OPERATING INSTRUCTIONS

sBot Speed – URe

Safety System

SICK
Sensor Intelligence.

Described product

sBot Speed – URe

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Purpose of this document

These operating instructions contain the information required during the life cycle of the safety system. This document describes:

- The individual components
- The project planning
- The mounting and electrical installation, insofar as special measures are necessary for the safety system
- The configuration
- The necessary thorough checks
- The commissioning
- The maintenance
- The troubleshooting

1.2 Scope

Important information

NOTE

The operating instructions of the components also apply. In the event of contradictions between the operating instructions, the information specified in the operating instructions for the safety system applies.

The relevant information must be made available to the employees for all work performed on the safety system.

Product

This document applies to the following products: sBot Speed – URe

Document identification

Document part number:

- This document: 8025396
- Available language versions of this document: 8025395

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

Other documents relevant for the product

Table 1: Available documents

Document type	Title	Part number
Operating instructions	nanoScan3 I/O	8024594
Operating instructions	Flexi Soft modular safety controller hardware	8012999
Operating instructions	Flexi Soft in Flexi Soft Designer	8012998

1.3 Target groups of these operating instructions

Some sections of these operating instructions are intended for certain target groups. However, the entire operating instructions are relevant for intended use of the product.

Table 2: Target groups and selected sections of these operating instructions

Target group	Sections of these operating instructions
Project developers (planners, developers, designers)	"Project planning", page 17 "Configuration", page 30 "Technical data", page 47
Installers	"Mounting", page 26
Electricians	"Electrical installation", page 27
Safety experts (such as CE authorized representatives, compliance officers, people who test and approve the application)	"Project planning", page 17 "Configuration", page 30 "Commissioning", page 42 "Technical data", page 47 "Checklists", page 51
Operators	"Operation", page 44 "Troubleshooting", page 46
Maintenance personnel	"Maintenance", page 45 "Troubleshooting", page 46

1.4 Symbols and document conventions

The following symbols and conventions are used in this document:

Warnings and other notes

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

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

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

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

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

Instructions to action

► The arrow denotes instructions to action.

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

✓ The check mark denotes the result of an instruction.

LED symbols

These symbols indicate the status of an LED:

○ The LED is off.
☼ The LED is flashing.
● The LED is illuminated continuously.

1.5 Terminology used

Term	Explanation
Safety System	Combination of safety controller, safety sensors, logic as well as circuit diagrams and documentation. The safety system also includes the necessary components to execute the functions described in this documentation.
Complete system	Combination of safety system, process controller, machine and all other actuators, sensors and switching elements that interact in the application.
Safety controller	Controller for safety applications which logically evaluates signals from safety sensors, safety command devices and other sources and securely switches the actuators of the machine on and off via safety outputs.
Robot controller	Programmable controller that controls and monitors the actions of the robot.

1.6 Further information

www.sick.com

The following information is available via the Internet:

- Safety Designer configuration software
- Flexi Soft Designer configuration software
- Guide for Safe Machinery (“Six steps to a safe machine”)

2 Safety information

2.1 General safety note

The information and tools will not fulfill the safety requirements for your application without further adjustments being made. The project planning provided by way of example is intended to serve as the basis to allow you to perform your own project planning and programming in line with your specific requirements. What this means is that the information and tools merely provide an example to demonstrate how a safety function can be taken care of.

When it comes to your own project planning and programming, you will need to rely on qualified staff given that it is your responsibility to ensure that the following requirements are complied with at the very least:

- ► Carrying out a risk assessment
- ► Taking into account applicable standards
- ► Verifying and validating the safety functions.

2.2 Intended use

The safety system provides protection against mechanical hazards (crushing, shearing, impact) caused by movement of the robot arm by means of area safeguarding. The safety system can only be used in certain applications.

The product may be used in safety functions.

The safety system must only be used within the limits of the prescribed and specified technical data and operating conditions at all times.

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

2.3 Inappropriate use

The safety laser scanner works as an indirect protective measure and cannot provide protection from pieces thrown from application nor from emitted radiation. Transparent objects are not detected.

If necessary, you must take additional measures to provide protection against hazards that do not result from movement of the robot arm.

The safety system is not suitable for the following applications (this list is not exhaustive):

- Outdoors
- Underwater
- In explosion-hazardous areas

2.4 Requirements for the qualification of personnel

The safety system must be configured, installed, connected, commissioned, and serviced by qualified safety personnel only.

Integration

For integration, a person is considered qualified 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.

2.5 Safe state

In the safe state, the accordingly configured safe output signal switching devices are in the OFF state.

The safe state is initiated in the following cases:

- Protective field PF1 interruption
- Invalid sequence of protective field interruption for automatic restart

The following errors are recognized and also lead to the safe output signal switching devices switching to the OFF state:

- Internal error at the safety controller or one of its components
- Internal error on the safety laser scanner
- Connection between the safety controller and safety laser scanner interrupted
- Voltage supply of the safety controller or the safety laser scanner interrupted

3 Product description

3.1 Design of the safety system

Design of the safety system

The safety system consists of a total of three components:

- Safety components (from SICK)
- Robot
- Safety command devices

The safety-related functions are distributed among the safety controller and the robot controller.

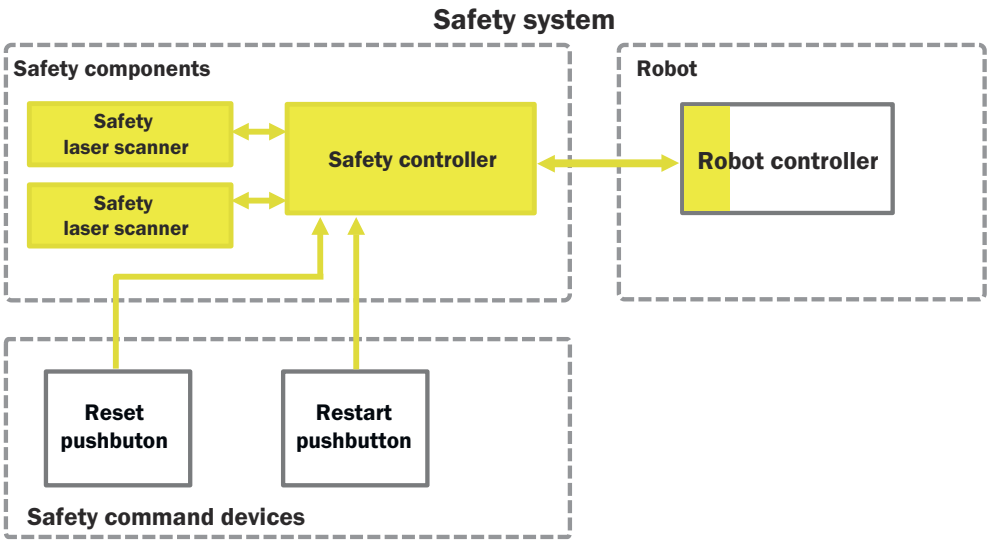


Figure 1: Construction of the safety system

The safety system ends at all inputs and outputs that are not used to wire the components of the safety system.

