined signal sequence while it is traveling into the hazardous area. The muting sensors must ensure that all dangers are eliminated in the event of someone entering the area protected by the electro-sen-

sitive protective device (i.e., a dangerous state must be terminated immediately). It is absolutely essential to ensure that a person cannot generate the same signal sequence as a transported object.

The placement of the muting sensors is determined by the shape of the object being detected. There are various options involving different numbers of sensor input signals. These include the following:

- Two sensors
- Two sensors and one additional C1 signal
- Four sensors (two pairs of sensors)
- Fours sensors (two pairs of sensors) and one additional C1 signal

Muting signals can be generated by the following sources:

- Optical sensors
- Inductive sensors
- Mechanical switches
- Controller signals

If optical sensors are used for muting applications, choose sensors with background suppression to ensure that only the material being transported fulfills the muting conditions. These sensors are only capable of detecting material up to a certain distance. Consequently, the input conditions for the muting sensors cannot be met by objects that are located any further away than this. This applies in particular to sequential muting.

Conditions for muting

While the muting status is active, the **Enable** output remains at 1, even if the **Electro-sensitive protective device** input switches to 0.

Depending on the selected muting type and configuration, different conditions are tested for a correct muting cycle, i.e., the correct initiation, maintenance and termination of the muting status.

In general, at least one muting sensor signal pair (**A1**/**A2** or **B1**/**B2**) must always be active to maintain the muting status.

You can achieve a higher level of safety and improved protection against manipulation using the following functions:

Table 5: Monitoring functions for muting

Monitoring	Parallel muting	Sequential muting	Cross muting
Sequence monitoring	–	✓	–
Direction detection	✓	✓	–
C1 input	✓	✓	✓
Concurrency monitoring time	✓	✓	✓
Total muting time	✓	✓	✓
With electro-sensitive protective device	✓	✓	✓

Calculation of the distance L_1 for parallel muting

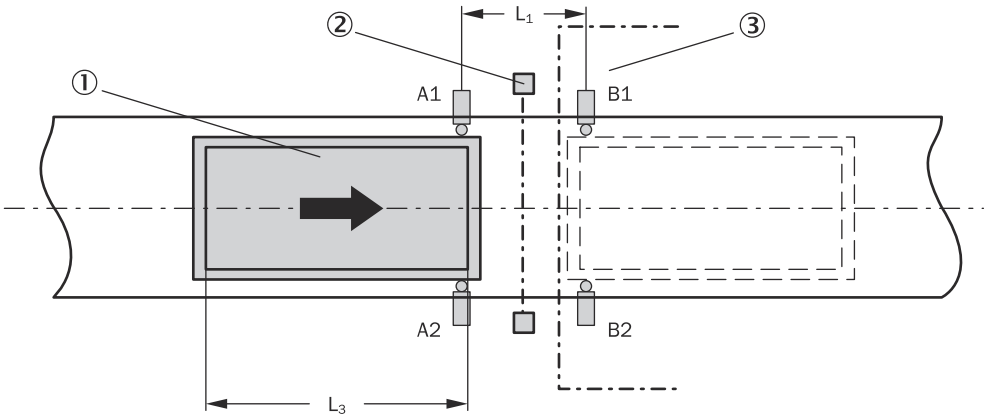


Figure 10: Example for parallel muting

① Transported material
② Electro-sensitive protective device (e.g., safety light curtain)
③ Hazardous area

In this example, the material moves from left to right. As soon as the first pair of muting sensors (A1 and A2) is activated, the protection afforded by the protective equipment (electro-sensitive protective equipment) is bypassed.

In the example, four muting sensors with identical response times are used. The two muting sensor pairs are mounted symmetrically, i.e., at the same distance from the detection range of the ESPE. Different configurations require separate consideration.

The distance L_1 is calculated using the following formula:

$L_1 \geq v \times 2 \times T_{IN\ muting\ sensor}$

The following prerequisites must be met:

- $v \times t > L_1 + L_3$
- $L_1 < L_3$

L_1	Distance between the sensors (arranged symmetrically in relation to the detection zone of the electro-sensitive protective device)
L_3	Length of the material in the conveying direction
v	Speed of the material (e.g., of the conveyor system)
t	Configured total muting time (s)
$T_{IN\ muting\ sensor}$	Response time of the slowest muting sensor used to initiate a muting status.

- The material can either be moved in both directions or only one transport direction can be allowed using the **Direction detection** configuration parameter.
- When the sensors are arranged in parallel, the position of the muting sensors is also used to monitor the width of the permissible object. Whenever objects move past the muting sensors, the width must always be the same.
- If optical sensors are used for parallel muting, pushbuttons with background suppression are typically used here to prevent a person from unintentionally activating both sensors at the same time.
- Prevent mutual interference of the sensors.

Calculation of the distance L_1 for sequential muting

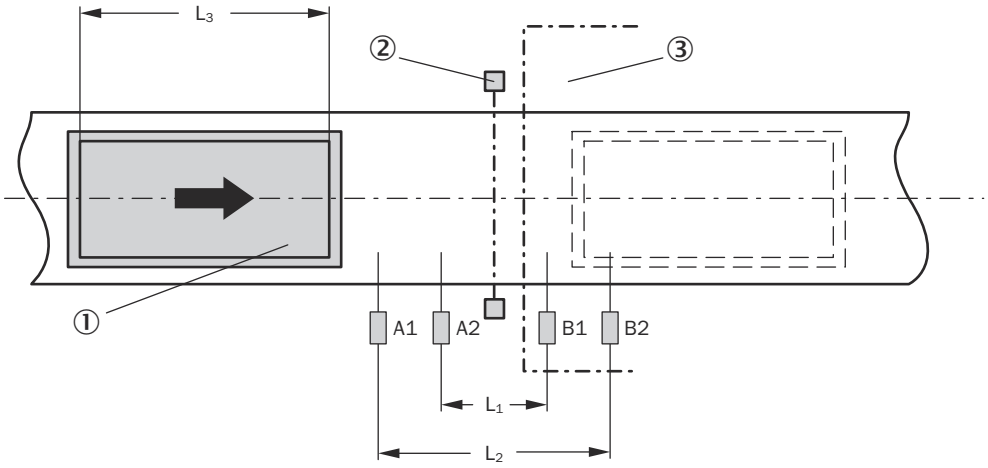


Figure 11: Example for sequential muting

① Transported material
② Electro-sensitive protective device (e.g., safety light curtain)
③ Hazardous area

In this example, the material moves from left to right. As soon as muting sensors A1 and A2 are activated, the protection afforded by the protective equipment (electro-sensitive protective equipment) is bypassed.

In the example, four muting sensors with identical response times are used. The two muting sensor pairs are mounted symmetrically, i.e., at the same distance from the detection range of the ESPE. Different configurations require separate consideration.

The distance L_1 is calculated using the following formula:

$L_1 \geq v \times 2 \times T_{IN\ muting\ sensor}$

The following prerequisites must be met:

- $v \times t > L_1 + L_3$
- $L_2 < L_3$

L_1	Distance between the inner sensors (arranged symmetrically in relation to the detection zone of the electro-sensitive protective device)
L_2	Distance between the outer sensors (arranged symmetrically in relation to the detection zone of the electro-sensitive protective device)
L_3	Length of the material in the conveying direction
v	Speed of the material (e.g., of the conveyor system)
t	Configured total muting time (s)
$T_{IN\ muting\ sensor}$	Response time of the slowest muting sensor used to initiate a muting status.

- The material can either be moved in both directions or only one transport direction can be allowed using the **Direction detection** configuration parameter.
- The sensor arrangement shown in this example is suitable for all types of sensor.
- Prevent mutual interference of the sensors.

Calculation of the distance L_1 for cross muting

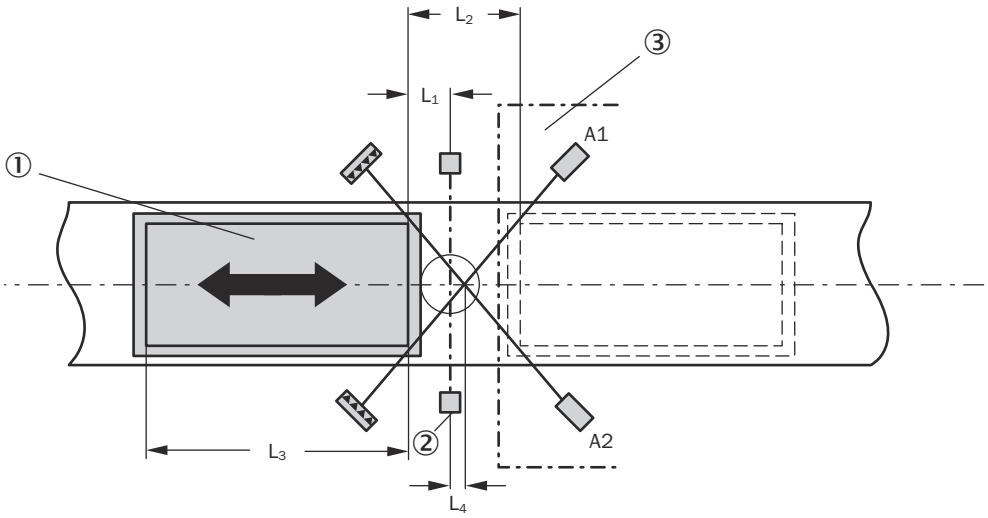


Figure 12: Example for cross muting

① Transported material
② Electro-sensitive protective equipment (e.g., safety light curtain)
③ Hazardous area

In this example, the material can move in both directions. As soon as the pair of muting sensors (A1 and A2) is activated, the protection afforded by the protective equipment (electro-sensitive protective equipment) is bypassed.

The distance L_1 is calculated using the following formula:

$L_1 \geq v \times T_{IN\ muting\ sensor}$

The following prerequisites must be met:

- $v \times t > L_2 + L_3$
- $L_4 \geq 0$

L_1	Minimum distance between the detection line of the ESPE and detection by A1 and A2
L_2	Distance between the two detection lines of the A1 and A2 sensors (sensors activated/sensors clear)
L_3	Length of the material in the conveying direction
L_4	Distance between the detection line of the ESPE and the point where the muting sensors intersect
v	Speed of the material (e.g., of the conveyor system)
t	Configured total muting time (s)
$T_{IN\ muting\ sensor}$	Response time of the slowest muting sensor used to initiate a muting status.

- In this example, the material is able to flow in both directions.
- The point where the muting sensors intersect should be placed behind the light beams of the ESPE in the hazardous area. If this is not possible, the point of intersection may be placed exactly in the path of the ESPE light beams, but not in front of it.
- The sensor arrangement shown in the example is suitable for through-beam photoelectric sensors and for photoelectric retro-reflective sensors.
- Prevent mutual interference of the sensors.

Further topics

- "Notes on wiring", page 23
- "Parallel muting V1", page 86
- "Sequential muting V1", page 89
- "Cross muting V1", page 92

5.4.3 Notes on wiring

If muting functions are to be implemented, potential errors must be taken into account as part of the wiring process. If certain signal combinations are to be transmitted via the same cable, additional precautions must be taken to ensure that the respective signals are correct. Suitable measures must be implemented (e.g., protected cable laying) to make sure that no errors can occur as a result of this wiring.

Table 6: Muting wiring combinations and requirements

Signal	A1	A2	B1	B2	C1	Conveyor	Electro-sensitive protective device	Override	Enable	Muting lamp	Muting status	Override required
A1	–	A	B	B	A	A	A	A	A	A	A	C
A2	A	–	B	B	A	A	A	A	A	A	A	C
B1	B	B	–	A	A	A	A	A	A	A	A	C
B2	B	B	A	–	A	A	A	A	A	A	A	C
C1	A	A	A	A	–	A	A	A	A	C	C	C
Conveyor	A	A	A	A	A	–	C	A	A	C	C	C
Electro-sensitive protective device	A	A	A	A	A	C	–	C	A	C	C	C
Override	A	A	A	A	A	A	C	–	A	A	C	A

A The specified signals may only be installed in the same cable if a short-circuit between these signals can be excluded, e.g., by means of protected cable laying.
B The specified signals may only be installed in the same cable if sequence monitoring is used or a short-circuit between these signals can be excluded, e.g., by means of protected cable laying.
C The specified signals may be installed in the same cable.
– Not applicable

Short-circuit to 24 V supply voltage

If a short-circuit to High (to 24 V DC) occurs at a physical input, the evaluated signal may produce a pulse if the signal for **Override** is reset as a result of short-circuit detection.

WARNING
Undesired override 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 that the transitions of the signals that expect an input pulse (input for the muting function blocks) meet the requirements of safety standards and regulations.
  - 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

5.5 Electrical integration

5.5.1 Internal circuitry

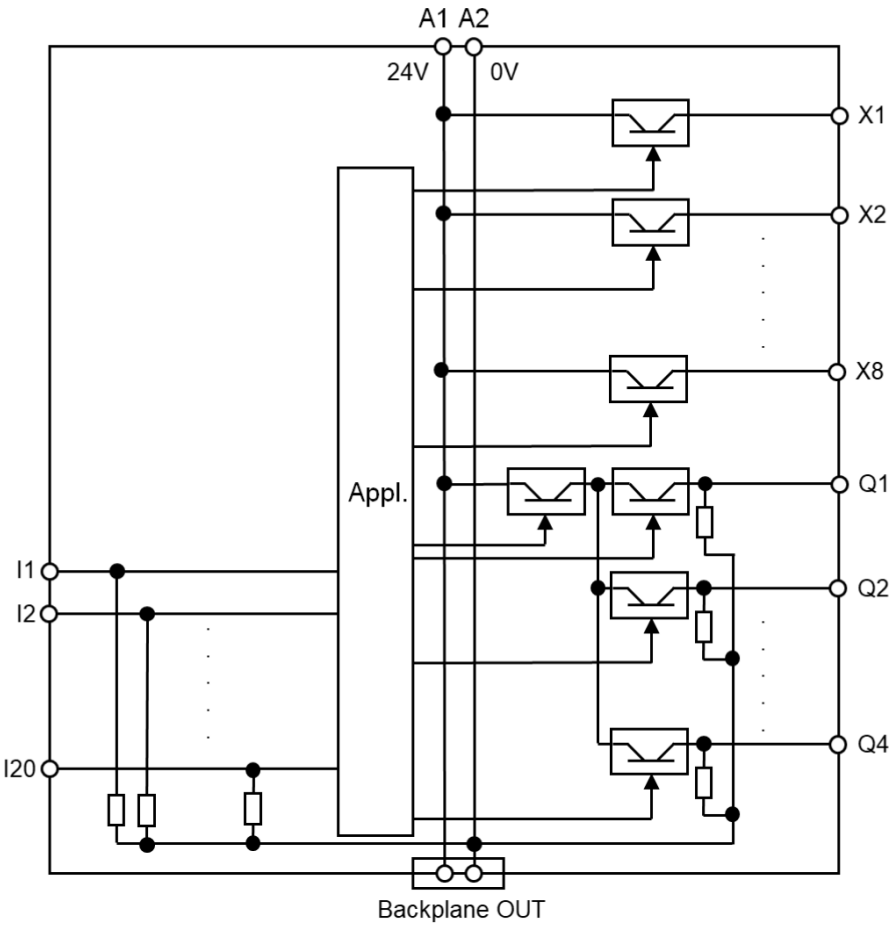


Figure 13: Internal circuitry main module

5.5.2 Fault detection using test outputs

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 and cross-circuits.
- ▶ Make sure the signal line is laid with protection (to prevent a cross-circuit with other signal lines).
- ▶ Take additional safety measures.

Prerequisites

- Use the test outputs of the module to which the device is connected.
- 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 frequency of ≥ 200 ms and a test pulse duration of 2 ms, you can detect a cross-circuit between the test outputs of 12 sequential modules.
  Using a test pulse frequency of ≥ 8 ms and a test pulse duration of 2 ms, you can detect a cross-circuit between any two sequential test output pairs of a module.
- Short circuits to 24 V DC (to High) on inputs that are connected to test outputs, regardless of the length of the test gaps and the test periods.
- Sensor wiring short-circuits to 24 V that could interfere with a switch-off condition.

The following faults cannot be detected:

- Short circuits between test outputs and the associated input.

Further topics

- "Configuring elements", page 47

5.5.3 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 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) on safety outputs.
- Actuator wiring short-circuits to 24 V.

Further topics

- "Device connection", page 32
- "Configuring elements", page 47

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.

In addition, the device must be checked for correct functioning after each change to the configuration.

▶ 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.
  - Notify the machine operators of the thorough check and instruct them accordingly.

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

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 machine operators been trained to work on the machine?
- Have the machine 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 machine operators 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 Safety

WARNING
Electrical voltage
There is a risk of injury from electrocution while connecting the devices.

▶ Disconnect the power for the entire plant/machine.

WARNING
Unintended start of the plant/machine
The plant/machine could inadvertently start while you are connecting the devices.

▶ Disconnect the power for the entire plant/machine.

NOTICE
Enclosure rating IP20 only applies if the front connector is mounted.

6.2 Mounting procedure

Prerequisites

- Environment meets the requirements of IP54 or higher, e.g., 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 14
- There is at least 30 mm of space for air circulation above and below the module.
- There is at least 25 mm of space in front of the module (front side). More space may be needed depending on the connections.
- Take suitable ESD protection measures.