Further topics

- "Components", page 14
- "Interfaces", page 24

3.2 Functionality

Overview

The safety system detects people in a monitored area. When a person approaches the robot, the safety system decreases the robot speed until it comes to a standstill.

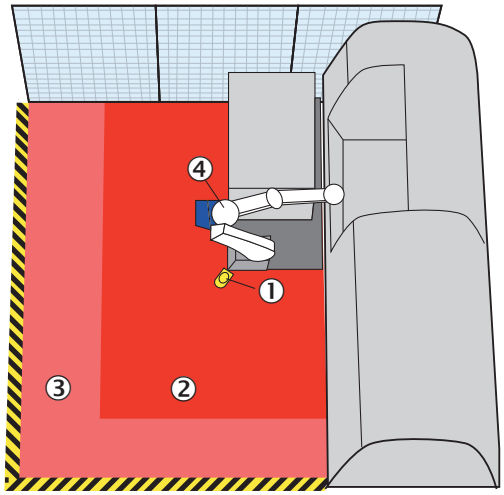


Figure 2: Robot application example

① Safety laser scanner
② Protective field PF1
③ Protective field PF2
④ Robot

Functionality

The safety laser scanner monitors the access area of the hazardous area with 2 protective fields. When a person approaches the robot, the protective fields are interrupted one after another.

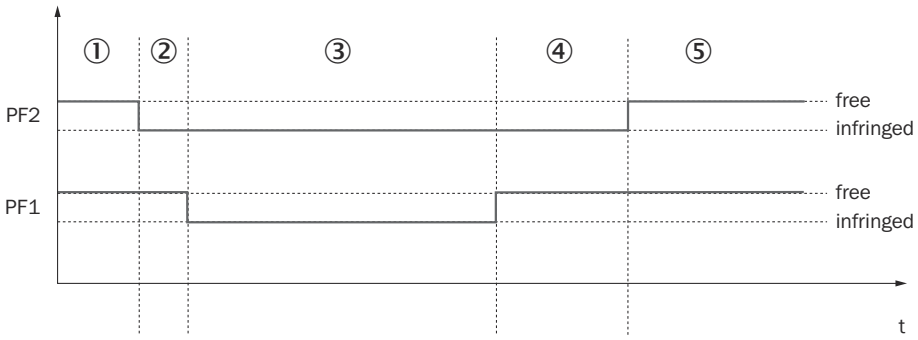
The robot speed is reduced if protective field PF2 is interrupted. If protective field PF1 is interrupted, the safety system triggers a protective stop.

Automatic restart

If the application allows this, you can configure an automatic restart. If the person moves away from the robot, the protective fields become clear again one after another. The robot automatically restarts when all of the protective fields are clear.

The safety system monitors the sequence in which each protective clear is interrupted and becomes free again. A valid sequence leads to an automatic restart. If the sequence is invalid, it cannot be ensured that the person has left. The safety system will switch to the safe state in this event. Robot automatic restart is prevented.

Signal image during normal operating cycle



① Both protective fields are clear. The robot works normally.

② Protective field PF2 is interrupted. The robot reduces its speed.

③ Both protective fields are interrupted. The robot executes a protective stop.

④ Protective field PF1 becomes clear again. The robot remains in a protective stop.

⑤ Both protective fields are clear. Reset and restart are done automatically or manually, depending on the configuration.

Further topics

- "Functions of the safety system", page 15
- "Automatic restart", page 15

3.3 Requirements on the application

General requirements

- The robot must be one of the following types from manufacturer Universal Robots:
  - UR3e
  - UR5e
  - UR10e
  - UR16e
- Robots and humans perform their work in the same workspace, but at different times (cooperation, see "Human-robot interaction", page 14).
- The robot works at a fixed position.
- The application does not require a protective field > 3 m
- Access to the hazardous area must be designed so that the protective fields of the safety laser scanner can cover the entire access area of the hazardous area. A person cannot enter or reach into the hazardous area without interrupting the protective fields.
- Bypassing the protective field (e.g. by reaching around or stepping over it) is not possible and this is ensured by additional measures as necessary.
- It is ensured that persons cannot bring any aids (e.g. ladder or chair) into the monitored area which could be used for persons to move over and stay above the scan plane without interrupting the protective field.
- The area to be monitored is free from all airborne particles or process residues in its operational status.

Requirements for automatic restart

- The safety laser scanner must be positioned and configured so that persons cannot walk behind the protective field.

3.4 Product characteristics

3.4.1 Components

Components relevant for the safety system

Table 3: Hardware

Component	Part of the safety system?	Included in scope of delivery
Flexi Soft safety controller • Main module • 2 × expansion module • System plug	Yes	Yes
nanoScan3 Pro I/O safety laser scanner (Depending on the variant, 1 × or 2 ×)	Yes	Yes
Reset pushbutton	Yes	No
Restart pushbutton	Yes	No
Robots of type UR3e, UR5e, UR10e or UR16e	Yes[1)]	No

1) Only the safety functions of the robot controller handled in this document are part of the safety system.

Table 4: Software and documentation

Name	Availability
Flexi Soft Designer project with logic for the safety controller	The files are available in the configuration software once the safety system has been added to the project.
Safety Designer project for configuring the safety laser scanner	
Complete subsystems for SISTEMA The calculation of the performance level can be carried out using the SISTEMA file. The manufacturer of the complete system must decide which measures should be taken against failures with the same cause. These measures must be selected in the SISTEMA file for each user-defined sub-system.	
Circuit diagram (ePLAN)	
Safety system operating instructions	
Quick Start Guide for the safety system	

Complementary information

Implementing all the safety functions for the application requires a complete system consisting of sensors, a controller, actuators, and control switches. The user is responsible for the safe design of the complete system and all safety functions.

All necessary components influence the parameters of the entire application that relate to safety technology. The components must therefore have an $MTTF_D$ value that is suitable for the entire application and satisfies the necessary performance level. The necessary performance level results from the risk assessment. Subsystems for SISTEMA are available for evaluation of the achieved performance level at:

www.sick.com

Further topics

- "Implementing emergency stop", page 24
- "Requirements for the reset pushbutton and restart pushbutton", page 24

3.4.2 Human-robot interaction

This safety system is suitable for cooperative human-robot interaction.

Table 5: Types of human-robot interaction

	Application with sequential processing	Application with simultaneous processing
Shared workspace	**Cooperation**	Collaboration
Different workspace	(Not interactive)	Coexistence

Cooperative human-robot interaction is characterized by the fact that tasks are being carried out in the same working area at different times.

3.4.3 Functions of the safety system

Table 6: Protective stop and reduced speed functions

Function	Trigger	Description
Trigger safety-rated monitored speed	Protective field PF2 interrupted	Activates robot speed decrease. Activates safe monitoring of robot speed.
Trigger protective stop	Protective field PF1 interrupted	Triggers the robot protective stop. Corresponds to stop category 2.

Whether the robot is reset or restarted manually or automatically must be configured in the safety controller.

Table 7: Reset and restart functions

Function	Trigger	Description
Automatic reset and restart with safe sequence monitoring[1)]	see "Automatic restart", page 15 If the protective field interruption sequence is invalid: manual reset and manual restart	
Manual reset and manual restart	Manual activation of reset pushbutton and restart pushbutton	If automatic reset and restart are not wanted, the system can be configured so that manual reset and manual restart are required after each protective stop. Expected frequency of requirement of this function: 9125/year

1) Automatic reset and restart is only possible in applications in which it is not possible to walk behind the protective field of the safety laser scanner.

3.4.4 Automatic restart

Important information

NOTE

- Automatic restart complies with ISO 10218.
- The robot controller must prevent unexpected start-up after switching on.
- You must attach a "Warning, automatic restart" pictogram to the system (see ISO 7010, registration number W018).

Sequence for automatic restart

Automatic restart of the robot only occurs when one or several people approach and then move away from the robot so that only protective fields PF1 and PF2 are interrupted in doing so.

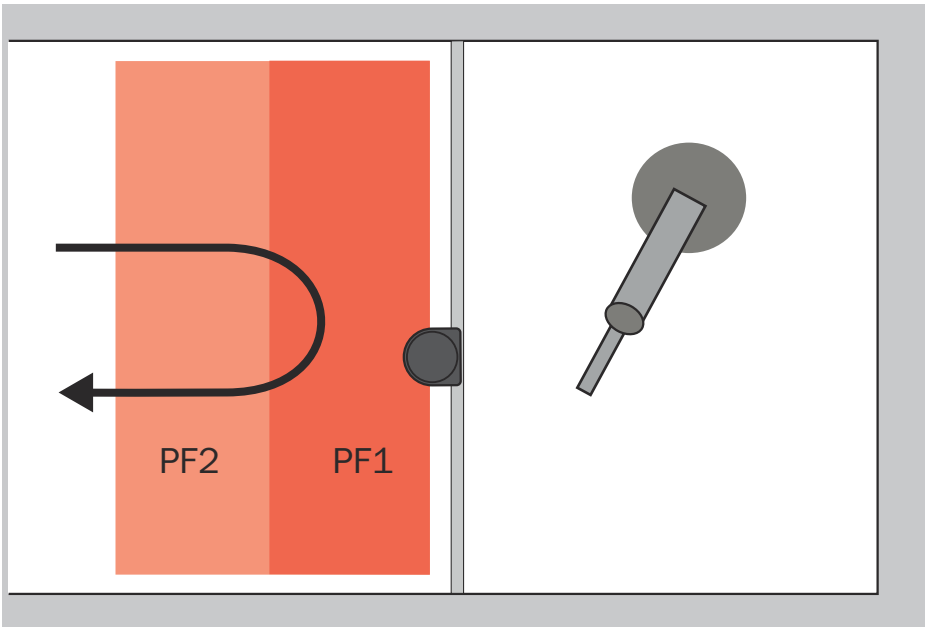


Figure 3: Movement path of a person for automatic restart

In doing so, the protective fields are interrupted in a certain sequence and then approved again. This sequence is expected by the logic of the safety controller and corresponds to the following signal image.

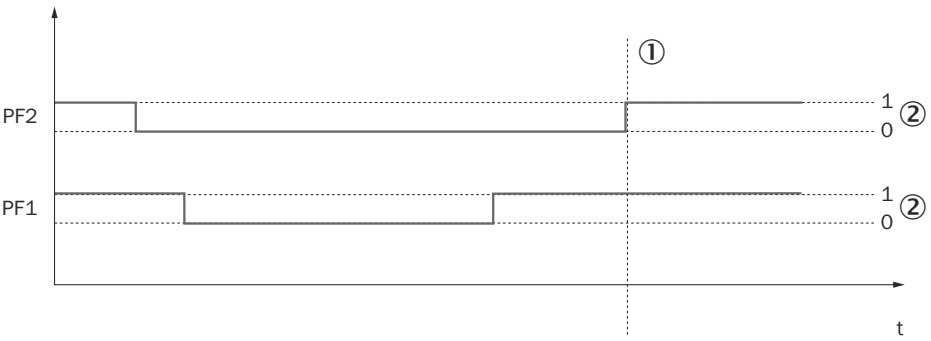


Figure 4: Signal image of a valid sequence for automatic restart

① Automatic restart is triggered.

② Signal states of the safety laser scanner safety outputs.

- Protective field clear: signal state = logical 1
- Protective field interrupted: signal state = logical 0

Complementary information

If the protective field interruption sequence is not complied with, the safety outputs of the safety system switch to a safe state. Automatic restart is prevented and manual reset with manual restart is required. The sequence is invalid if, for example:

- Protective field PF2 becomes clear at the same time as protective field PF1 (discrepancy PF1 / PF2).
- Protective field PF1 is interrupted without protective field PF2 having been interrupted prior to this.

4 Project planning

4.1 Manufacturer of the overall system

The safety system was developed under consideration of typical application cases. A partial safety function can be implemented with the safety system in these application cases. The manufacturer must check whether the safety system is suitable for its specific application case (risk assessment according to ISO 12100). Further protective measures may be required in addition to the safety system.

If the thorough check shows that the safety system is not suitable for the specific application case, the safety system can be used as a basis for an individualized development suitable for the specific application case. This case will not be considered further in this document.

In any event, additional work is necessary for the safety system to be used, e.g. subsequent configuration of the safety controller.

The manufacturer has the following duties:

- ► Executing a risk assessment.
- ► Verifying and validating the safety functions.
- ► Integrating the individual components in accordance with the appropriate standards.
- ► Please note that C standards have priority compared to statements about this safety system.

4.2 Operating entity of the overall system

Changes to the electrical integration of the safety system in the machine control and changes to the mechanical mounting of the safety system 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.

Changes to the safety system's configuration may impair the protective function. The effectiveness of the safety system must be checked after any change to the configuration. The person carrying out the change is also responsible for maintaining the protective function of the safety system.

4.3 Design

4.3.1 Position of the safety laser scanner

Requirements for the position of the safety laser scanner

Position the safety laser scanner so that it meets all of the following criteria:

- The scan plane runs horizontally.
- The scan plane runs 300 mm above the floor. The risk assessment may indicate that a lower scan plane is necessary.
- The safety laser scanner must be positioned within the minimum distance of protective field PF1 to the hazardous area.