Approach

1. Attach main module to mounting rail.

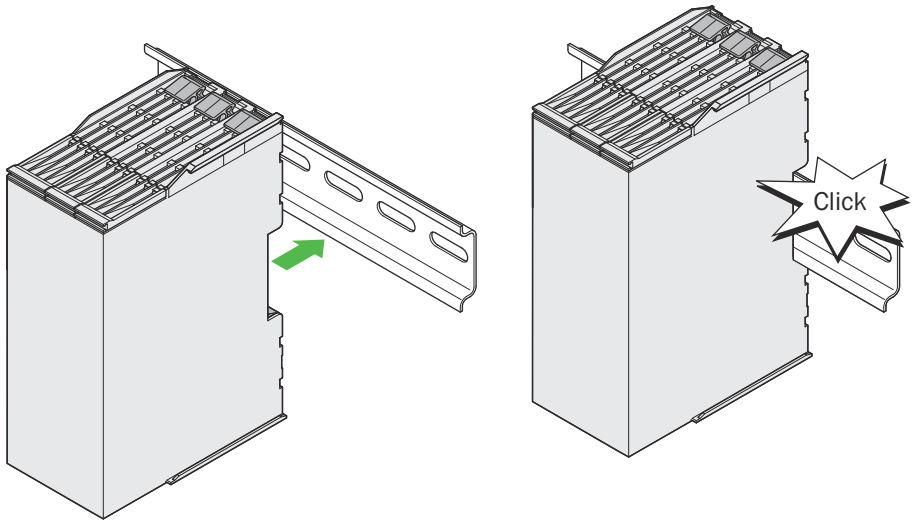


Figure 14: Main module mounting

✓ The main module engages with an audible click.

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

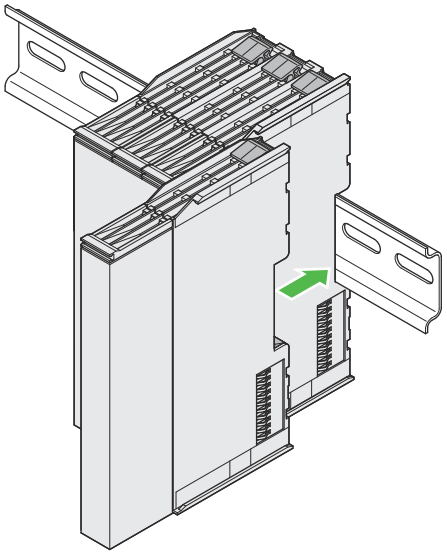
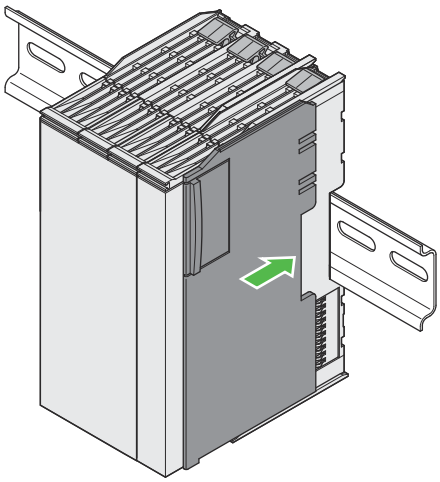


Figure 15: Expansion module mounting

✓ 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.

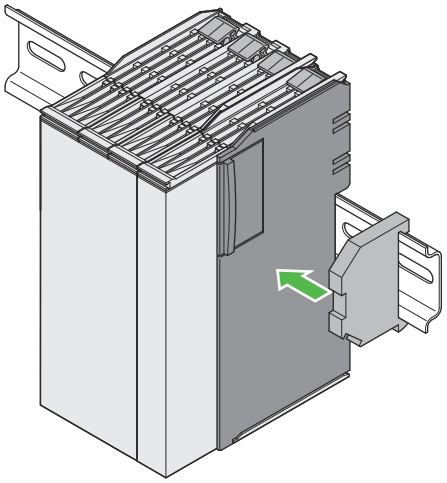


Figure 16: Housing end cap and end clamp mounting

6.3 Mounting the SmartPlug in the main module

Approach

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.

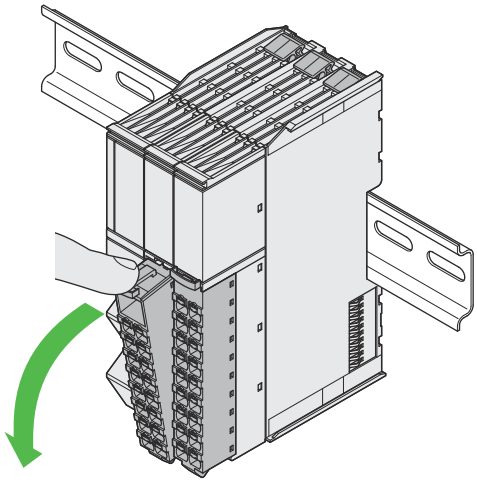
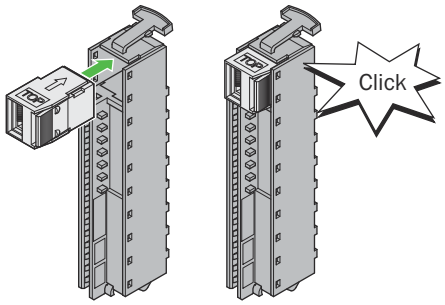


Figure 17: Pull out the front connector

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.

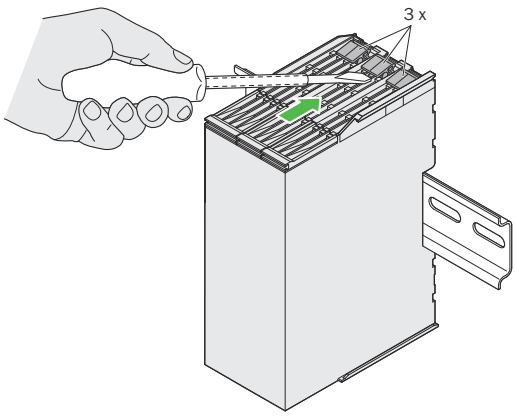
✓ The front connector engages with an audible click.

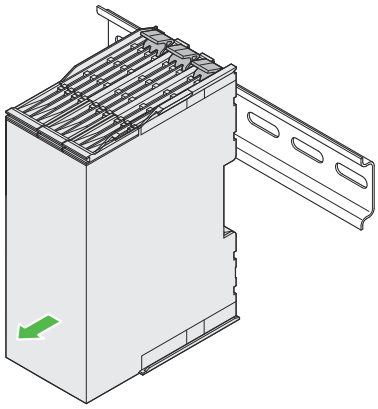
6.4 Disassembly

Prerequisites

- Electrician screwdriver (slotted screwdriver)

Approach





1. Press the unlocking mechanism(s) on the upper side of the module towards the back using the electrician screwdriver.
2. Loosen the module from the mounting rail.

6.5 Module exchange

Approach

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.

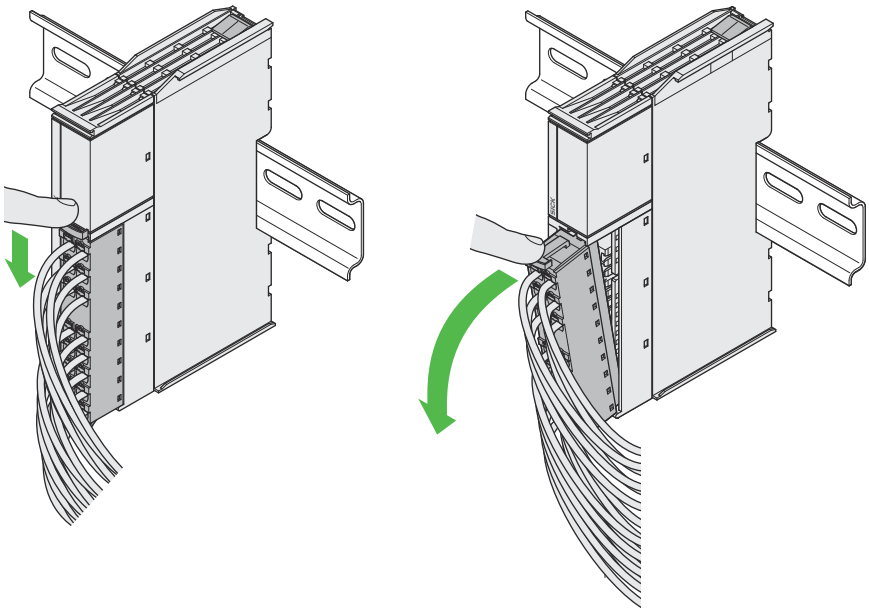


Figure 18: Dismantle front connector

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.

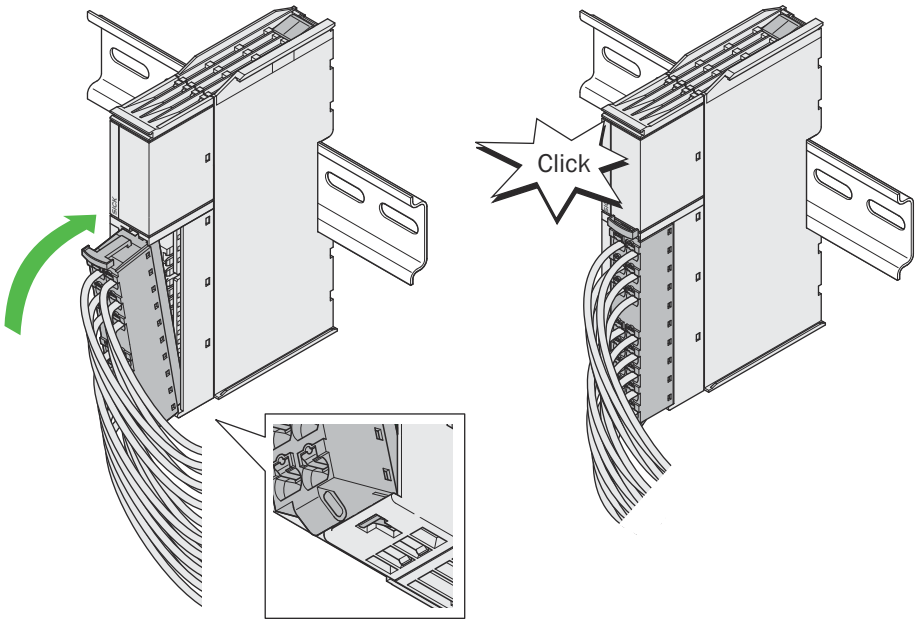


Figure 19: Mount the front connector

✓ The front connector engages with an audible click.

Further topics

- "Mounting procedure", page 27
- "Disassembly", page 30
- "Offline, online and security configuration", page 37

7 Electrical installation

7.1 Safety

WARNING
Electrical voltage
There is a risk of injury from electrocution while connecting the devices.

▶ Disconnect the power for the entire plant/machine.

WARNING
Unintended start of the plant/machine
The plant/machine could inadvertently start while you are connecting the devices.

▶ Disconnect the power for the entire plant/machine.

NOTICE
Enclosure rating IP20 only applies if the front connector is mounted.

7.2 Device connection

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.
- The GND of all connected devices must have the same potential as A2 of the main module. Exceptions are actuators which are connected to an expansion module with its own voltage supply.
- The GND connections of the actuators to the safety outputs are in star formation with the GND connection of the voltage supply.

Pin assignment

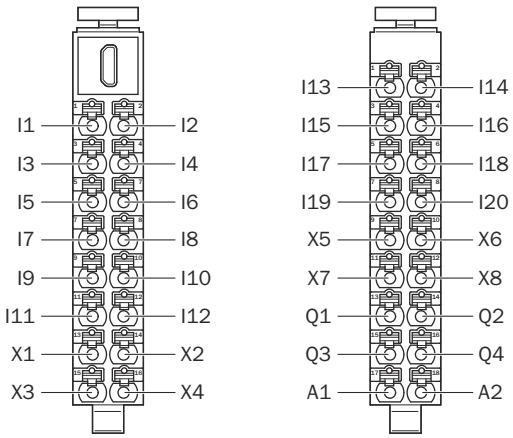


Figure 20: Terminals on front connectors

Table 7: Left front connector pin assignment

Terminal	Pin assignment	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 8: Right front connector pin assignment

Terminal	Pin assignment	Description
1	I13	Safety capable input
2	I14	
3	I15	
4	I16	
5	I17	
6	I18	
7	I19	
8	I20	
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

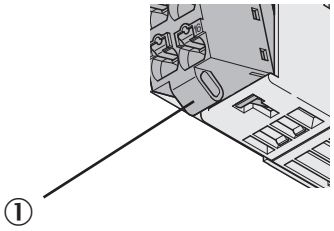


Figure 21: Eyelet on front connector

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 24

7.3 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	□	□	■	■	■	■	□
...				...			

7.3.1 Coding front connector and module

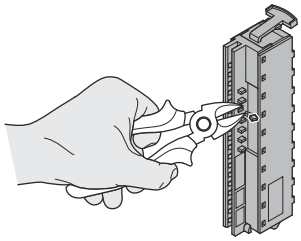
Prerequisites

- Slotted screwdriver 3.5 mm × 0.6 mm
- Diagonal cutter

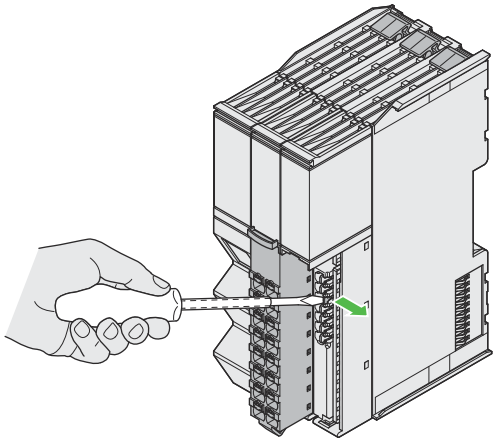
Approach

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 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.

8.1.1 User interface

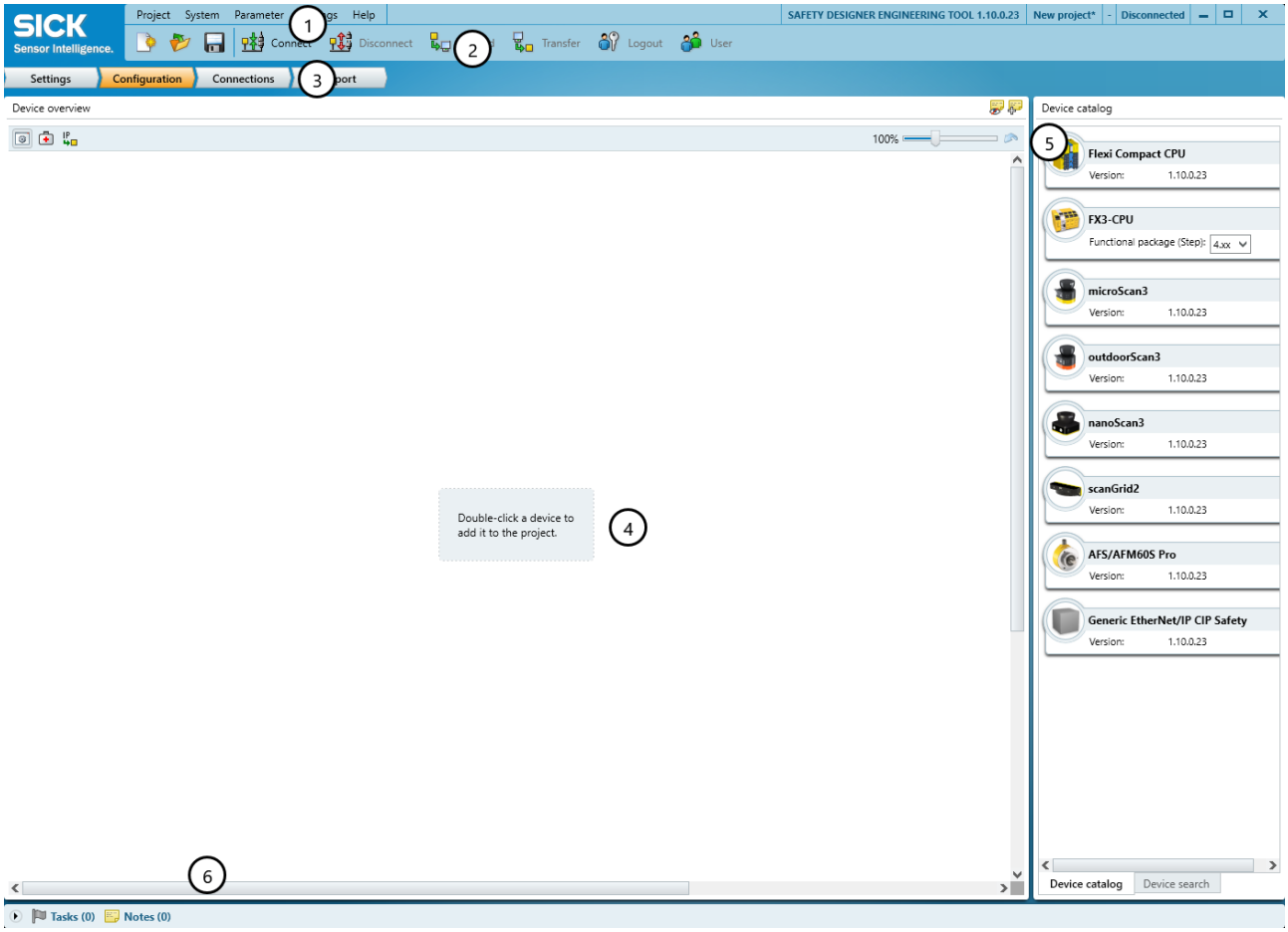


Figure 22: Software controls

① Menu bar
② Toolbar
③ Main navigation
④ Working range
⑤ Device catalog
⑥ Task list and notes

8.1.2 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

If you leave a computer that is connected to devices unattended, you must log out and switch to the **Machine Operator** user group so that unauthorized persons cannot transfer configurations to the devices.

User groups

Table 9: 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.
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 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 device is saved in the system plug. Therefore, the passwords are retained when the device is replaced if the system plug is still used.

8.2 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.

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 having to reconfigure the device. 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

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 13

8.3 Overview main navigation menu

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

8.4 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 your own elements.
- In the Navigation pane, you can switch between the **Hardware configuration**, the **BOM info**, 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.

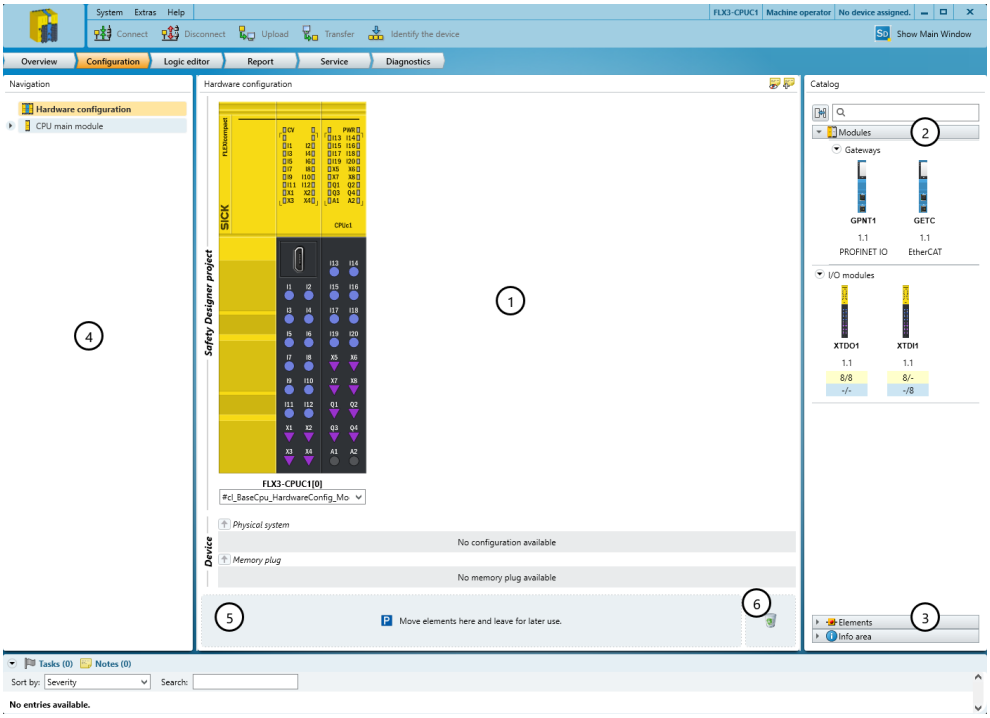


Figure 23: Configuration

① Workspace
② Module catalog
③ Element catalog
④ Navigation
⑤ Parking area
⑥ Trashcan

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 24: Edit mode button

8.4.1 Configuring the general settings

Approach

1. In the **Navigation** under **Hardware configuration** click on **General settings**.
2. Select the desired settings.

8.4.2 Specifying the device identification attributes

Overview

The device can be identified by assigning various attributes, for example the device name or application name. An application image can optionally be selected for the application.

The attributes are later displayed, for example, in a report or in diagnostics.

Approach

1. In the **Navigation** under **CPU main module**, click on **Device identification**.
2. Specify device identification attributes for the safety controller.

8.4.3 Protecting the configuration in the SmartPlug with a password

Approach

1. In the **Navigation** under **CPU main module**, click on **Password protection**.
2. Select the **Upload only as authorized client** option.

Complementary information

The password is stored in the SmartPlug. The password protection is therefore still effective if the main module is replaced.

8.4.4 Adding expansion modules

Overview

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

Approach

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

✓ The expansion module is added to the workspace.

8.4.5 Input elements

Table 10: Categories of input elements

Category	Details in the configuration software report			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	• Without test pulse (deactivated) • Test pulse duration = 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	Without test pulse (deactivated)	OSSD test pulse filter active	• Transponder safety switch e.g., Sistra • Safety light curtain e.g., deTec4 • Safety laser scanner e.g., microScan3, nanoScan3
Safety sensors with test input Safety sensors with a test input, signal processing unit and test output	Single-channel input	Test pulse duration ≥ 4 ms		• Type 2/4 safety photoelectric sensor e.g., L41 • Flexi Loop

Category	Details in the configuration software report			Examples
	Mode	Test pulses	Other parameters	
Safety pressure mats[1)2)]	Dual-channel input with short-circuit detection (with/ without diodes)	Test pulse duration ≥ 2 ms		• Safety pressure mats • Edges and bars

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

8.4.5.1 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 11: 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.
ON-OFF	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 frequency and the test pulse duration in the **Test outputs** tab. For dual-channel elements, these parameters can be configured individually for each channel.
Test pulse frequency	
Test pulse duration	

Parameter	Description
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 duration 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 frequency is > 8 ms and a long delay 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

- "Discrepancy time", page 43
- "Maximum response time", page 122
- "Data sheet", page 117
- "Report main navigation menu", page 103

8.4.5.2 Discrepancy time

Overview

The safety controller evaluates dual-channel elements with or without a discrepancy time. The discrepancy time determines how long the two inputs can continue to have different values (for dual channel equivalent mode) or the same value (for dual-channel complementary mode) after the value of one of the two input signals changes.

Discrepancy conditions for equivalent and complementary evaluation

Table 12: Dual-channel evaluation

Mode	Input A	Input B	Discrepancy timer [1]	Status of dual-channel evaluation	Input in the logic editor	Discrepancy error
Dual channel equivalent	0	0	0	Deactivated	0	0
	0	1	< discrepancy time	Discrepant	0	Unchanged [2]
	1	0	< discrepancy time	Discrepant	0	Unchanged [2]
	1	1	0	Active [3]	1	0
	X	X	≥ discrepancy time (timeout)	Error	0	1

Mode	Input A	Input B	Discrepancy timer [1]	Status of dual-channel evaluation	Input in the logic editor	Discrepancy error
Dual channel complementary	0	1	0	Deactivated	0	0
	0	0	< discrepancy time	Discrepant	0	Unchanged [2]
	1	1	< discrepancy time	Discrepant	0	Unchanged [2]
	1	0	0	Active [3]	1	0
	X	X	≥ discrepancy time (timeout)	Error	0	1

1) Discrepancy time activated: The discrepancy timer starts on the first signal change that leads to a discrepant status.
Discrepancy time deactivated: The discrepancy timer is inactive. No timeout ever occurs.
2) Unchanged = the last status is retained.
3) If the dual-channel element adheres to the correct sequence.

Sequence error

A dual-channel evaluation can only switch to Active (input changes in the logic from 0 to 1) if the following conditions are met:

- The status was set to Deactivated at least once since it was last Active, i.e., it is not possible to switch from Active to Discrepant and then back to Active.
- The discrepancy time has either not yet elapsed or is deactivated.

If the correct sequence for achieving the Active status has not been observed, the safety controller indicates a sequence error within a maximum of 100 ms.

Complementary information

Value range: 0 ms ... 60 s

- When **Discrepancy time** is deactivated, the value is set to infinite.
- If signals from tested sensors are connected, the discrepancy time must be greater than the test pulse duration (ms) + the max. tolerated test pulse delay (ms) of the safety capable input used.
- A discrepancy error (timeout) is reset when the Disabled status is achieved.

Further topics

- "Possible faults", page 112

8.4.6 Output elements

Table 13: Categories of output elements

Category	Details in the configuration software report			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)	• Increased capacitive loads not allowed • Increased capacitive loads allowed	• Safety relay, e.g., ReLy • Safety contactors • Safety locking devices, e.g., MLP1 • Valves • Motors • Robot • Lamps

8.4.6.1 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.
  - Manually switch off all safety outputs simultaneously for min. 2 s once a year. The supply voltage to the outputs must be within the operating range during this manual test.

WARNING
Ineffectiveness of the protective device due to longer fault detection time with the Increased capacitive loads allowed option.

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** option results in a longer fault detection time. This primarily applies to single-channel outputs.

- Take into account the extended error detection time.

Configuration options for output elements

Table 14: 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.

Parameter	Description
Output testing	**Without test pulses** When this option is selected, the test pulses for this output are deactivated. Additional measures for all safety outputs of the module may be required, see "Safety-related parameters", page 117. 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, test pulses are activated depending on other elements on the module. If no element on the safety outputs of the same module is configured with the **Without test pulses** option, the test pulses are activated. The report shows whether the test pulses are activated or deactivated. This option is suitable for connected devices where the test pulses have no effect on the connected device and they are not needed to achieve the required safety-related characteristics.
	With test pulses When this option is selected, the test pulses for this output are activated. This option is required for connected devices where regular test pulses are essential for achieving the required safety-related characteristics. "Safety-related parameters", page 117
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.

Further topics

- "Discrepancy time", page 43
- "Maximum response time", page 122
- "Data sheet", page 117
- "Report main navigation menu", page 103

8.4.7 Adding, configuring and expanding elements

8.4.7.1 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.

Approach

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

8.4.7.2 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.

Approach

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 47

8.4.7.3 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.

Approach

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.

8.4.8 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.

Approach

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

8.4.8.1 Exporting customized elements

Approach

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.

8.4.8.2 Importing customized elements

Approach

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.

8.4.9 Tag name editor

You can use the tag name editor to edit the tag names of the elements in use from one central location. For example, you can assign descriptive names to make it easier to identify the elements in the application. You can also export the tag names for other applications.

8.4.9.1 Editing tag names

Approach

1. In the **Navigation** pane, open the **Tag name editor**.
2. Click on **Logic results and CPU marker** or **Locale I/O**.
✓ The **Tag name editor** opens.
3. Edit the tag names.
✓ The new tag names are applied.

8.4.9.2 Importing and exporting tag names

Overview

You can import tag names from a CSV file or export them to a CSV file.

Approach

To import tag names

1. In the **Navigation** pane, click on **Import/export tag names** under **Tag name editor**.
2. Click on the **Import tag names** button.
3. Select the desired CSV file.
✓ The tag names are imported.

To export tag names

1. In the **Navigation** pane, click on **Import/export tag names** under **Tag name editor**.
2. Click on the **Export tag names** button.
3. Select the desired destination, enter a file name, and click on **OK**.
✓ The tag names are saved as a CSV file.

8.5 Logic editor main navigation

Logic editor main navigation

The function logic is programmed in a graphic **logic editor**.

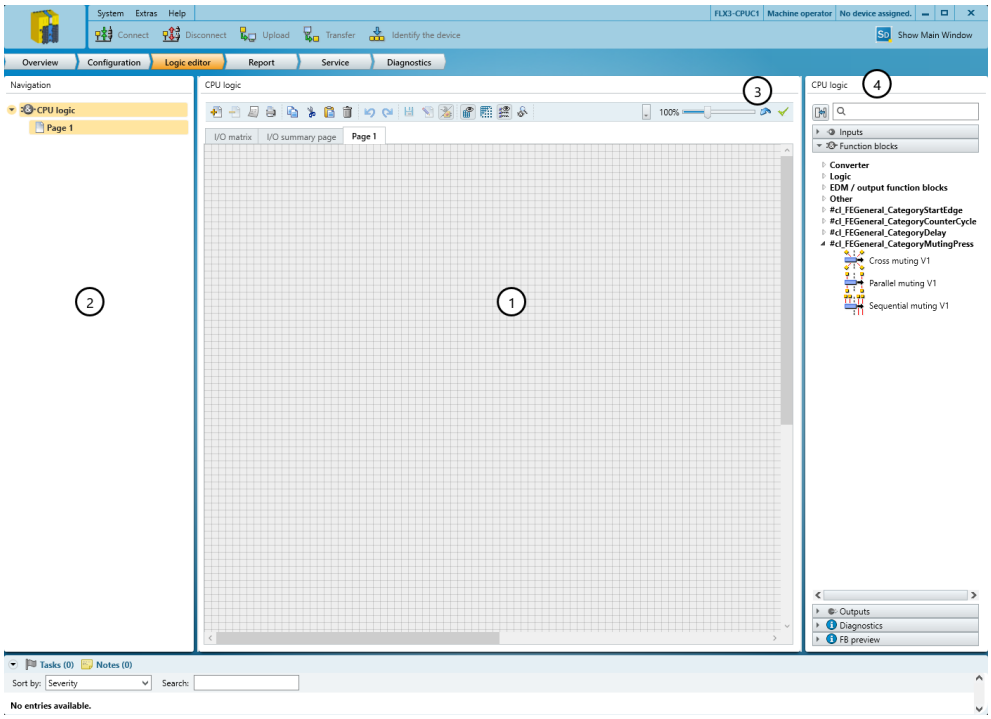


Figure 25: Logic editor

① Work sheet

② Navigation
③ Toolbar
④ CPU logic catalog

8.5.1 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
- CPU marker
- The **Static 0** and **Static 1** input elements
  - The output of the **Static 0** element is always set to 0.
  - The input of the **Static 1** element is always set to 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

- "CPU marker"
- "Jump addresses", page 101
- "Connecting elements", page 102

8.5.2 Function blocks

Function blocks

The logic is programmed using function blocks. Function blocks contain inputs and outputs. The status of the outputs depends on the status of the inputs and the logic of the function block. Some function blocks can also be parameterized.

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.

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 will be shown in red as long as all inputs have not been connected.
- Each function block has a function block index. The function block index shows the execution sequence.

Further topics

- "Connecting elements", page 102
- "Configuring function blocks", page 102

8.5.2.1 Logical function blocks

8.5.2.1.1 NOT V1

Overview

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

Principle of operation

Table 15: Inputs

Input	Description
Input	Data type: Boolean

Table 16: Outputs

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

8.5.2.1.2 AND V1

Overview

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

Principle of operation

Table 17: Inputs

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

Table 18: Outputs

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

Table 19: Parameter

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.

8.5.2.1.3 OR V1

Overview

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

Principle of operation

Table 20: Inputs

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

Table 21: Outputs

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

Table 22: Parameter

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.

8.5.2.1.4 XOR V1 (exclusive OR)

Overview

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

Principle of operation

Table 23: Inputs

Input	Description
Input 1 Input 2	Data type: Boolean

Table 24: Outputs

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

8.5.2.1.5 XNOR V1 (exclusive NOR)

Overview

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

Principle of operation

Table 25: Inputs

Input	Description
Input 1 Input 2	Data type: Boolean

Table 26: Outputs

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

8.5.2.1.6 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 27: Inputs

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

Table 28: Outputs

Output	Description
Q	Data type: Boolean • If the **Reset** input = 1, then the output = 0. • If the **Set** input = 1 and the **Reset** input = 0, then the output = 1. • If the **Set** input = 0 and the **Reset** input = 0, then the output keeps the last value.
/Q	Data type: Boolean The value at the output is the inverted value of the Q output.

Table 29: Parameter

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 30: 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

8.5.2.1.7 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 31: Inputs

Input	Description
J	Data type: Boolean
K	
Clock	Data type: Boolean 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 32: Outputs

Output	Description
Q	Data type: Boolean • If the **J** input = 1 and the **K** input = 0, then the **Q** output = 1. • If the **J** input = 0 and the **K** input = 1, then the **Q** output = 0. • If the **J** and **K** inputs = 0, the **Q** output keeps the last value. • If the **J** and **K** inputs = 1, the **Q** output inverts the last value.
/Q	Data type: Boolean The value at the output is the inverted value of the Q output.

Table 33: Parameter

Parameter	Description
Inverted	• Input J and K: 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. • Input Clock: No inversion: The function block reacts to rising signal edges. With inversion: The function block reacts to falling signal edges.

Table 34: JK Flip-Flop V1 truth table without input inversion

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

X: Value can be 0 or 1.
↑: Rising signal edge
↓: Falling signal edge

8.5.2.2 Function blocks for data conversion

8.5.2.2.1 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.

An individual function block converts 8 decimal values depending on the set value range. You can convert larger value areas by using several function blocks and configuring them accordingly.

Principle of operation

Table 35: Inputs

Input	Description
Input	Data type: UINT8

Table 36: Outputs

Output	Description
Output value 0 ... Output value 7	Data type: Boolean Depends on the **Conversion mode** parameter and the value at the input.

Table 37: Parameter

Parameter	Description
Conversion mode	• 1-of-N Exactly 1 output = 1. Example: Decimal value 5: 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: Output 0 ... 5 = 1, all other outputs = 0.
Range offset	0 ... 31 A function block covers 8 decimal values. You must use several function blocks in order to be able to convert more than 8 decimal values. With the **Range offset** parameter, you determine which value range the function block converts. You can use the following formula to calculate which decimal value corresponds to a function block output: **Decimal value = N + 8 × R** • N = Number of the output • R = Area offset **Example of output 0 with Range offset = 0:** • Output 0 + 8 × 0 => output 0 = value 0 **Example of output 7 with Range offset = 31:** • Output 7 + 8 × 31 => output 7 = value 255

8.5.2.2.2 One-hot to UInt8 V1

Overview

The function block converts binary inputs into decimal values.

Principle of operation

Table 38: Inputs

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

Table 39: Outputs

Output	Description
Result	Data type: UINT8 Depending on the **Conversion mode** parameter.
Status	Data type: Boolean • If an invalid combination is present at the inputs, the **Status** output changes to 0 (error). • If a correct input combination is present, the function block resets the error. The **Status** output changes back to 1 in this case.

Table 40: Parameter

Parameter	Description
Conversion mode	• One-hot Exactly one input = 1. If several inputs = 1 or no input = 1, then the function block evaluates this as an error. • Highest dominant At least one input = 1. The input with the highest value determines the decimal value at the output. If no input = 1, then the function block evaluates this as an error. • Lowest dominant At least one input = 1. The input with the lowest value determines the decimal value at the output. If no input = 1, then the function block evaluates this as an error.
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. The decimal value at the **Result** output depends on the area offset and the number of the input and is calculated using this formula: **Decimal value at the Result output = N +8 × R** • N = Number of the input • R = Area offset **Example for Range offset = 0:** • Input 0 +8 × 0 => decimal value at the **Result** output = 0 • Input 7 +8 × 0 => decimal value at the **Result** output = 7 **Example for Range offset = 31:** • Input 0 +8 × 31 => decimal value at the **Result** output = 248 • Input 7 +8 × 31 => decimal value at the **Result** output = 255

8.5.2.2.3 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 41: Inputs

Input	Description
Input 1	Data type: UINT8

Table 42: Outputs

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

Table 43: 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

8.5.2.2.4 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 44: Inputs

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

Table 45: Outputs

Output	Description
Output 1	Data type: UINT8

Table 46: 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

8.5.2.3 Function blocks for time functions

8.5.2.3.1 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 is present. The output is switched off without delay if a falling signal edge is present.