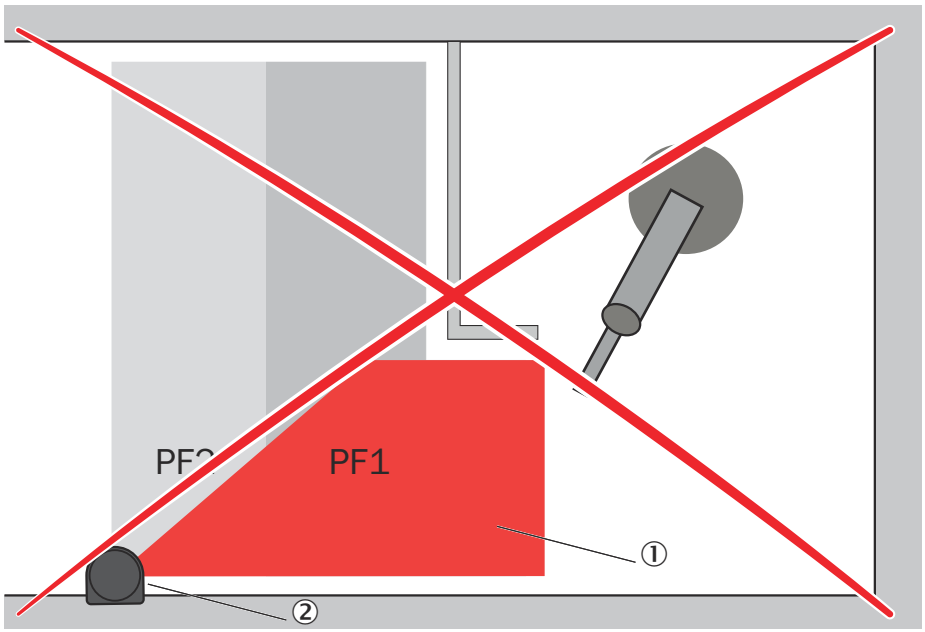


Figure 5: Safety laser scanner placed with too great a distance to the hazardous area

① Protective field PF1 cannot be configured according to the requirements of the safety system.

② Safety laser scanner

- For the variant with 1 safety laser scanner: The safety laser scanner must monitor the entire point of access to the hazardous area. There are no areas that are not monitored where are person can be present (e.g. in front of a physical guard).

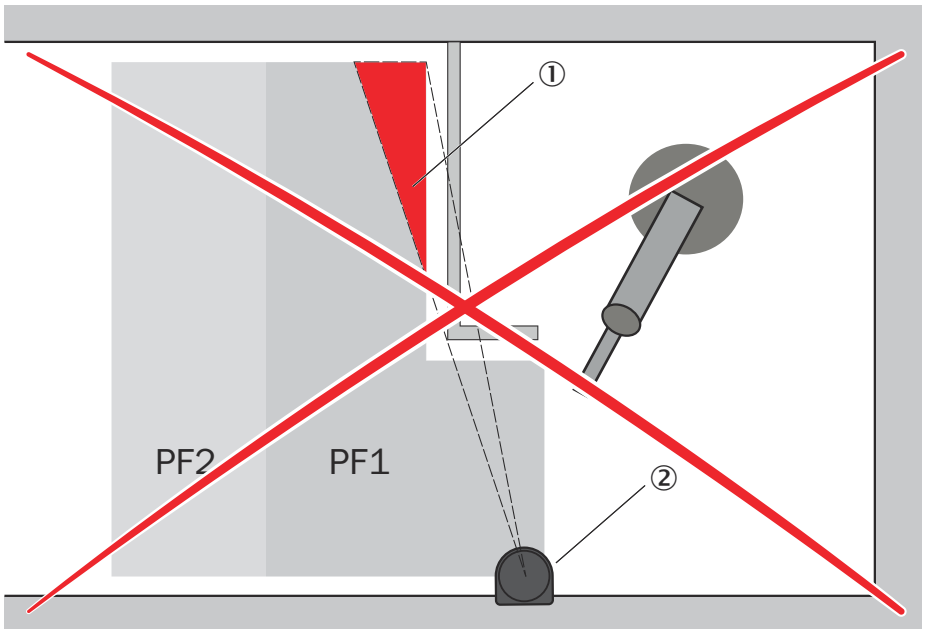


Figure 6: Non-monitored area in the shadow of the physical guard

① Non-monitored area

② Safety laser scanner

- In variants with two safety laser scanners: the scanners are positioned so that the entire area around the hazardous area can be monitored, e.g. at opposing corners of the hazardous area.

Examples for possible positions of the safety laser scanner in variants with a safety laser scanner

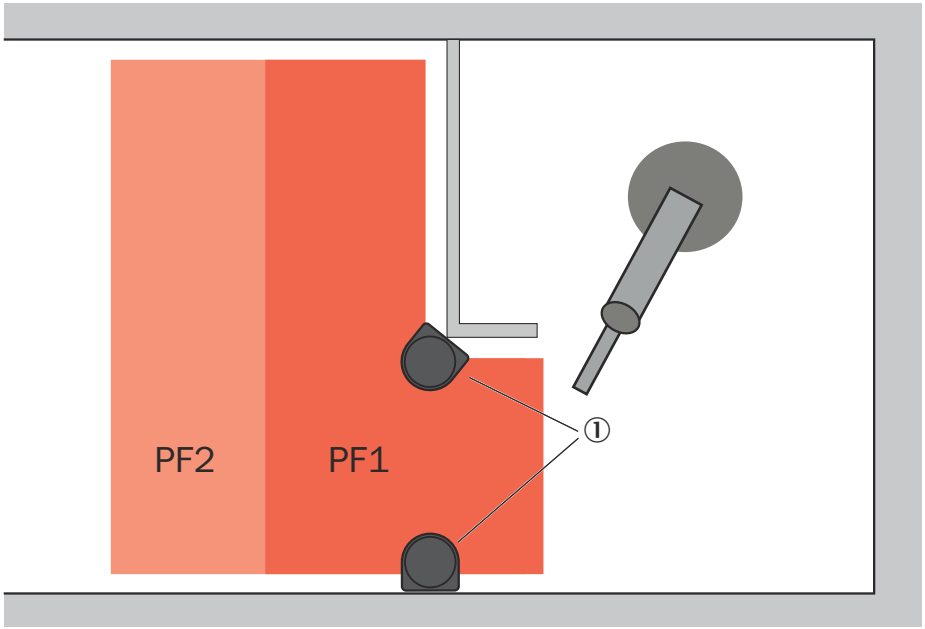


Figure 7: Possible positions of the safety laser scanners when used with a physical guard

① Safety laser scanner

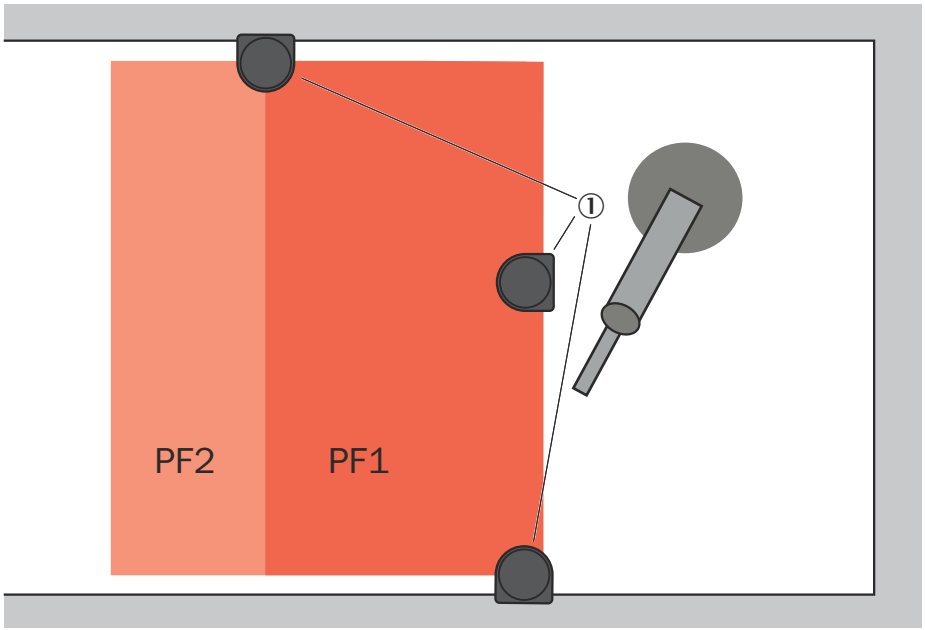


Figure 8: Possible positions of the safety laser scanner when used without a physical guard

① Safety laser scanner

Examples for possible positions of the safety laser scanner in variants with 2 safety laser scanners

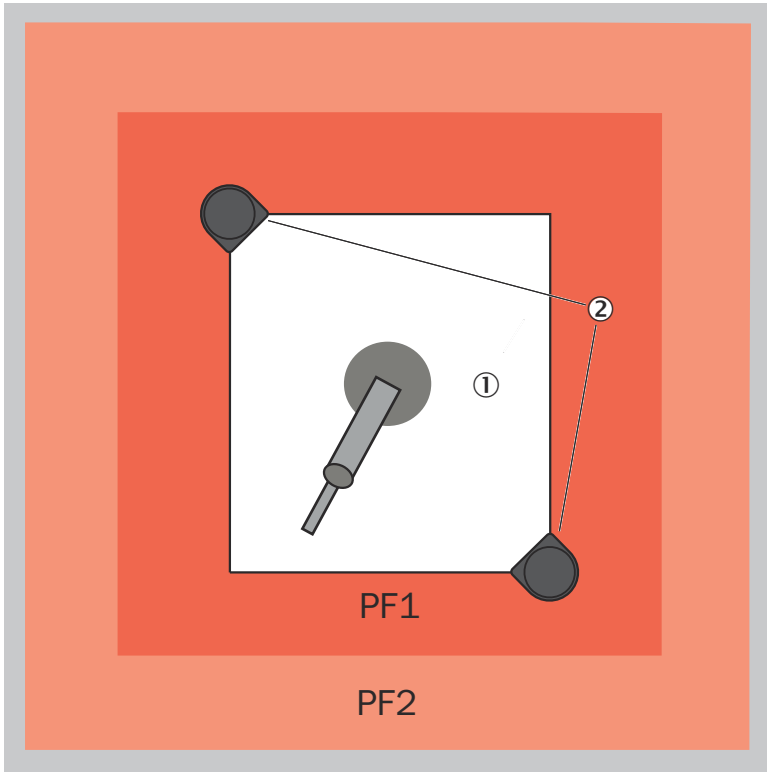


Figure 9: Possible positions of the safety laser scanner in variants with 2 safety laser scanners

① Hazardous area
② Safety laser scanner positions

4.3.2 Protective field design

4.3.2.1 Overlapping protective fields

The safety laser scanner simultaneously monitors 2 protective fields. These protective fields partially overlap.

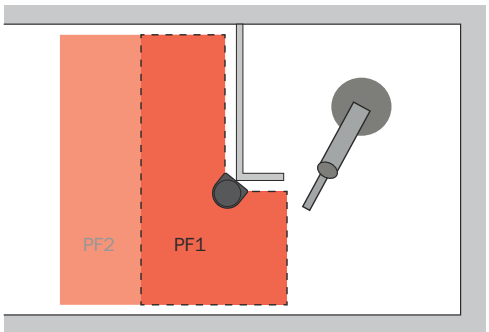


Figure 10: Only protective field PF1

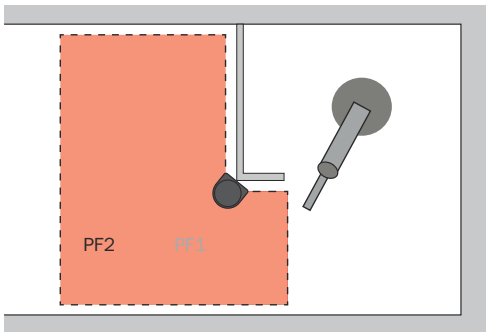


Figure 11: Only protective field PF2

4.3.2.2 Difference between the minimum distances to the hazardous area

Need for difference between the minimum distances

The sequence for automatic restart requires that protective field PF2 is interrupted before protective field PF1 when the hazardous area is approached. The minimum distance to the hazardous area must therefore be greater for protective field PF2 than for protective field PF1.

The sequence for automatic restart requires a discrepancy of 100 ms when the protective fields are interrupted. At an approach speed of 1600 mm/s, this results in a difference between the minimum distances of 160 mm.