Principle of operation

Table 47: Inputs

Input	Description
Control	Data type: Boolean

Table 48: Outputs

Output	Description
Enabled	Data type: Boolean Depending on the **Switch-on delay time** parameter.

Table 49: Parameter

Parameter	Description
Switch-on delay time	0 ... 300 s in 1-ms steps [1)] • The delay time begins with a rising signal edge at the **Control** input. If, after expiration of the configured delay time, the **Control** input is still 1, the **Enabled** output = 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.

1) 0 = No delay

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 = 1 and a switch-on delay time > 0 is configured, then the **Enabled** output = 0. If the **Control** input remains at 1, then the **Enabled** output remains 0 until the configured switch-on delay time has expired (Prerequisite: First logic cycle < configured switch-on delay time).

8.5.2.3.2 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 is present. The output is switched on without delay if a rising signal edge is present.

Principle of operation

Table 50: Inputs

Input	Description
Control	Data type: Boolean

Table 51: Outputs

Output	Description
Enabled	Data type: Boolean Depending on the **Switch-off delay time** parameter.

Table 52: Parameter

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

1) 0 = No delay

Sequence/timing diagram

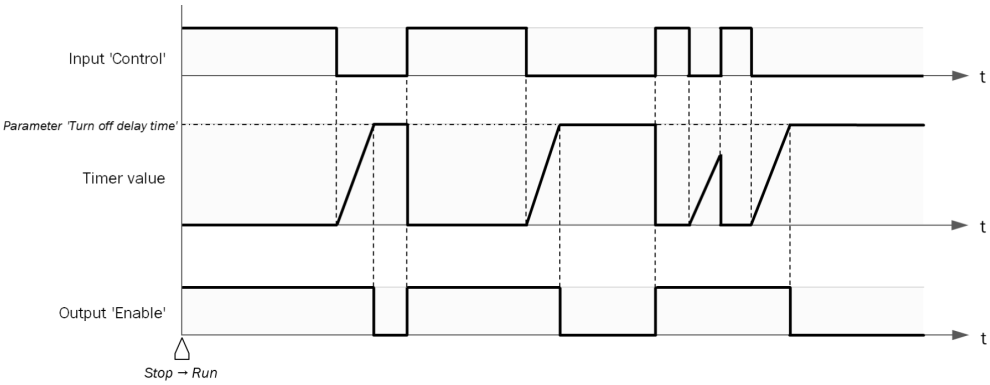


Figure 26: Sequence/timing diagram

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.

8.5.2.3.3 Adjustable on-delay timer V1

Overview

This function block outputs a rising signal edge (0–1) at the **Control** input at the **Enabled** output after a delay.

You can configure up to four delay times. The delay times are activated via the associated inputs. The total delay time at the **Enable** output is equal to the sum of all the activated delay times.

Principle of operation

Table 53: Inputs

Input	Description
Control	Data type: Boolean
Delay 1 ... Delay 4 (optional)	Data type: Boolean

Table 54: Outputs

Output	Description
Enabled	Data type: Boolean If the **Control** input returns to 0 before the selected total delay time expires, the **Enabled** output remains = 0
Time changed	Data type: Boolean 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 55: Parameter

Parameter	Description
Delay 1 ... Delay 4	0 ... 600 s in 1 ms increments An input is only available if you configure a delay time > 0 for the corresponding parameter.

Sequence/timing diagram

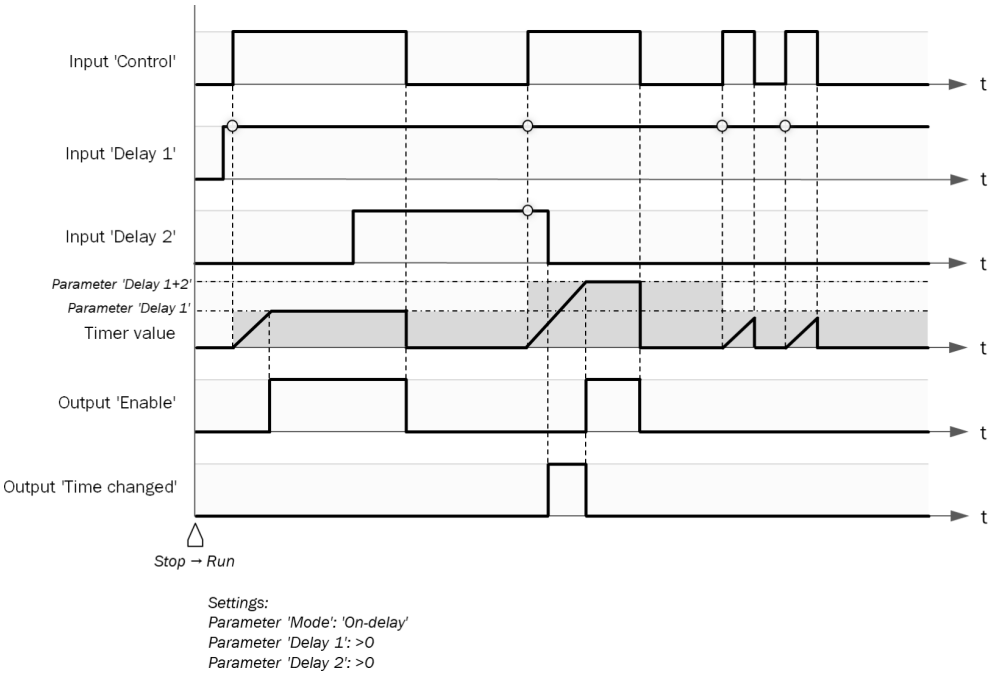


Figure 27: Sequence/timing diagram

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 **Enable** output = 0.

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

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

8.5.2.3.4 Adjustable off-delay timer V1

Overview

This function block outputs a falling signal edge (1–0) at the **Control** input at the **Enabled** output after a delay.

You can configure up to four delay times. The delay times are activated via the associated inputs. The total delay time at the **Enable** output is equal to the sum of all the activated delay times.

Principle of operation

Table 56: Inputs

Input	Description
Control	Data type: Boolean
Delay 1 ... Delay 4 (optional)	Data type: Boolean

Table 57: Outputs

Output	Description
Enabled	Data type: Boolean If the **Control** input returns to 1 before the selected total delay time expires, the **Enabled** output remains = 1
Time changed	Data type: Boolean 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 58: Parameter

Parameter	Description
Delay 1 ... Delay 4	0 ... 600 s in 1 ms increments An input is only available if you configure a delay time > 0 for the corresponding parameter.

Sequence/timing diagram

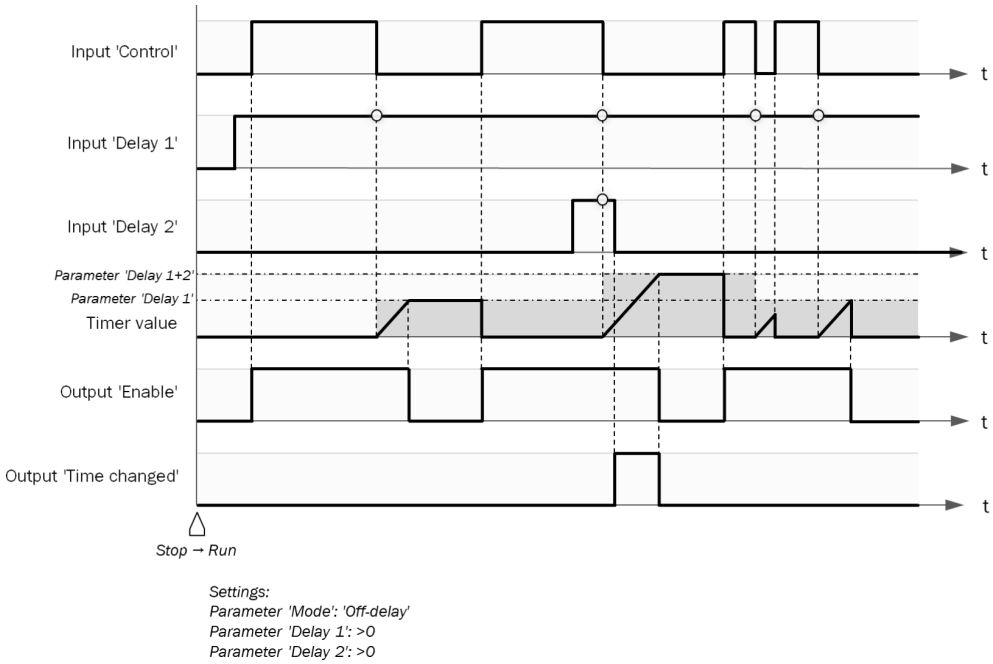


Figure 28: Sequence/timing diagram

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 **Enable** output = 0.

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

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

8.5.2.3.5 Clock generator V1

Overview

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

Principle of operation

Table 59: Inputs

Input	Description
Enable	Data type: Boolean

Table 60: Outputs

Output	Description
Clock	Data type: Boolean • If the **Enable** input = 1, then the **Clock** output pulsates. • If the **Enable** input = 0, then the **Clock** output becomes = 0.

Table 61: Parameter

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, then 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 29 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 29 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

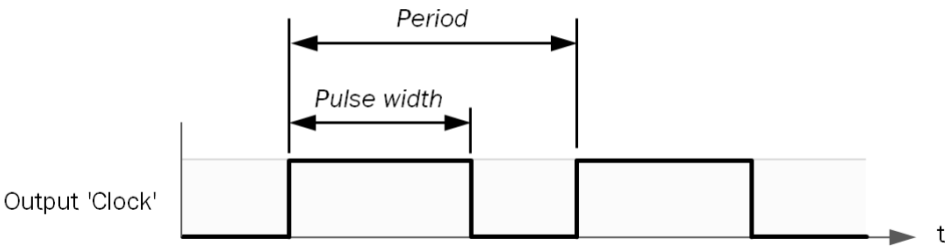


Figure 29: Parameter diagram

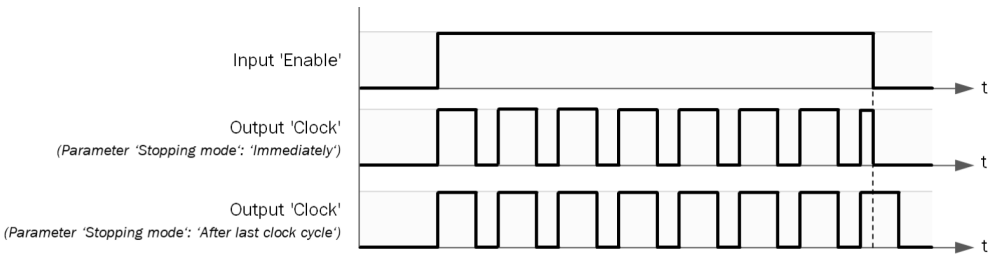


Figure 30: Sequence/timing diagram

8.5.2.3.6 Event counter (up) V1

Overview

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

Principle of operation

Table 62: Inputs

Input	Description
Up	Data type: Boolean A rising signal edge (0–1) at the **Up** input increases the value of the internal counter 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: Boolean A rising signal edge (0–1) at the input sets the value of the internal counter 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 63: Outputs

Output	Description
Counter value	Data type: UINT16 Outputs the value of the internal counter (0 ... 65,535).
Upper limit	Data type: Boolean Is 1 as long as the counter = Maximum value
Overflow	Data type: Boolean See the **Behavior with overflow** parameters

Table 64: Parameter

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

8.5.2.3.7 Event counter (down) V1

Overview

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

Principle of operation

Table 65: Inputs

Input	Description
Down	Data type: Boolean A rising signal edge (0–1) at the **Down** input decreases the value of the internal counter 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: Boolean A rising signal edge (0–1) at the input sets the value of the internal counter to the configured value of the Reload value parameter.

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 66: Outputs

Output	Description
Counter value	Data type: UINT16 Outputs the value of the internal counter (0 ... 65,535).
Lower limit	Data type: Boolean Is 1 as long as the counter = 0
Underflow	Data type: Boolean See the **Behavior with underflow** parameters

Table 67: Parameter

Parameter	Description
Initialization value	The start value of the internal counter is set to the value of the **Maximum value** parameter in the first logic cycle.
Behavior with underflow	This parameter controls the behavior of the function block when the internal counter has reached the value 0 and then another counting pulse occurs at the **Down** input. • No underflow function All other rising signal edges at the **Down** input are ignored. • Underflow function o The **Underflow** output is 1 for the duration of a logic cycle. o The value of the internal counter is set to the **Maximum value** parameter.
Maximum value	1 ... 65,535
Reload value	Corresponds to the **Maximum value** parameter.

8.5.2.3.8 Event counter (up and down) V1

Overview

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

Principle of operation

Table 68: Inputs

Input	Description
Up	Data type: Boolean A rising signal edge (0–1) at the **Up** input increases the value of the internal counter by “1” as long as the maximum value has not been reached. [1)] If the maximum value is exceeded, the behavior depends on the **Overflow behaviour** 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: Boolean A rising signal edge (0–1) at the **Down** input decreases the value of the internal counter by “1” as long as 0 has not been reached. [1)] If the value falls below 0, the behavior depends on the **Underflow behaviour** 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: Boolean A rising signal edge (0–1) at the input sets the value of the internal counter to 0.
Set to Reload value	Data type: Boolean A rising signal edge (0–1) at the input sets the value of the internal counter to the configured value of the Reload value parameter. 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 69: Outputs

Output	Description
Counter value	Data type: UINT16 Outputs the value of the internal counter (0 ... 65,535).
Upper limit	Data type: Boolean Is 1 as long as the counter = Maximum value
Lower limit	Data type: Boolean Is 1 as long as the counter = 0
Overflow	Data type: Boolean See the **Overflow behaviour** parameters
Underflow	Data type: Boolean See the **Underflow behaviour** parameters

Table 70: Parameter

Parameter	Description
Initialization value	The parameter defines to which start value the internal counter is set after the first logic cycle. • Set to 0 at start The **Lower limit** output is immediately set to 1. • Set to Reload value at start If Reload value = Maximum value, then the **Upper limit** output is immediately set to 1. If Reload value = 0, then the **Lower limit** output is immediately set to 1. • Set to maximum value at start The **Upper limit** output is immediately set to 1.

Parameter	Description
Overflow behaviour	This parameter controls the behavior of the function block when the internal counter has reached the maximum value and then another counting pulse occurs at the **Up** input. • No overflow function All other rising signal edges at the **Up** input are ignored. • No overflow function o The **Overflow** output is 1 for the duration of a logic cycle. o The value of the internal counter is set to 0.
Underflow behaviour	This parameter controls the behavior of the function block when the internal counter has reached the value 0 and then another counting pulse occurs at the **Down** input. • Underflow function All other rising signal edges at the **Down** input are ignored. • No underflow function o The **Underflow** output is 1 for the duration of a logic cycle. o The value of the internal counter is set to the **Maximum value** parameter.
Maximum value	1 ... 65,535 The value must be greater than or equal to Reload value.
Reload value	0 ... 65,535 The value must be less than or equal to the **Maximum value** parameter.

8.5.2.4 Function blocks for input evaluation

8.5.2.4.1 Two hand control (2 inputs) V1

Overview

This function block provides the logic for monitoring the inputs of a two-hand control device. The category 1 (Type IIIA) or category 4 (Type IIIC) according to EN 574 depends on the wiring and parameterization.

Principle of operation

Table 71: Inputs

Input	Description
1A (NO) 1B (NC)	Data type: Boolean

Table 72: Outputs

Output	Description
Enable	Data type: Boolean • 0 = not enabled • 1 = enabled The **Enable** output is set to 1 if the following conditions are met: o Both inputs are inactive at the same time for at least the duration of the logic execution time o Both inputs are then active
Synchronization status	Data type: Boolean • 0 = Error Synchronization time exceeded. • 1 = No error or unknown

Synchronization time

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

Fixed value: 500 ms in accordance with EN 574

Sequence monitoring

The **Enable** output is set to 1 if both inputs were inactive at the same time for at least the logic execution time before being activated.

If the **Enable** output = 1 and then at least one input becomes inactive, then the **Enable** output = 0.

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

8.5.2.4.2 Two hand control (4 inputs) V1

Overview

This function block provides the logic for monitoring the inputs of a two-hand control device. The category 1 (Type IIIA) or category 4 (Type IIIC) according to EN 574 depends on the wiring and parameterization.

Principle of operation

Table 73: Inputs

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

Table 74: Outputs

Output	Description
Enable	Data type: Boolean • 0 = not enabled • 1 = enabled The **Enable** output is set to 1 if the following conditions are met: o Both input pairs are inactive at the same time for at least the duration of the logic execution time o Both input pairs are then active
Status of input pair 1	Data type: Boolean
Status of input pair 2	• 0 = Error Input pair has not gone into a complementary status within the discrepancy time. • 1 = No error or unknown
Synchronization status	Data type: Boolean • 0 = Error Synchronization time exceeded. • 1 = No error or unknown

Table 75: Parameter

Parameter	Description
Discrepancy time (pair 1)	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 If set to 0, discrepancy monitoring is deactivated. The effective value is the input value rounded up to the next multiple of the logic execution time. The effective discrepancy time must be = 0 or ≥ the logic execution time.
Discrepancy time (pair 2)	

Synchronization time

The synchronization time is the amount of time for which the input pairs 1 and 2 are allowed to have different values.

Fixed value: 500 ms in accordance with EN 574

The synchronization time evaluates the relationship between the two dual-channel evaluation functions. By contrast, the discrepancy time relates to one pair of inputs for one dual-channel evaluation function.

Sequence monitoring

The **Enable** output is set to 1 if both input pairs were inactive at the same time for at least the logic execution time before being activated.

If the **Enable** output = 1 and then at least one input of an input pair becomes inactive, then the **Enable** output = 0.

Sequence/timing diagram

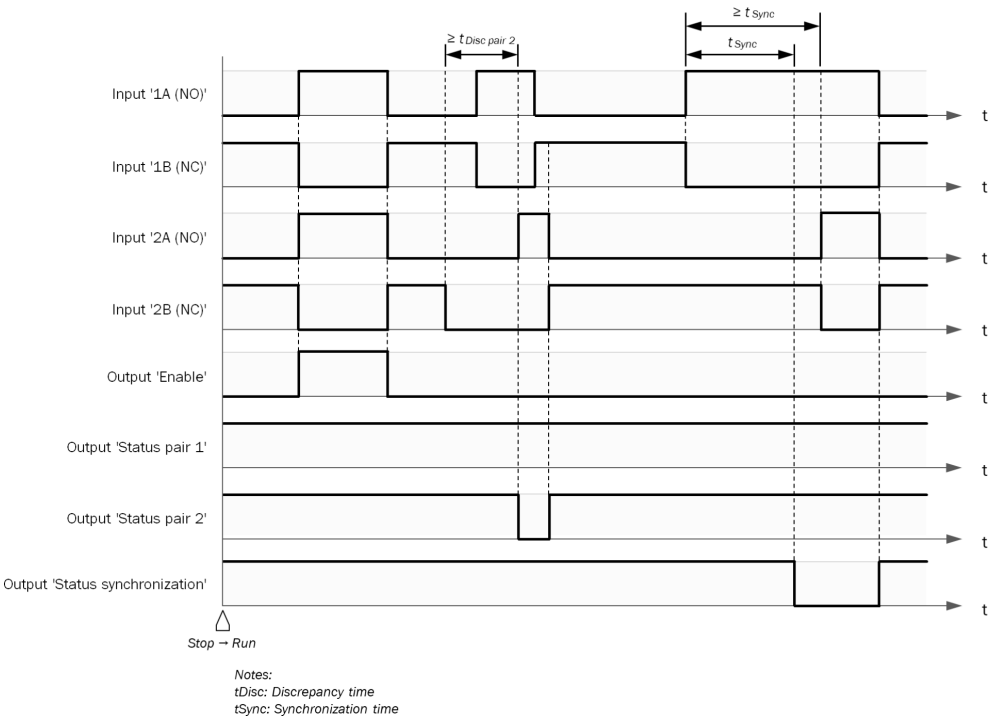


Figure 31: Sequence/timing diagram

Complementary information

- Different propagation times of the input signals can lead to a lengthening or shortening of the discrepancy time and/or synchronization time.
- Possible statuses of an input pair

Table 76: Possible statuses of an input pair

Input A (normally open)	Input B (normally closed)	Status
0	0	Discrepant
0	1	Deactivated
1	0	Active
1	1	Discrepant

Further topics

- "Configuration options for input elements", page 42

8.5.2.4.3 Dual channel monitor V1

Overview

This function block evaluates dual-channel switches or sensors. The function block checks the sequence and discrepancy of two inputs.

You can use the function block if, for example, you are unable to configure dual-channel evaluation in the hardware configuration.

Principle of operation

Table 77: Inputs

Input	Description
Input A	Data type: Boolean
Input B	

Table 78: Outputs

Output	Description
Enable	Data type: Boolean The dual-channel evaluation can only switch to active (**Enable** output changes from 0 to 1) after a correct sequence. The inputs are not allowed to change from active to discrepant and then back to active. The **Enable** output can only change back to 1 if both inputs are inactive at the same time for at least the logic execution time.
Status	Data type: Boolean • 0 = Error Discrepancy error or sequence error • 1 = No error

Table 79: Parameter

Parameter	Description
Input mode	• Equivalent • Complementary

Parameter	Description
%Ignore%	This parameter determines the behavior of the function block during the first logic cycle. • Active In the first logic cycle, both inputs must be inactive at the same time for at least one logic cycle. If one of the two inputs is already active during the first logic cycle, the **Enable** output remains 0 until both inputs are 0 at the same time for at least one logic cycle and both inputs are subsequently activated. • Not active If one input is already active during the first logic cycle, the **Enable** output switches to 1 as soon as the second input is activated during the discrepancy time. If both inputs are already active during the first logic cycle, the **Enable** output switches to 1.
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 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. If signals from tested sensors are connected, the discrepancy time must exceed the test pulse duration + the maximum OFF-ON delay of the test output that is being used. You can find these values, for example, in the report. When set to 0, both inputs must switch during the same logic cycle.

Table 80: Truth table

Input mode	Input A	Input B	Status	Output Enable
Equivalent	0	0	Deactivated	0
	0	1	Discrepant, input A switched off	0
	1	0	Discrepant, input B switched off	0
	1	1	Active, if the correct sequence has been observed and the configured discrepancy time has not been exceeded	1
Complementary	0	1	Deactivated	0
	0	0	Discrepant, input A switched off	0
	1	1	Discrepant, input B switched off	0
	1	0	Active, if the correct sequence has been observed and the configured discrepancy time has not been exceeded	1

Sequence/timing diagram

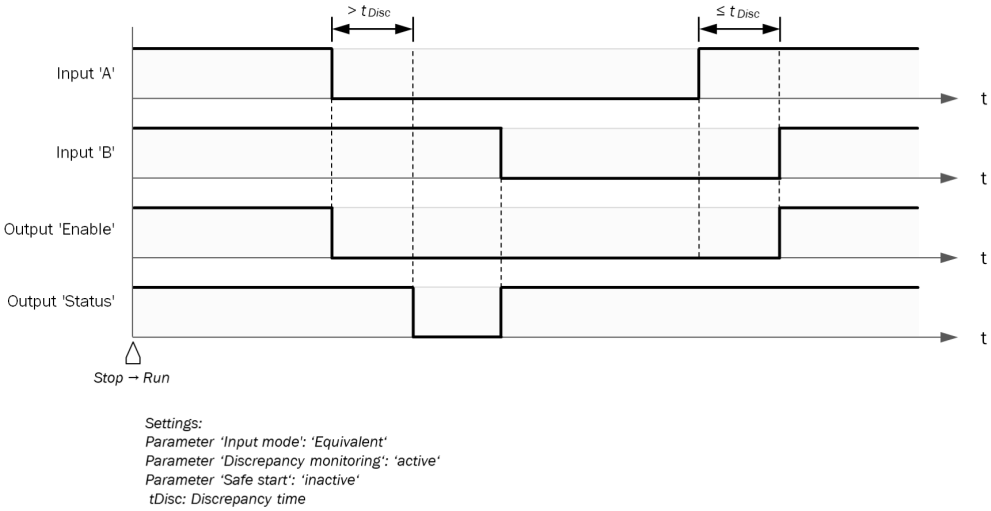


Figure 32: Sequence/timing diagram

Complementary information

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

Further topics

- "Configuration options for input elements", page 42

8.5.2.4.4 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 81: Inputs

Input	Description
Input	Data type: Boolean

Table 82: Outputs

Output	Description
Edge detected	Data type: Boolean 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 83: Parameter

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

Sequence/timing diagram

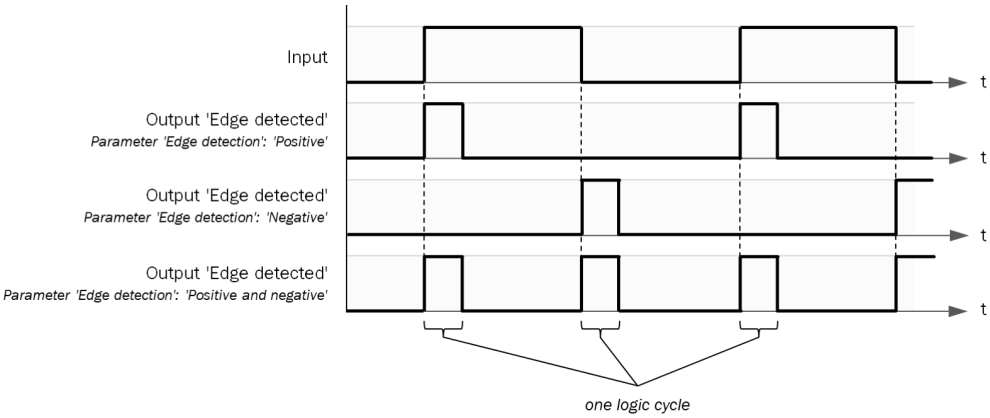


Figure 33: Sequence/timing diagram

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.

8.5.2.5 Function blocks for output control

8.5.2.5.1 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 **Enable** 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, then 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 84: Inputs

Input	Description
Control input	Data type: Boolean 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: Boolean 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 85: Outputs

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

Table 86: Parameter

Parameter	Description
Max. feedback delay	1 ms ... 60 s Maximum permitted delay until the feedback signal = 1. 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 edge of the **Enable** 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 Switch-on monitoring: If a falling edge of the **Enable** output is present, the function block monitors whether the **EDM feedback signal** input switches to 1 within the configured **Max. feedback delay**.

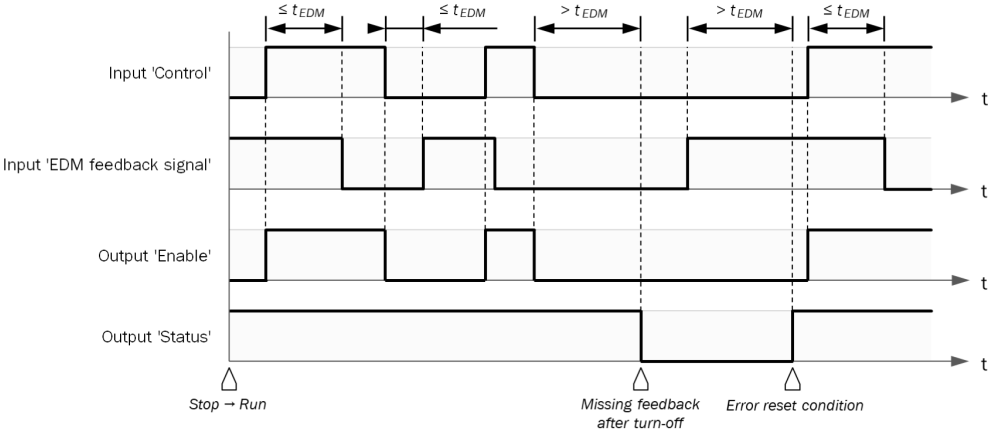
Errors and reset conditions

Table 87: Errors and reset conditions

Applies to EDM operating mode		Error	Reset condition
Switch-on monitoring	Turn-on monitoring and turn-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 feedback delay time.	**Control input** input = 0

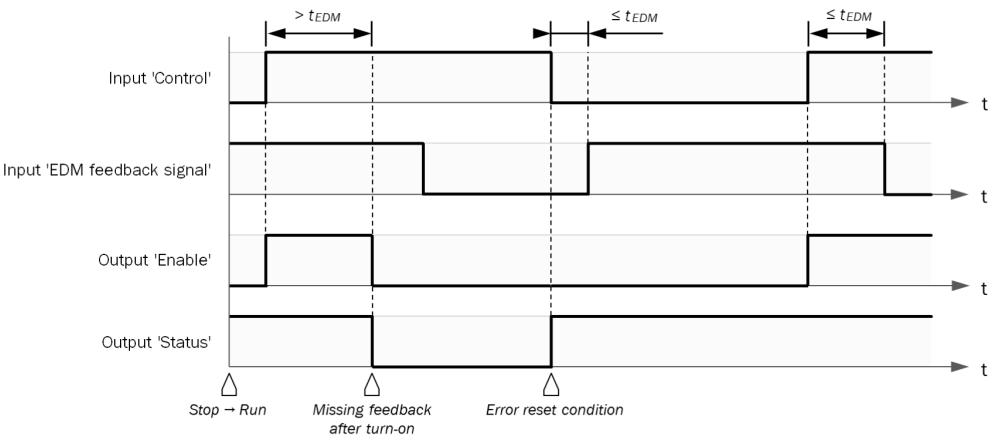
Applies to EDM operating mode		Error	Reset condition
Switch-on monitoring	Turn-on monitoring and turn-off monitoring		
No	Yes	After the **Control input** input = 0, the **EDM feedback signal** input does not switch to 1 within the configured feedback delay time.	The **EDM feedback signal** input = 1 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



Settings:
Parameter 'EDM-Mode': 'Turn-on/off monitoring'
tEDM: Parameter 'Max. EDM feedback delay time'

Figure 34: Sequence/timing diagram



Settings:
Parameter 'EDM-Mode': 'Turn-on or turn-on/off monitoring'
tEDM: Parameter 'Max. EDM feedback delay time'

Figure 35: Sequence/timing diagram

Complementary information

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

- Signal propagation time between the **Enable** 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 **Enable** to be delayed, you must implement this delay by using another function block that is located upstream of the **External device monitoring V1** function block. Otherwise, errors may result.

8.5.2.5.2 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 physical inputs and outputs 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 on 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 88: Inputs

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

Table 89: Outputs

Output	Description
Output	Data type: Boolean Depends on the **Bypass** parameter and the internal logic. You need to first connect the associated inputs to the input elements before the output can be configured.

Table 90: Parameter

Parameter	Description
Number of inputs (I/O settings tab)	1 ... 8
Bypass (I/O settings tab)	Bypass bridges the fast shut off function with the help of the **Bypass** input. If the **Bypass** input = 1, then **Output** remains = 1 and the physical output = High.
Internal logic (Parameter tab)	You can configure the internal logic of the function block.

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.

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 enable the robot movement.

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

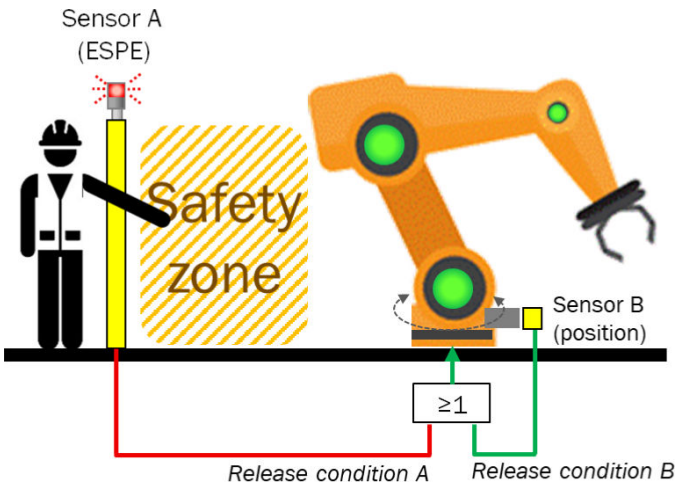


Figure 36: Example: Two alternative enable conditions

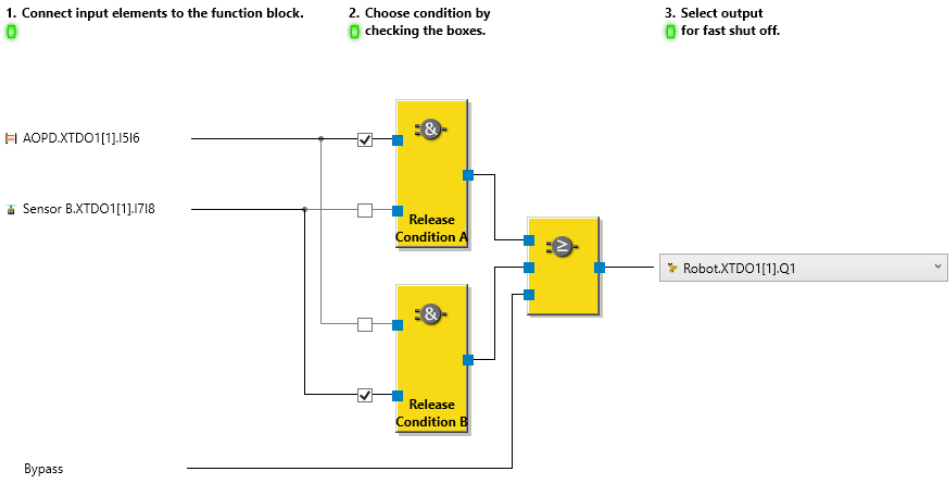


Figure 37: Example of Fast shut off V1 internal logic for alternative enable conditions

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 91: 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	Normal response time + switch-on delay of 3 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 3 logic cycles in advance in the logic before the input signal changes to 0 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 122

8.5.2.6 Function blocks for applications

8.5.2.6.1 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 92: Inputs

Input	Description
Reset	Data type: Boolean 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: Boolean See **Enable** output.

Table 93: Outputs

Output	Description
Enable	Data type: Boolean Resets the safety device. • When the **Release** input = 1 and the function block detects a valid reset pulse on the **Reset** input, the **Enable** output switches to 1. • The **Release** output remains = 1 as long as the **Enable** input = 1.
Reset required	Data type: Boolean The output pulsates at 1 Hz to indicate that the function block is expecting a valid reset pulse at the **Reset** input so that the **Enable** output can switch to 1. When the **Release** input = 1 and the function block detects a rising signal edge at the **Reset** input, the **Ready for reset** output switches permanently to 1. You can use this output to control an indicator lamp.
Ready for reset	Data type: Boolean The output switches to 1 when a valid pulse at the **Reset** input leads to activation of the **Enable** output.