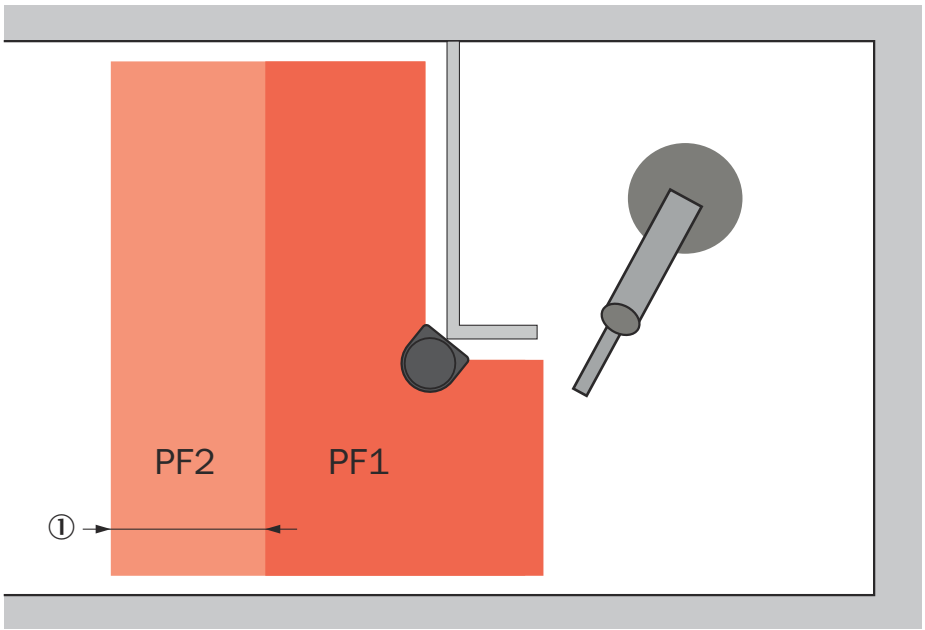


Figure 12: Difference between the minimum distances to the hazardous area

① Difference between the minimum distances to the hazardous area between protective fields PF1 and PF2 (S_{Diff})

Influence of S_{Diff} on the minimum distance for protective field PF1

The actual difference between the minimum distances S_{Diff} has a retroactive effect on the minimum distance for protective field PF1. When protective field PF2 is interrupted, the safety-rated monitored speed is triggered.

If the robot monitors the reduced speed before an approaching person interrupts protective field PF1, the values for the reduced speed can be used for calculation of the minimum distance for protective field PF1. This leads to a smaller minimum distance for protective field PF1.

It takes 500 ms for the robot to monitor the reduced speed (see robot documentation). In addition, the response time of the safety system has to be considered (in delivery status: 89 ms). At an approach speed of 1600 mm/s over a period of 589 ms, this results in a distance between the minimum distances of 943 mm. If you have a deviating response time (e. g. because of a changed configuration of the safety controller or the safety laser scanner) you must adjust the distance accordingly.

- $S_{Diff} \leq 943$ mm: use the robot stopping time at maximum speed (Normal mode) to calculate the minimum distance for protective field PF1.
- $S_{Diff} > 943$ mm: use the robot stopping time at safety-rated monitored speed (Reduced mode) to calculate the minimum distance for protective field PF1.

Complementary information

In the safety configuration of the robot controller, you can configure the stopping time for the maximum speed (Normal mode) and the safety-rated monitored speed (Reduced mode).

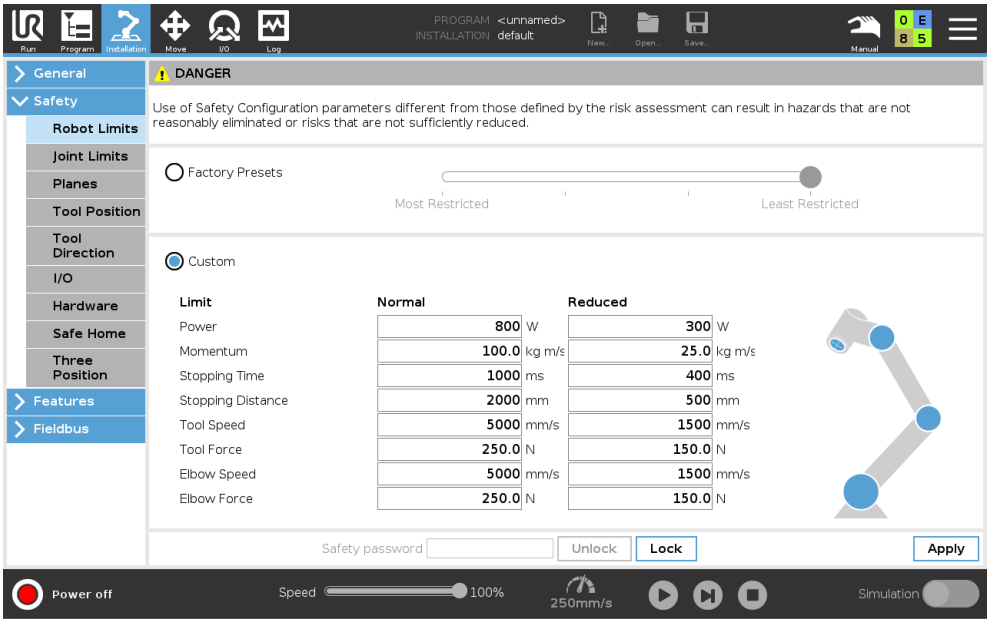


Figure 13: Configuration of stopping times in the robot controller

Further topics

- "Response time of safety system", page 47

4.3.2.3 Calculating minimum distance of protective field PF1

Overview

Interrupting protective field PF1 triggers a robot protective stop. You must calculate the minimum distance of protective field PF1 so that the robot comes to a standstill in the event of a protective field interruption before the person reaches the hazardous area.

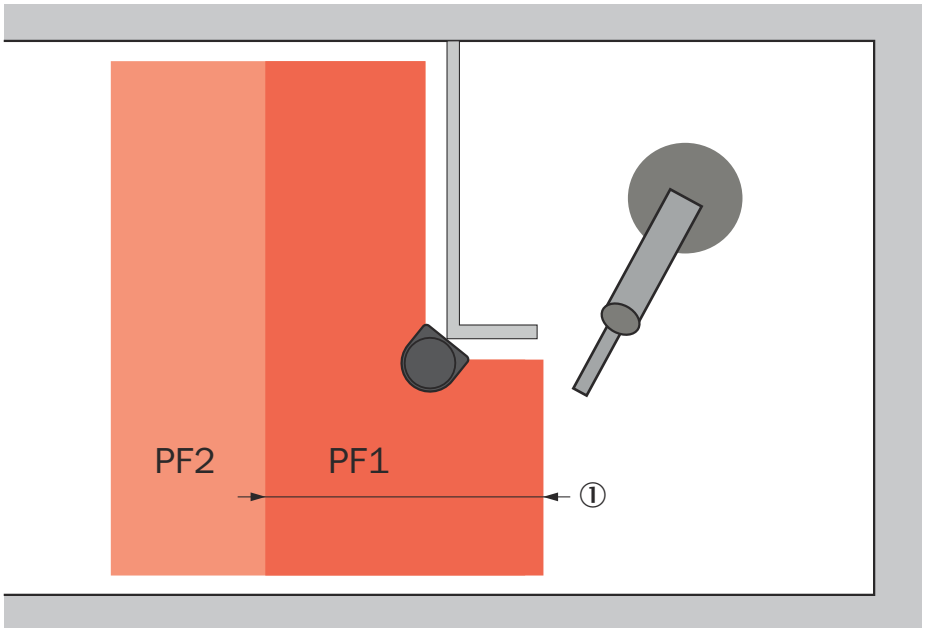


Figure 14: Minimum distance of protective field PF1

① Minimum distance to the hazardous area of protective field PF1 (S_{PF1})

Prerequisites

- S_{Diff} is determined.