Sequence/timing diagram

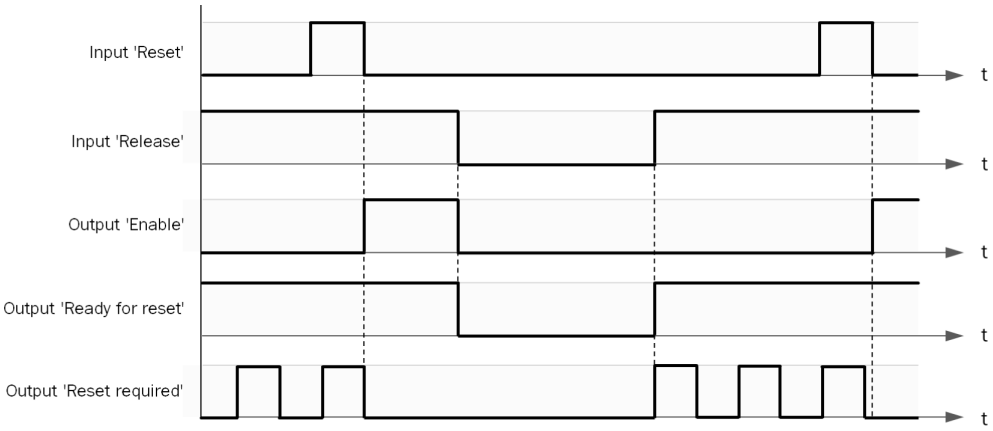


Figure 38: Sequence/timing diagram

Complementary information

To evaluate the minimum length of the reset pulse (here: 100 ms), the reset signal must be sampled twice after a 0→1 transition is detected. The required minimum length of the reset signal is therefore extended by one logic execution time.

8.5.2.6.2 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 94: Inputs

Input	Description
Restart	Data type: Boolean 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: Boolean See **Enable** output.

Table 95: Outputs

Output	Description
Enable	Data type: Boolean Resets the safety device. • When the **Release** input = 1 and the function block detects a valid restart pulse on the **Restart** input, the **Enable** output switches to 1. • The **Enable** output remains = 1 as long as the **Enable** input = 1.
Restart required	Data type: Boolean The output pulsates at 1 Hz to indicate that the function block is expecting a valid restart pulse at the **Restart** input so that the **Enable** output can switch to 1. When the **Release** input = 1 and the function block detects a rising signal edge at the **Restart** input, the **Restart required** output switches permanently to 1. You can use this output to control an indicator lamp.
Ready for restart	Data type: Boolean The output switches to 1 when a valid pulse at the **Restart** input leads to activation of the **Enable** output.

Sequence/timing diagram

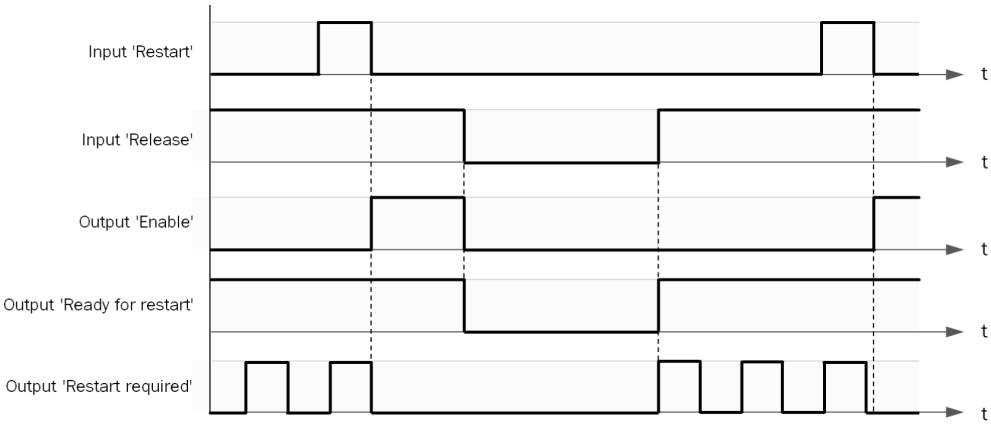


Figure 39: Sequence/timing diagram

Complementary information

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

8.5.2.6.3 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 function block.

Principle of operation

Table 96: Inputs

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

Table 97: Outputs

Output	Description
Enabled	Data type: Boolean **The output switches to 1 if all of the following conditions are met:** • The **Release 1** and **Release 2** inputs are and remain set to 1. • All connected **Operator 1 ... Operator 3** inputs change from 0 to 1 (rising signal edge). • No rising or falling signal edge is detected at the **Cycle request** input during or after the **Operator 1 ... Operator 3** inputs change from 0 to 1. **The output switches 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. • A rising or falling signal edge is detected at the **Cycle request** input. During the first logic cycle, the **Enabled** output = 0.

Table 98: Parameter

Parameter	Description
Cycle request condition	• Rising signal edge • Falling signal edge
Number of operators	• 2 operators • 3 operators

Parameter	Description
Number of release inputs	0 ... 2

Sequence/timing diagram

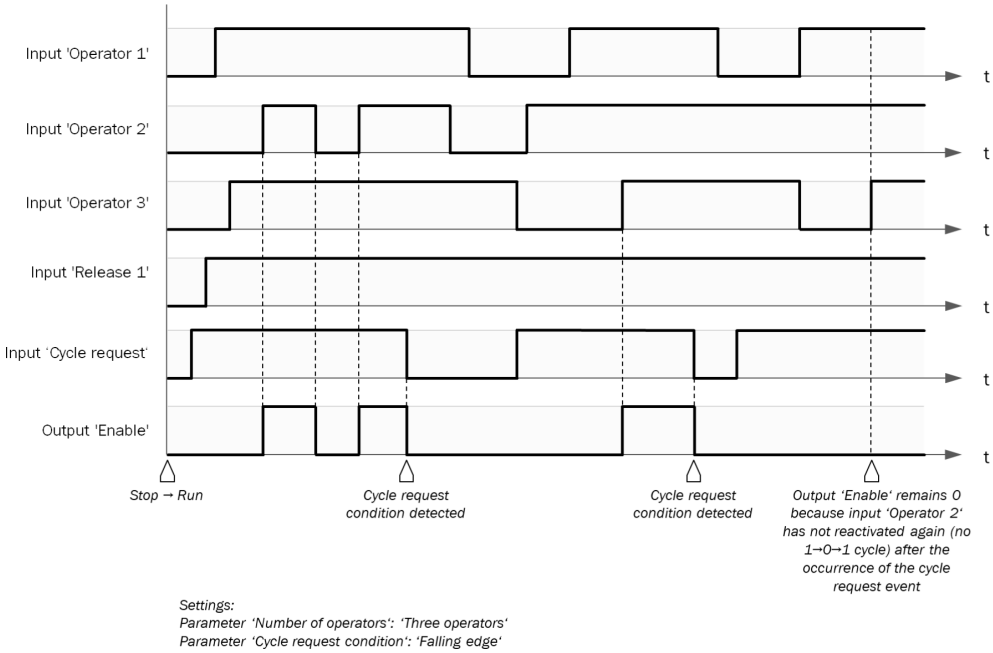


Figure 40: Sequence/timing diagram

8.5.2.6.4 Operating mode switch V1

Overview

This function block selects an output based on an input value.

Principle of operation

Table 99: Inputs

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

Table 100: Outputs

Output	Description
Output 1 ... Output 8	Data type: Boolean If exactly one input x = 1, then output x = 1. **Example:** • 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: Boolean 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.

Output	Description
Status	Data type: Boolean • Output = 0, if the error output combination is active. • Output = 1, if exactly one input is 1.

Table 101: Parameter

Parameter	Description
Number of inputs	2 ... 8
Discrepancy time	0 ... 10 s in 1 ms increments 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.
Error output combination	If no input = 1 or more than one input = 1 for the selected discrepancy time, the function block sets its outputs to the configured error output combination. Selected outputs switch to 1, and non-selected outputs switch to 0. For unused inputs (**Number of inputs** parameter), the corresponding value in the error output combination is set to 0. When a valid input combination is present again, the function block sets to 1 the output corresponding to the input. If a faulty input combination is already present in the first logic cycle, the error output combination is activated without delay.

Behavior of the function block

- Exactly one input must be = 1 at all times.
- If more than one input or no input is set to 1, the last output set to 1 remains 1 for the duration of the set discrepancy time. The **Status** output is 1.
- If no input or more than one input = 1 after the discrepancy time elapses, the outputs 1 ... 8 are set to the configured error output combination. The **Status** output is 0.

Sequence/timing diagram

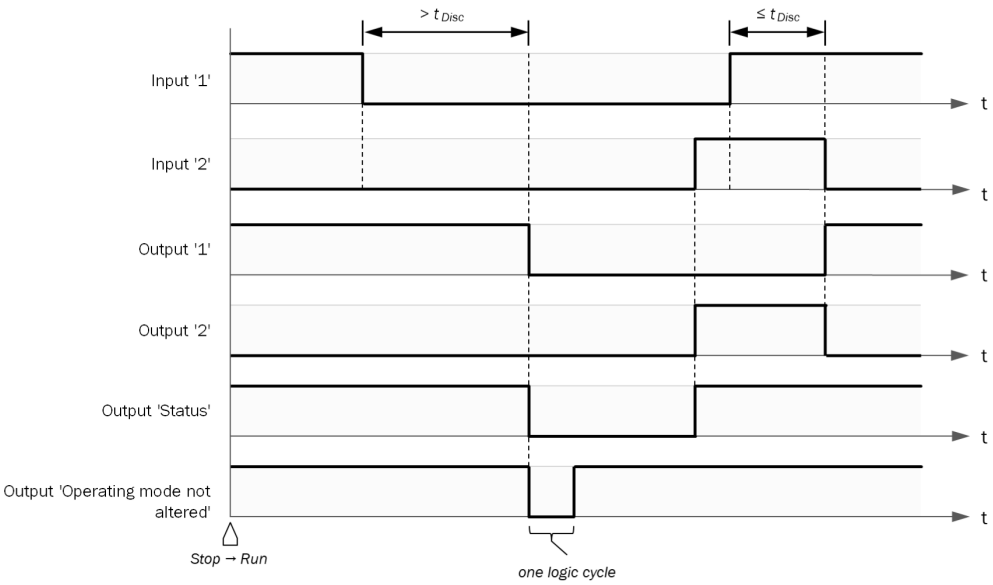


Figure 41: Sequence/timing diagram

8.5.2.6.5 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 102: Inputs

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

Table 103: Outputs

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

Table 104: Parameter

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.

8.5.2.6.6 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 105: Inputs

Input	Description
Input 1	Data type: Boolean
Input 2 ... Input 8 (optional)	
Set	Data type: Boolean Depending on the Inversion parameter, a rising or a falling signal edge saves the current status of inputs 1 ... 8 at the **Set** input. The function block also saves the statuses of the inputs when the **Set** input is already 1 in the first logic cycle.

Table 106: Outputs

Output	Description
Output 1 ... Output 8	Data type: Boolean • 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 107: Parameter

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. • Input Set No inversion: Saving done with rising signal edge. With inversion: Saving done with falling signal edge.

8.5.2.7 Function blocks for muting

Muting is an automated 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 bypasses monitoring by the electro-sensitive protective equipment.

8.5.2.7.1 Parallel muting V1

Overview

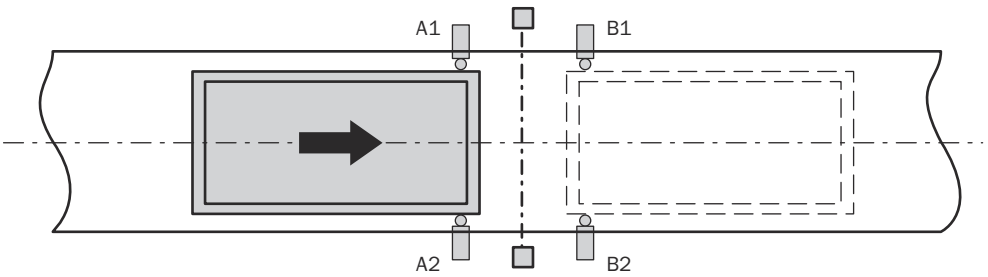


Figure 42: Muting with two sensor pairs arranged in parallel (A1 / A2 and B1 / B2)

Principle of operation

Table 108: Inputs

Input	Description
Electro-sensitive protective device	Data type: Boolean The input must be connected to the electro-sensitive protective device.
A1 A2 B1 B2	Data type: Boolean Signal from the muting sensor
Override (optional)	Data type: Boolean "Input Override", page 94
Conveyor (optional)	Data type: Boolean "Input Conveyor", page 97

Input	Description
C1 (optional)	Data type: Boolean 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

Output	Description
Enable	Data type: Boolean
Muting lamp	Data type: Boolean 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: Boolean 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: Boolean
Muting error	Data type: Boolean "Output Muting error", page 97
Override status	Data type: Boolean
Status	Data type: Boolean • 0 = Error • 1 = No error The value at the output is the inverted value of the **Muting error** output.

Table 110: Parameter

Parameter	Description
Direction detection	• Disabled • Forward (A1/A2 first) (A1 / A2 first) • Backward (B1/B2 first) (B1 / B2 first) "Parameter Direction detection", page 98
Condition of the other sensor pair for muting start	• Both sensors are free • At least one sensor is free "Parameter Condition of other sensor pair for muting start", page 99
Condition for end of muting	• With muting sensor pair • With electro-sensitive protective equipment (ESPE) "Parameter Muting end condition", page 99

Parameter	Description
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Parameter Total muting time", page 98
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. "Parameter Concurrency monitoring time", page 98
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 98
Additional muting time after the ESPE is released	0 ms, 200 ms, 500 ms, 1,000 ms "Parameter Additional muting time after the electro-sensitive protective device indicates a clear path", page 99
Input C1	• Active • Deactivated
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

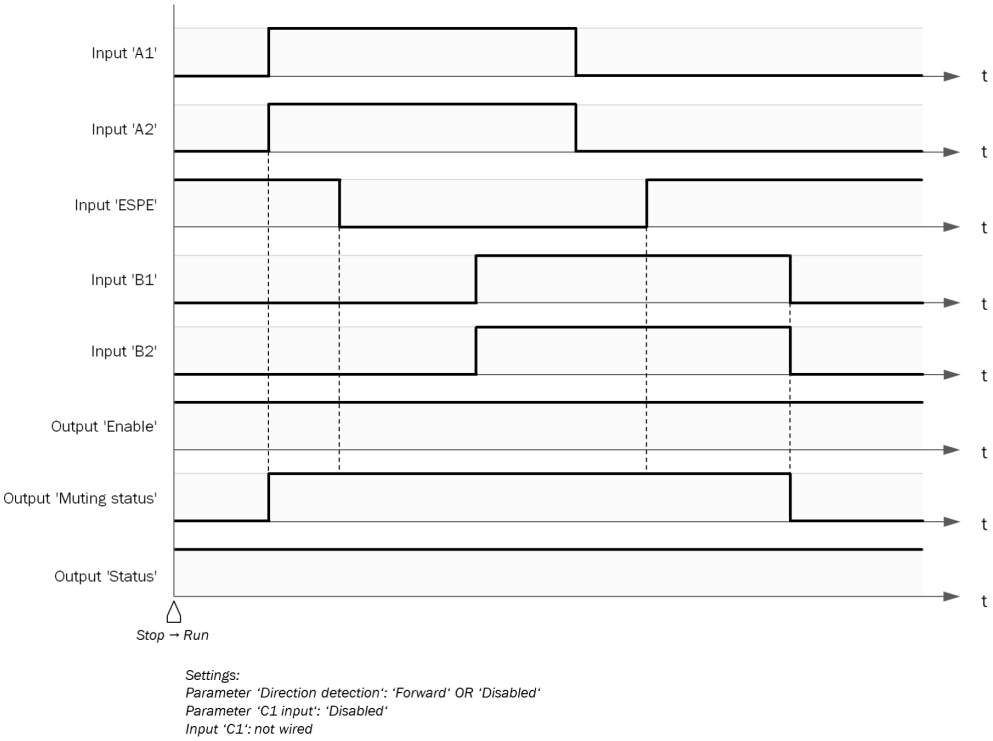


Figure 43: Sequence/timing diagram

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).

Further topics

- "Safety notes for muting applications", page 15

8.5.2.7.2 Sequential muting V1

Overview

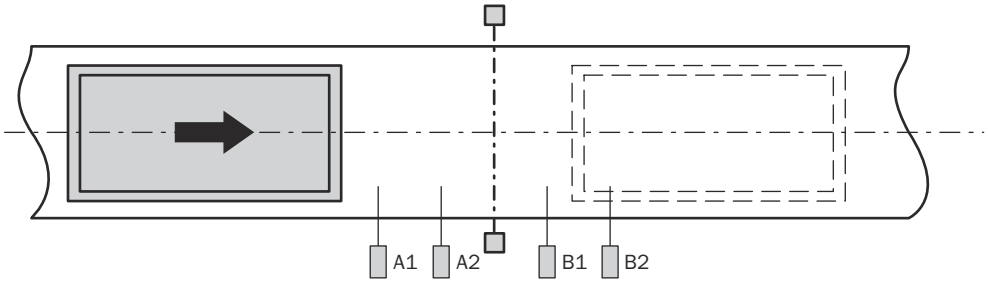


Figure 44: Muting with two sensor pairs arranged in sequence (A1 / A2 and B1 / B2)

Principle of operation

Table 111: Inputs

Input	Description
Electro-sensitive protective device	Data type: Boolean The input must be connected to the electro-sensitive protective device.
A1 A2 B1 B2	Data type: Boolean Signal from the muting sensor
Override (optional)	Data type: Boolean "Input Override", page 94
Conveyor (optional)	Data type: Boolean "Input Conveyor", page 97
C1 (optional)	Data type: Boolean 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

Output	Description
Enable	Data type: Boolean

Output	Description
Muting lamp	Data type: Boolean 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: Boolean 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: Boolean
Muting error	Data type: Boolean "Output Muting error", page 97
Override status	Data type: Boolean
Status	Data type: Boolean • 0 = Error • 1 = No error The value at the output is the inverted value of the **Muting error** output.

Table 113: Parameter

Parameter	Description
Direction detection	• Disabled • Forward (A1 / A2 first) • Backward (B1 / B2 first) "Parameter Direction detection", page 98
Condition of the other sensor pair for muting start	• Both sensors clear • At least one sensor clear "Parameter Condition of other sensor pair for muting start", page 99
Condition for end of muting	• With muting sensor pair • With electro-sensitive protective device (ESPE) "Parameter Muting end condition", page 99
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Parameter Total muting time", page 98
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. "Parameter Concurrency monitoring time", page 98

Parameter	Description
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 98 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 ESPE is released	0 ms, 200 ms, 500 ms, 1,000 ms "Parameter Additional muting time after the electro-sensitive protective device indicates a clear path", page 99
Input C1	• Active • Deactivated
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

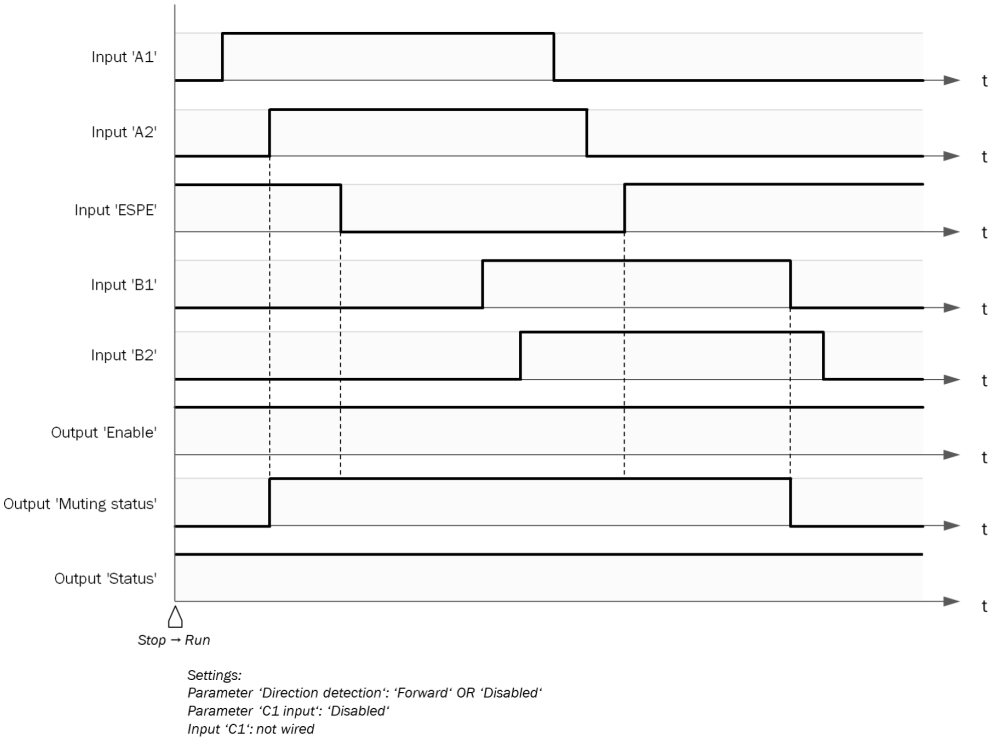


Figure 45: Sequence/timing diagram

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).

Further topics

- "Safety notes for muting applications", page 15

8.5.2.7.3 Cross muting V1

Overview

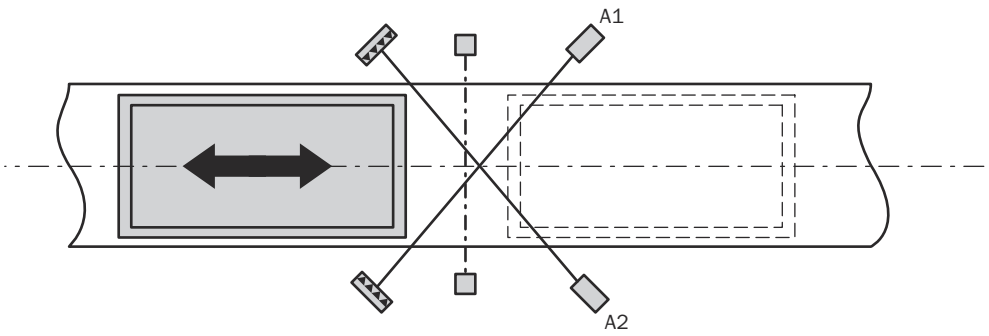


Figure 46: Muting with a sensor pair arranged crosswise (A1 / A2)

Principle of operation

Table 115: Inputs

Input	Description
Electro-sensitive protective device	Data type: Boolean The input must be connected to the electro-sensitive protective device.
A1 A2	Data type: Boolean Signal from the muting sensor
Override (optional)	Data type: Boolean "Input Override", page 94
Conveyor (optional)	Data type: Boolean "Input Conveyor", page 97

Input	Description
C1 (optional)	Data type: Boolean 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

Output	Description
Enable	Data type: Boolean
Muting lamp	Data type: Boolean 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: Boolean 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: Boolean
Muting error	Data type: Boolean "Output Muting error", page 97
Override status	Data type: Boolean
Status	Data type: Boolean • 0 = Error • 1 = No error The value at the output is the inverted value of the **Muting error** output.

Table 117: Parameter

Parameter	Description
Condition of the other sensor pair for muting start	• Both sensors clear • At least one sensor clear "Parameter Condition of other sensor pair for muting start", page 99
Condition for end of muting	• With muting sensor pair • With electro-sensitive protective device (ESPE) "Parameter Muting end condition", page 99
Total muting time	0 = infinite, 5 s ... 3,600 s, adjustable in 1 s increments "Parameter Total muting time", page 98
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. "Parameter Concurrency monitoring time", page 98

Parameter	Description
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 98
Additional muting time after the ESPE is released	0 ms, 200 ms, 500 ms, 1,000 ms "Parameter Additional muting time after the electro-sensitive protective device indicates a clear path", page 99
Input C1	• Active • Deactivated
Override input	• Active • Deactivated
Conveyor	• Active • Deactivated

Sequence/timing diagram

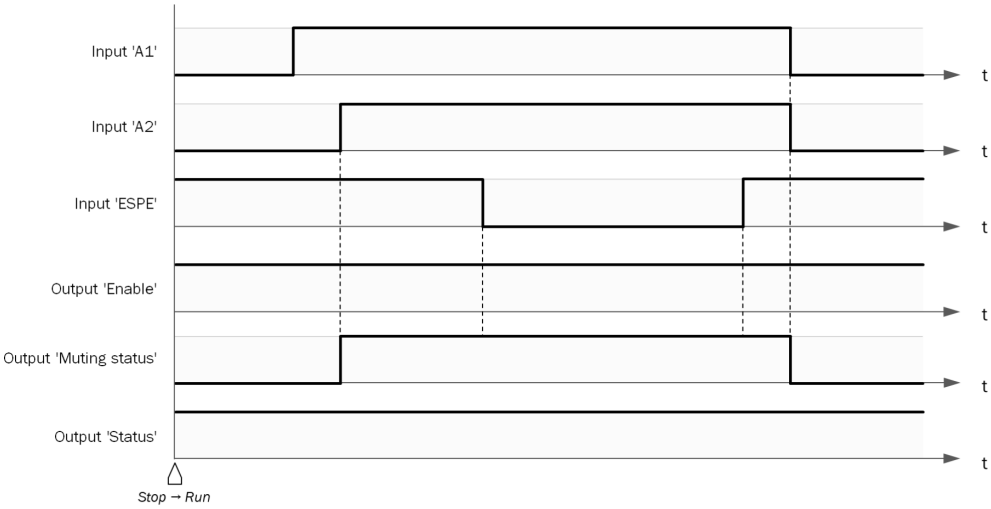


Figure 47: Sequence/timing diagram

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).

Further topics

- "Safety notes for muting applications", page 15

8.5.2.7.4 Input Override

Overview

An **Override** input signal allows you to remove transported objects that have been left stranded in the protective field of the protective device (e.g., safety light curtain) as a result of a power failure, an emergency stop, muting errors, or similar circumstances.

The **Override** function allows you to activate the **Enable** output of the muting function block even though no valid muting sequence has been detected and the protective equipment (e.g., safety light curtain) is signaling that a dangerous state may exist. The **Override** input should only be used if the hazardous area has been visually inspected beforehand, there is no one within the hazardous area, and nobody will be able to access the hazardous area while the **Override** input is in use.

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 override if the hazardous area has been visually inspected beforehand, there is no one within the hazardous area, and nobody will be able to access the hazardous area while the **Override** input is in use.

Override

The Override status output switches to 1 and the Override required output pulsates at 2 Hz if all of the following conditions are met:

- The **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)
- The **Enable** output = 0

If the conditions for the **Override required** output are met and a valid override sequence involving a 0–1–0 transition (at least 100 ms but not exceeding 3 s; longer or shorter pulses will be ignored) occurs at the **Override** input, the **Enable** output = 1 in exactly the same way as if the muting conditions had been met. Once all the muting sensor signal inputs have switched back to 0 and the **Electro-sensitive protective device** input = 1 (e.g., is indicating that the protective field of a safety light curtain is now clear), the next valid muting cycle is expected. If the next object does not meet the conditions for a muting cycle but does meet the conditions for the **Override required** output, then another override cycle can be used to remove the transported material. The number of override cycles is limited (see table 119, page 96).

NOTE
A reset pushbutton may also be suitable for the Override function.

Table 118: Conditions for Override required and when override is possible

Muting status	At least one of the muting sensor signal inputs A1, A2, B1, B2 = 1	Input Electro-sensitive protective device	Output Override required	Override possible
0	No	0	0	No
0	No	1	0	No
0	Yes	0	Pulsates (2 Hz)	Yes, unless the maximum permissible number of override cycles has been exceeded.
0	Yes	1	0	No
1	No	0	0	No

Muting status	At least one of the muting sensor signal inputs A1, A2, B1, B2 = 1	Input Electro-sensitive protective device	Output Override required	Override possible
1	No	1	0	No
1	Yes	0	0	No
1	Yes	1	0	No

Example sequence for **Override** and **Override required**:

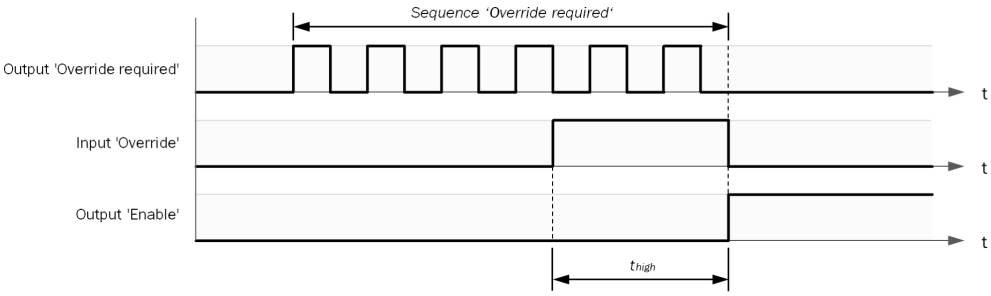


Figure 48: Sequence/timing diagram for Override and Override required

NOTE

t_{high} ≥ 100 ms, but ≤ 3 s.

Otherwise the pulse on the **Override** input is ignored.

During an override cycle, the **Enable** output is set to 1 in the same way as during a valid muting sequence. 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 119: Number of permissible override cycles

Total muting time	Number of permissible override cycles	Comments
5 s	360	Maximum number of override cycles = 360
10 s	360	
20 s	180	= 60 min/total muting time
30 s	120	
1 min	60	
5 min	12	
15 min	5	Minimum number of override cycles = 5
30 min	5	
60 min	5	
Disabled (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.

Once the **Override required** output has started pulsating at 2 Hz and a subsequent override signal = 1, muting begins again and the **Enable** output changes to 1.

If the muting cycle is stopped because of a faulty muting sensor input signal, the **Override required** output switches to 1 for the duration of the logic execution time if the remaining conditions for the **Override required** output are met. If the faulty muting sensor signal input switches back to 1 first and then returns to 0, the muting cycle is once again stopped and the **Override required** output switches to 1 if the remaining conditions for the **Override required** output are met.

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.

8.5.2.7.5 Input Conveyor

Input Conveyor

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 120: Effect of the Band signal input

Timer function	Effect of the Band signal input
Monitoring of the total muting time	• 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, a one-time increase of 5 seconds is added onto the total muting time.
Concurrence monitoring	

Complementary information

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

8.5.2.7.6 Output Muting error

Output Muting error

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 121: Error statuses and reset information for muting function blocks

Output Muting error	Resetting the error status	Comments
• Total muting time monitoring error • Concurrence monitoring error • Direction detection error • Sequence monitoring error • Error with transition from Stop status to Run status	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 **Enable** 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 suppressed.

8.5.2.7.7 Parameter Direction detection

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)** (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)** (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.

8.5.2.7.8 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.

8.5.2.7.9 Parameter Concurrency monitoring time

Parameter Concurrency monitoring time

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.

8.5.2.7.10 Parameter Total muting time

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 **Enable** 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.

8.5.2.7.11 Parameter Additional muting time after the electro-sensitive protective device indicates a clear path

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.

8.5.2.7.12 Parameter Muting end condition

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 **Enable** 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.

8.5.2.7.13 Parameter Condition of other sensor pair for muting start

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 the last one = 0, the **Electro-sensitive protective device** input = 1 (i.e., the protective field is clear).

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).

8.5.3 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.

- CPU marker

Further topics

- "CPU marker"
- "Jump addresses", page 101
- "Connecting elements", page 102

8.5.4 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 122: 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 123: 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

Process data status bits	Value	Description
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 112

8.5.5 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 (1 or 0) as the associated source jump address without a delay. They can be used to do the following, for example:

- Create a reverse path.
- Connect function blocks on different pages of the logic editor.

Complementary information

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

8.5.6 Logic programming in the logic editor

8.5.6.1 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.
- CPU markers cause a delayed response time.
- 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.

8.5.6.2 Adding an element

Approach

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

8.5.6.3 Connecting elements

Approach

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.

8.5.6.4 Configuring function blocks

Approach

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 50
- "Logical function blocks", page 51
- "Function blocks for applications", page 78

8.5.6.5 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.

8.5.7 Logic execution time

Logic execution time

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

The logic execution time depends on the type and number of function blocks used. It is a multiple of 4 ms.

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 execution 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 execution time, then the logic execution time is automatically increased by 4 ms.

The logic execution time has an accuracy of ± 500 ppm (parts per million).

8.5.8 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.

8.5.9 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

8.6 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.

8.7 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

8.8 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.

Approach

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.

8.9 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

Approach

1. Use one of the following options to check whether a connection to the correct safety controller exists.
   - Click on **Identification** 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 to device**.

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

3. Verify the configuration.

Further topics

- "Konfigurationsübertragung verifizieren"
- "Verifying the configuration content and configuration transfer at the same time", page 105

8.10 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, then 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 106

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

Prerequisites

- Existing connection between the configuration software and device

Approach

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 106

8.11 Checksums

Checksums

The configuration software displays various checksums in the report and on the hardware configuration information page.

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

Checksums:

- Overall checksum value
  The total checksum includes the safety configuration and the standard configuration.
- Safety checksum
  The safety checksum includes the safety configuration.
- Standard checksum
  The standard checksum includes the standard configuration (configuration data of the non-safety function).
- Verification checksum
  This checksum includes the safety configuration at the time of the most recent verification. If this checksum and the verification checksum are identical, the configuration of the safety controller is considered verified.

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

8.12 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.

Approach

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 test is intended to ensure that the hazardous area is monitored by the protective device and any attempted access to the hazardous area is prevented.

- Carry out the checks according to the instructions from the manufacturer of the machine and from the operating entity.

10 Operation

10.1 Regular thorough check

The test is intended to ensure that the hazardous area is monitored by the protective device and any attempted access to the hazardous area is prevented.

- ▶ Carry out the checks according to the instructions from the manufacturer of the machine and from the operating entity.

11 Maintenance

11.1 Regular thorough check

The test is intended to ensure that the hazardous area is monitored by the protective device and any attempted access to the hazardous area is prevented.

- Carry out the checks according to the instructions from the manufacturer of the machine and from the operating entity.

12 Troubleshooting

12.1 Status indicators

Possible indications

Table 124: 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 module 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 125, page 110	Application is ready to run.	▶ Press the start button in the configuration software.
☀ Red / green (1 Hz)	see table 125, page 110	Application is running. A recoverable external error is present at this module.	▶ Check the cabling of the flashing inputs and outputs.
● Green	see table 125, page 110	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, presumably at this 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. ▶ Run diagnostics using the configuration software.
● Red	○	Critical error, presumably at 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 125: CV indications

Display CV Main module	Description	Measures
○	see table 124, page 110	

Display CV Main module	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 124, page 110	
☼ Yellow (lights up every 2 s)	see table 124, page 110	

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

Table 126: 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 127: 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 128: 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 129: 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 12

12.2 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.

Possible faults and their causes

Table 130: Faults in the logic

Fault	Responses	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

Table 131: Faults in the safety capable inputs (I)

Fault	Responses	Causes
Electro-mechanical switch/safety switch (EMSS), safety sensors with test input, Flexi Loop: safety capable 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 capable 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 • Discrepancy time • Sequence error
Safety pressure mats: safety capable 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 capable input
Safety pressure mats: safety capable input 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

Table 132: Faults in the safety outputs (Q)

Fault	Responses	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	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] • **Status Qx short-circuit to High** process data status bit = 0 • **Status Qx short-circuit to High** module status bit = 0	• Short-circuit to other voltage-carrying line
Test pulses are not detected correctly when the output is “On”[3] [5]		• 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) Reset of 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, then 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.

Table 133: Faults in the test outputs (X)

Fault	Responses	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 110
- "Input elements", page 41
- "Diagnostics using Safety Designer", page 115

12.3 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.

12.3.1 Error history

Error history

Table 134: Error history information

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 103

13 Decommissioning

13.1 Disposal

Approach

- 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.