Procedure

► Calculate the minimum distance to the hazardous area of protective field PF1. The following calculation example in accordance with ISO13855 can be used to do so.
$S_{PF1} = K \times (t_{Safetysystem} + t_{Robot}) + TZ + ZR + C$

Parameter	Description
K	Approach speed of a person. The approach speed is 1600 mm/s according to EN ISO 10218-2.
$t_{Safetysystem}$	Response time of safety system 89 ms [1]
t_{Robot}	Robot stopping time Depending on S_{Diff}, you must take into account the robot stopping time at maximum speed (Normal mode) or at safety-rated monitored speed (Reduced mode).
TZ	Tolerance range of safety laser scanner 65 mm[2]
ZR	Supplement for reflection-related measurement errors [3] 350 mm[2]
C	Supplement to protect against reaching over in millimeters (mm) C = 1200 mm – (0.4 × protective field height (mm)) At a protective field height of 300 mm: 1080 mm

1) Value at time of delivery. The actual value depends on the set multiple sampling of the safety laser scanner and the logic execution time.
2) Value at time of delivery. Check the actual value using operating instructions 8024594.
3) Is not used in all application cases.

Further topics

- "Response time of safety system", page 47

4.3.3 Implementing emergency stop

Integration of the emergency stop is not part of the safety system. Implementation of the emergency stop via the robot controller is done solely on your authority and responsibility.

4.3.4 Requirements for the reset pushbutton and restart pushbutton

Prerequisites

- The reset pushbutton and the restart pushbutton must be designed according to EN 60204.

Requirements for the integration design

- The reset pushbutton and the restart pushbutton must be installed outside of the hazardous area.
- The reset pushbutton and the restart pushbutton must be installed outside of the protective fields.
- From the position of the reset pushbutton and the restart pushbutton, there must be a complete view of the hazardous area.

Complementary information

If the safety system is configured with manual reset and manual restart, the mission time of 20 years is initially not reached. The reason for this is that the $B10_D$ value for the reset pushbutton and restart pushbutton in the SISTEMA file corresponds to the minimum value of ISO 13849. Accordingly, reset pushbutton and the restart pushbutton would then be have to be exchanged in a timely manner. The $B10_D$ value of commercial pushbuttons is much higher than the minimum values of ISO 13849. If you transmit the $B10_D$ value of your components to SISTEMA, the mission time of 20 will very probably be reached.

4.4 Integrating the equipment into the electrical control

NOTE

Several safety functions are generally necessary in order to ensure a safe design for the entire application. This requires additional components that are not part of the safety system, such as switches, fuses, and contactors. The circuit diagrams contain information on wiring the safety system with additional components within an application.

4.4.1 Interfaces

Table 8: Robot controller interfaces

Flexi Soft safety controller	Type	Description
Q1 / Q2	Safety output (OSSD pair)	LOW = protective stop in Automatic operating mode
Q3 / Q4	Safety output (OSSD pair)	LOW = trigger safety-rated monitored speed

4.4.2 Circuit diagram

A detailed circuit diagram is available as a PDF.

4.5 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.

The following tests must be planned:

- A thorough check must be carried out during commissioning and following modifications.
  The check must detect if it is possible to enter the hazardous area without being detected.
- The regular thorough checks of the safety system must fulfill certain minimum requirements. The minimum requirements for the thorough check of the safety system comply at least with the sum of the minimum requirements for the thorough check of the components of the safety system (see operating instructions of the components).
  The check must detect if it is possible to enter the hazardous area without being detected. Such possibilities may exist due to modifications, manipulations or external influences.
- In many cases, depending on the application conditions, the risk assessment can determine that further thorough checks are required.

The thorough checks must be carried out by qualified safety personnel or specially qualified and authorized personnel, and must be documented in a traceable manner.

The regular thorough checks serve to assess the effectiveness of the safety system and to identify defects as a result of changes or other influences (e.g., damage or manipulation).

5 Mounting

5.1 For mounting the components

NOTE
Information is included in the operating instructions for the components.

6 Electrical installation

6.1 Electrical installation of the components

NOTE
Information is included in the operating instructions for the components.

6.2 General requirements

The manufacturer must take measures against failures resulting from the same cause. The manufacturer must document this appropriately in SISTEMA. During the electrical installation, the following, for example, must be taken into consideration:

- Protection against overvoltage, overcurrent, etc. per the manufacturer instructions for the individual components
- Mechanical fastening of the wiring of the pushbutton for the hold to run device, e.g. with cable ties
- Measures for controlling the consequences of voltage failure, voltage fluctuations, overcurrent and undercurrent in the voltage supply of the robot controller

6.3 Safety controller pin assignment

Important information

NOTE
If the robot controller and the safety controller use a different voltage source, the potential difference must be balanced out (0 V connection).

NOTE
A complete circuit diagram of the safety system is available as a PDF.

Safety controller setup

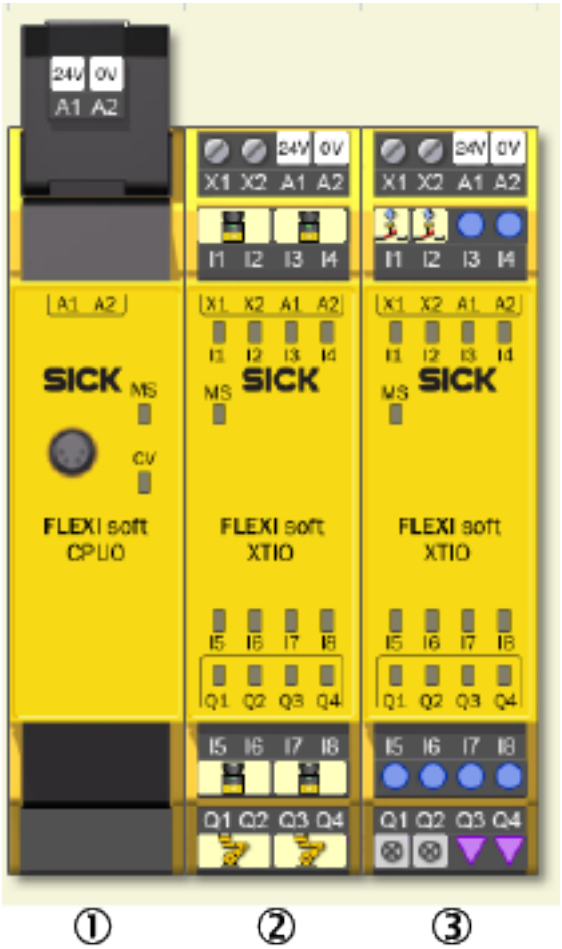


Figure 15: Safety controller setup

Table 9: Modules of the safety controller

Module 1	FX3-CPU0 main module
Module 2	FX3-XTIO I/O module
Module 3	FX3-XTIO I/O module