14 Technical data

14.1 Data sheet

Safety-related parameters

Table 135: 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
SIL claim limit (IEC 62061)	SILCL 2	SILCL 3	SILCL 3	SILCL 3
Cate-gory (ISO 13849-1)	Category 3	Category 4	Category 4	Category 4
Performance level (ISO 13849-1)	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 [years]	500	500	500	500
T_M ISO 13849-1 [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 136: Safety-related characteristic data - CPU logic processing

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

Table 137: 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
SIL claim limit (IEC 62061)	SILCL 3	SILCL 3	SILCL 3	SILCL 3
Category (ISO 13849-1)				
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 13849-1)	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 [years]	500	500	500	500
T_M ISO 13849-1 [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.
- Manually switch off all safety outputs simultaneously for min. 2 s once a year. The supply voltage to the outputs must be within the operating range during this manual test.

General data

Table 138: General data

Climatic conditions	
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	10% ... 95%, non-condensing
Operating altitude	Max. 4,000 m above sea level
Mechanical strength	
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	III (EN 61140)
Immunity to interference	EN 61000-6-2
Emitted interference	EN 61000-6-4
Connections	
Connection type	Spring terminals
Wire cross-section	Single wire or fine-stranded wire: 0.14 mm^2 ... 1.5 mm^2 Fine-stranded wire with ferrule: a) with plastic ferrule max. 1.0 mm^2 b) without plastic ferrule max. 1.0 mm^2 AWG according to UL/CSA: 26 ... 14 For UL and CSA applications: Use copper conductors only min. rated for 85 °C.
Housing	
Enclosure rating	IP20 (EN 60529)
Contamination rating	2 (IEC 61010-1)
Control device type	Open device (IEC 61010-2-201)
Weight (± 5%)	CPUc1: 277 g

Voltage supply (A1 / A2)

Table 139: 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.
Max. power loss	CPUc1: 6.2 W
Power consumption at nominal voltage (without outputs)	3 W
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	15 s

Type of terminal connections	Spring terminals

1) When selecting the voltage supply for the safety controller, you need to take into the account the no load current of all modules of the station, and the peak current consumption of all electrical consumers connected to the outputs of the safety controller. The maximum permissible supply current depends, amongst other things, on the ambient temperature and must not exceed the permitted value of 8 A (Ta = 55 °C). Take into consideration the effect of lack of ventilation or the power loss in cables or other devices on the ambient temperature in the control cabinet.

Safety capable inputs (I)

Table 140: Technical data for the safety capable inputs (I)

Input voltage High	11 V DC ... 30 V DC
Input voltage Low	–3 V DC ... +5 V DC
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 connection2)	≤ 100 µA
Input capacitance	15 nF
Discrepancy time	4 ms ... 30 s, configurable

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 141: 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
Max. output voltage Low 1)	–50 V DC ... –30 V DC
Output current High	≤ 100 mA
Leakage current Low	≤ 0.1 mA
Output resistance Low 2)	≤ 25 Ω
Test pulse duration	2 ms ... 100 ms, configurable
Test pulse frequency	8 ms ... 1,000 ms, configurable
Load capacity	
@ 2 ms test pulse duration	≤ 0.5 µF
@ 4 ms test pulse duration	≤ 1 µF
Inductive load at nominal voltage @ 100 mA	1,000 mH

1) Max. –30 V DC, to avoid damaging the output.
Max. –50 V DC, for fast switch-off of inductive loads.
2) The output current is actively limited.

Test outputs (X) used as non-safe outputs

Table 142: 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
Max. output voltage Low 1)	–50 V DC ... –30 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 [2] @ 100 mA	1,000 mH
Load capacity	1,000 µF

1) Max. –30 V DC, to avoid damaging the output.
Max. –50 V DC, for fast switch-off of inductive loads.
2) Only permissible if used as a PNP output.

Safety outputs (Q)

Table 143: 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
Max. 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 duration[4]	< 650 µs or deactivated
Test pulse frequency	≥ 190 ms
Cross-circuit detection using test pulses[5]	
Cable resistance	Max. 2.5 Ω (z. B. 100 m × 1.5 mm^2 = 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.)

14.2 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.

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.

14.2.1 Calculating the response time

Overview

You need to consider each signal path separately when calculating the response time.

Important information

NOTE
The calculation applies exclusively to the safety controller. You need to separately consider the response times of sensors and actuators.

Approach

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

Table 144: 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 or IN5 • "IN1 - Response time of safety capable inputs (I)", page 123 • "IN5 - Response time for processing of incoming process data", page 123	

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 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 fast shut off logic	No delay time	0
3. Outputs	Response time of the observed output in the signal path	OUT1, OUT2 or OUT5 • "OUT1 - Response time of safety outputs (Q)", page 124 • "OUT2 - Response time of test outputs (X)", page 124 • "OUT5 - Response time for processing of outgoing process data", page 124	
Total			

IN1 - Response time of safety capable inputs (I)

Table 145: 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 frequency of the test output • For safety pressure mats: the longer test pulse frequency of the two test outputs • For electro-mechanical switch/safety switch (EMSS): test pulse duration of the test output	
Total		

IN5 - Response time for processing of incoming process data

Table 146: IN5 - Response time for processing of incoming process data

When relevant?		Description	Value [ms]
IN5	When using Flexi Loop on the expansion module (diagnostic data).	2 × internal update interval (56 ms) - 4 ms = 108 ms	
Total			

OUT1 - Response time of safety outputs (Q)

Table 147: 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]: • Without the **Increased capacitive loads allowed** option: 5 ms • With the **Increased capacitive loads allowed** option: 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]: • Without the **Increased capacitive loads allowed** option: 5 ms • With **Increased capacitive loads allowed** option: 50 ms	
Fast shut off is used.	0.5 ms	
Total		

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 148: OUT2 - Response time of test outputs (X)

When relevant?	Description	Value [ms]
Always	1 ms	
Total		

OUT5 - Response time for processing of outgoing process data

Table 149: OUT5 - Response time for processing of outgoing process data

When relevant?		Description	Value [ms]
OUT5	When using Flexi Loop on the expansion module (service data).	2 × internal update interval (56 ms) - 1 ms = 111 ms	
Total			

Further topics

- "Report main navigation menu", page 103
- "Input elements", page 41
- "Configuration options for input elements", page 42

14.3 Dimensional drawings

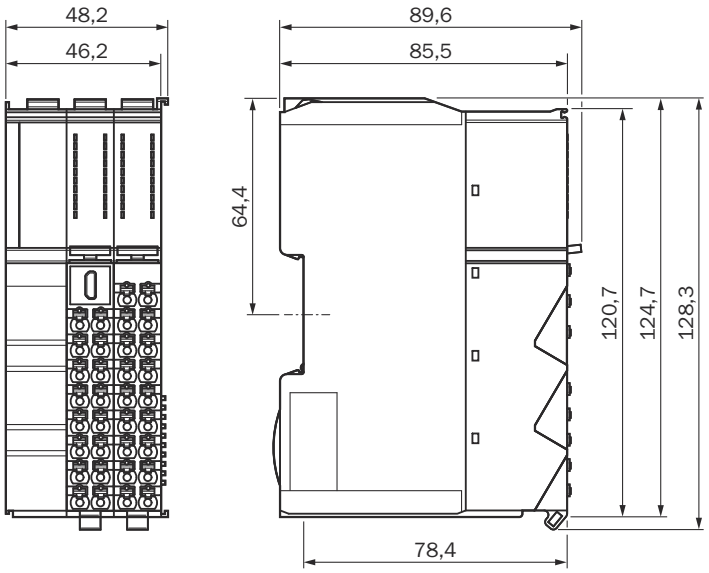


Figure 49: Dimensional drawing CPUc1

15 Annex

15.1 Compliance with EU directives

EU declaration of conformity (extract)

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.

Complete EU declaration of conformity for download

You can call up the EU declaration of conformity and the current operating instructions for the protective device by entering the part number in the search field at www.sick.com (part number: see the type label entry in the “Ident. no.” field).

16 List of figures

1. FLX3-CPUC1 module ... 11
2. LEDs for indicating the status ... 12
3. SmartPlug ... 13
4. Clearances for adequate air circulation ... 15
5. Safety requirements when mounting the muting sensors ... 16
6. Detection of material during muting ... 17
7. Muting with two sensor pairs arranged in parallel (A1 / A2 and B1 / B2) ... 18
8. Muting with two sensor pairs arranged in sequence (A1 / A2 and B1 / B2) ... 18
9. Muting with a sensor pair arranged crosswise (A1 / A2) ... 18
10. Example for parallel muting ... 20
11. Example for sequential muting ... 21
12. Example for cross muting ... 22
13. Internal circuitry main module ... 24
14. Main module mounting ... 27
15. Expansion module mounting ... 28
16. Housing end cap and end clamp mounting ... 29
17. Pull out the front connector ... 29
18. Dismantle front connector ... 31
19. Mount the front connector ... 31
20. Terminals on front connectors ... 32
21. Eyelet on front connector ... 34
22. Software controls ... 36
23. Configuration ... 40
24. Edit mode button ... 40
25. Logic editor ... 49
26. Sequence/timing diagram ... 59
27. Sequence/timing diagram ... 60
28. Sequence/timing diagram ... 62
29. Parameter diagram ... 63
30. Sequence/timing diagram ... 63
31. Sequence/timing diagram ... 69
32. Sequence/timing diagram ... 72
33. Sequence/timing diagram ... 73
34. Sequence/timing diagram ... 75
35. Sequence/timing diagram ... 75
36. Example: Two alternative enable conditions ... 77
37. Example of Fast shut off V1 internal logic for alternative enable conditions ... 78
38. Sequence/timing diagram ... 80
39. Sequence/timing diagram ... 81
40. Sequence/timing diagram ... 83
41. Sequence/timing diagram ... 84
42. Muting with two sensor pairs arranged in parallel (A1 / A2 and B1 / B2) ... 86
43. Sequence/timing diagram ... 88
44. Muting with two sensor pairs arranged in sequence (A1 / A2 and B1 / B2) ... 89
45. Sequence/timing diagram ... 91
46. Muting with a sensor pair arranged crosswise (A1 / A2) ... 92
47. Sequence/timing diagram ... 94
48. Sequence/timing diagram for Override and Override required ... 96
49. Dimensional drawing CPUc1 ... 125

17 List of tables

1. Ordering information for main module 6
2. Ordering information for IO expansion module 6
3. Interfaces of the module 11
4. Status indicator 13
5. Monitoring functions for muting 19
6. Muting wiring combinations and requirements 23
7. Left front connector pin assignment 33
8. Right front connector pin assignment 33
9. User groups 37
10. Categories of input elements 41
11. Configuration options for input elements 42
12. Dual-channel evaluation 43
13. Categories of output elements 44
14. Configuration options for output elements 45
15. Inputs 51
16. Outputs 51
17. Inputs 51
18. Outputs 51
19. Parameter 51
20. Inputs 52
21. Outputs 52
22. Parameter 52
23. Inputs 52
24. Outputs 52
25. Inputs 52
26. Outputs 52
27. Inputs 53
28. Outputs 53
29. Parameter 53
30. RS Flip-Flop V1 truth table without inversion 53
31. Inputs 53
32. Outputs 54
33. Parameter 54
34. JK Flip-Flop V1 truth table without input inversion 54
35. Inputs 54
36. Outputs 54
37. Parameter 55
38. Inputs 55
39. Outputs 55
40. Parameter 56
41. Inputs 56
42. Outputs 56
43. Truth table UInt8 to Bool V1 57
44. Inputs 57
45. Outputs 57
46. Truth table Bool to UInt8 V1 57
47. Inputs 58
48. Outputs 58
49. Parameter 58
50. Inputs 58
51. Outputs 58
52. Parameter 59
53. Inputs 59
54. Outputs 60

55. Parameter..... 60
56. Inputs..... 61
57. Outputs..... 61
58. Parameter..... 61
59. Inputs..... 62
60. Outputs..... 62
61. Parameter..... 63
62. Inputs..... 64
63. Outputs..... 64
64. Parameter..... 64
65. Inputs..... 65
66. Outputs..... 65
67. Parameter..... 65
68. Inputs..... 66
69. Outputs..... 66
70. Parameter..... 66
71. Inputs..... 67
72. Outputs..... 67
73. Inputs..... 68
74. Outputs..... 68
75. Parameter..... 69
76. Possible statuses of an input pair..... 70
77. Inputs..... 70
78. Outputs..... 70
79. Parameter..... 70
80. Truth table..... 71
81. Inputs..... 72
82. Outputs..... 72
83. Parameter..... 72
84. Inputs..... 73
85. Outputs..... 74
86. Parameter..... 74
87. Errors and reset conditions..... 74
88. Inputs..... 76
89. Outputs..... 77
90. Parameter..... 77
91. Response times..... 78
92. Inputs..... 79
93. Outputs..... 79
94. Inputs..... 80
95. Outputs..... 81
96. Inputs..... 82
97. Outputs..... 82
98. Parameter..... 82
99. Inputs..... 83
100. Outputs..... 83
101. Parameter..... 84
102. Inputs..... 85
103. Outputs..... 85
104. Parameter..... 85
105. Inputs..... 85
106. Outputs..... 85
107. Parameter..... 86
108. Inputs..... 86
109. Outputs..... 87
110. Parameter..... 87
111. Inputs..... 89

112. Outputs....89
113. Parameter....90
114. Valid sequence for muting sensor input signals with sequence monitoring....92
115. Inputs....92
116. Outputs....93
117. Parameter....93
118. Conditions for Override required and when override is possible....95
119. Number of permissible override cycles....96
120. Effect of the Band signal input....97
121. Error statuses and reset information for muting function blocks....97
122. Process data status bits of the modules....100
123. Process data status bits of the individual inputs or outputs....100
124. PWR and CV indications....110
125. CV indications....110
126. I indications (safety capable input)....111
127. I indications (safety capable input) - Flexi Loop....111
128. Q indications (safety output)....111
129. X indications (test output)....112
130. Faults in the logic....112
131. Faults in the safety capable inputs (I)....113
132. Faults in the safety outputs (Q)....113
133. Faults in the test outputs (X)....114
134. Error history information....115
135. Safety-related characteristic data - safety capable inputs (I)....117
136. Safety-related characteristic data - CPU logic processing....117
137. Safety-related characteristic data - safety outputs (Q)....118
138. General data....118
139. Voltage supply....119
140. Technical data for the safety capable inputs (I)....120
141. Technical data for the test outputs (X) when used with safety capable inputs....120
142. Technical data when using test outputs (X) as non-safe outputs (PNP or NPN)....120
143. Technical data for the safety outputs (Q)....121
144. Calculating the maximum response time....122
145. IN1 - Response time of safety capable inputs (I)....123
146. IN5 - Response time for processing of incoming process data....123
147. OUT1 - Response time of safety outputs (Q)....124
148. OUT2 - Response time of test outputs (X)....124
149. OUT5 - Response time for processing of outgoing process data....124

8026636/2021-03-19/en

Australia
Phone +61 (3) 9457 0600
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Austria
Phone +43 (0) 2236 62288-0
E-Mail office@sick.at

Belgium/Luxembourg
Phone +32 (0) 2 466 55 66
E-Mail info@sick.be

Brazil
Phone +55 11 3215-4900
E-Mail comercial@sick.com.br

Canada
Phone +1 905.771.1444
E-Mail cs.canada@sick.com

Czech Republic
Phone +420 234 719 500
E-Mail sick@sick.cz

Chile
Phone +56 (2) 2274 7430
E-Mail chile@sick.com

China
Phone +86 20 2882 3600
E-Mail info.china@sick.net.cn

Denmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Finland
Phone +358-9-25 15 800
E-Mail sick@sick.fi

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Germany
Phone +49 (0) 2 11 53 010
E-Mail info@sick.de

Greece
Phone +30 210 6825100
E-Mail office@sick.com.gr

Hong Kong
Phone +852 2153 6300
E-Mail ghk@sick.com.hk

Hungary
Phone +36 1 371 2680
E-Mail ertekesites@sick.hu

India
Phone +91-22-6119 8900
E-Mail info@sick-india.com

Israel
Phone +972 97110 11
E-Mail info@sick-sensors.com

Italy
Phone +39 02 27 43 41
E-Mail info@sick.it

Japan
Phone +81 3 5309 2112
E-Mail support@sick.jp

Malaysia
Phone +603-8080 7425
E-Mail enquiry.my@sick.com

Mexico
Phone +52 (472) 748 9451
E-Mail mexico@sick.com

Netherlands
Phone +31 (0) 30 229 25 44
E-Mail info@sick.nl

New Zealand
Phone +64 9 415 0459
0800 222 278 – tollfree
E-Mail sales@sick.co.nz

Norway
Phone +47 67 81 50 00
E-Mail sick@sick.no

Poland
Phone +48 22 539 41 00
E-Mail info@sick.pl

Romania
Phone +40 356-17 11 20
E-Mail office@sick.ro

Russia
Phone +7 495 283 09 90
E-Mail info@sick.ru

Singapore
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Slovakia
Phone +421 482 901 201
E-Mail mail@sick-sk.sk

Slovenia
Phone +386 591 78849
E-Mail office@sick.si

South Africa
Phone +27 10 060 0550
E-Mail info@sickautomation.co.za

South Korea
Phone +82 2 786 6321/4
E-Mail infokorea@sick.com

Spain
Phone +34 93 480 31 00
E-Mail info@sick.es

Sweden
Phone +46 10 110 10 00
E-Mail info@sick.se

Switzerland
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Taiwan
Phone +886-2-2375-6288
E-Mail sales@sick.com.tw

Thailand
Phone +66 2 645 0009
E-Mail marcom.th@sick.com

Turkey
Phone +90 (216) 528 50 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone +971 (0) 4 88 65 878
E-Mail contact@sick.ae

United Kingdom
Phone +44 (0)17278 31121
E-Mail info@sick.co.uk

USA
Phone +1 800.325.7425
E-Mail info@sick.com

Vietnam
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Detailed addresses and further locations at **www.sick.com**

SICK AG | Waldkirch | Germany | www.sick.com

SICK
Sensor Intelligence.