Module 1 connections

Table 10: Module 1 connections

Terminal	Connect to	Function
A1	Voltage supply +24 V DC	Voltage supply
A2	Voltage supply 0 V DC	Voltage supply

Module 2 connections

Table 11: Module 2 inputs

Terminal	Connect to	Function
I1	1. Safety laser scanner OSSD pair 1, OSSD A (white)	Protective field PF1
I2	1. Safety laser scanner OSSD pair 1, OSSD B (green)	Protective field PF1

Terminal	Connect to	Function
I3	1. Safety laser scanner OSSD pair 2, OSSD A (yellow)	Protective field PF2
I4	1. Safety laser scanner OSSD pair 2, OSSD B (black)	Protective field PF2
I5	2. Safety laser scanner OSSD pair 1, OSSD A (white)	Protective field PF1
I6	2. Safety laser scanner OSSD pair 1, OSSD B (green)	Protective field PF1
I7	2. Safety laser scanner OSSD pair 2, OSSD A (yellow)	Protective field PF2
I8	2. Safety laser scanner OSSD pair 2, OSSD B (black)	Protective field PF2

Table 12: Module 2 outputs

Terminal	Connect to	Function
Q1	Robot controller CI0	Protective stop
Q2	Robot controller CI1	Protective stop
Q3	Robot controller CI2	Safety-rated monitored speed
Q4	Robot controller CI3	Safety-rated monitored speed

Module 3 connections

Table 13: Module 3 inputs

Terminal	Connect to	Function
I1	Reset pushbutton	Reset
I2	Restart pushbutton	Restart

Table 14: Module 3 outputs

Terminal	Connect to	Function
Q1	Reset pushbutton indicator lamp	Reset required
Q2	Restart pushbutton indicator lamp	Restart required

Complementary information

The enabling device is not connected to the safety controller, but must be connected to terminals CI4/CI5 of the robot controller.

7 Configuration

7.1 Requirements for software and firmware

Table 15: SICK component versions

Software and firmware	Version
Flexi Soft Designer	1.9.6
Safety Designer	2023.01
FX3-CPU0 firmware	4.0
FX3-XTIO firmware	3.0
nanoScan3 Pro I/O firmware	1.0

Table 16: Robot controller versions

Software and firmware	Version
Polyscope	5.6

7.2 Overview of the software structure

Software structure and software logic for configuration with manual reset and manual restart

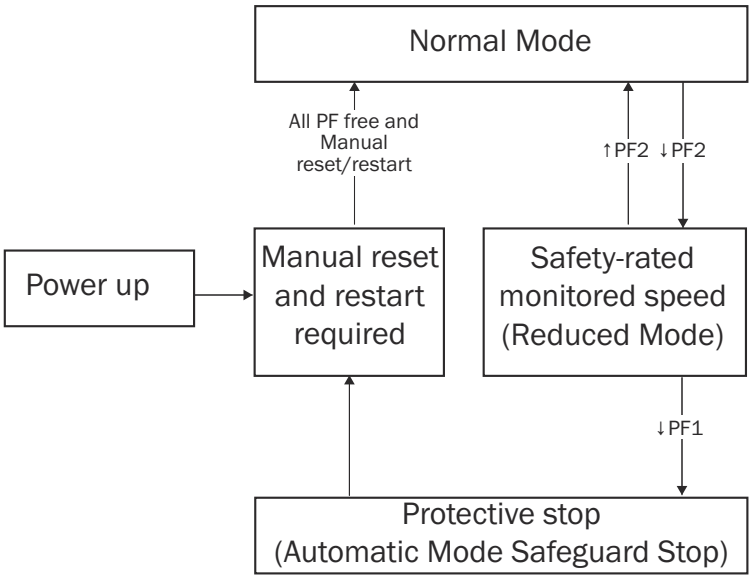


Figure 16: Software structure for configuration with manual reset and manual restart

↑ Protective field becomes clear.
↓ Protective field is interrupted.

In order to change to Normal mode after switching on or a protective stop, the operator must execute manual reset with manual restart. Both protective fields must be clear during reset and restart.

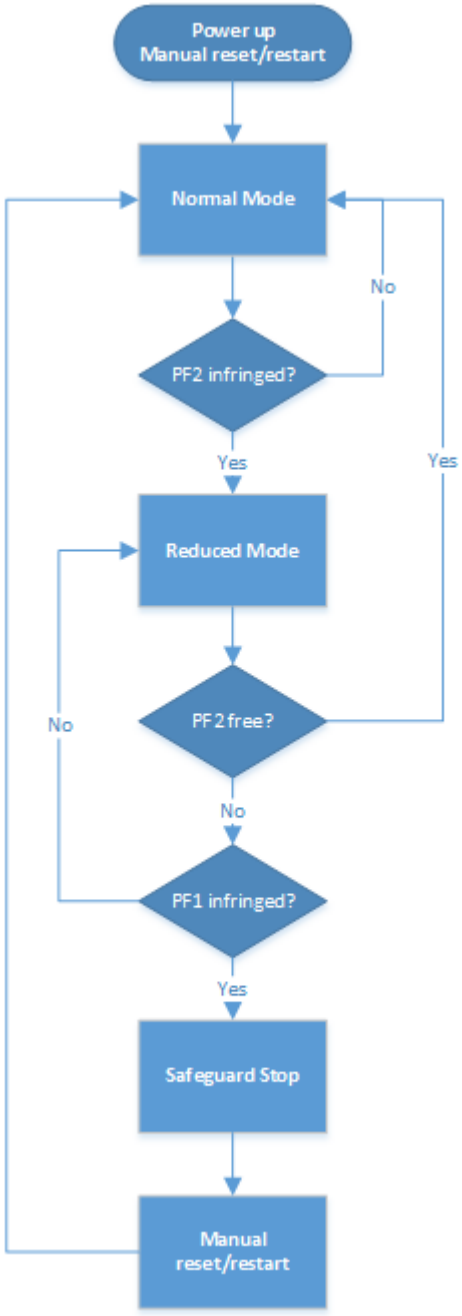


Figure 17: Software logic for configuration with manual reset and manual restart

Software structure and software logic for configuration with automatic reset and automatic restart

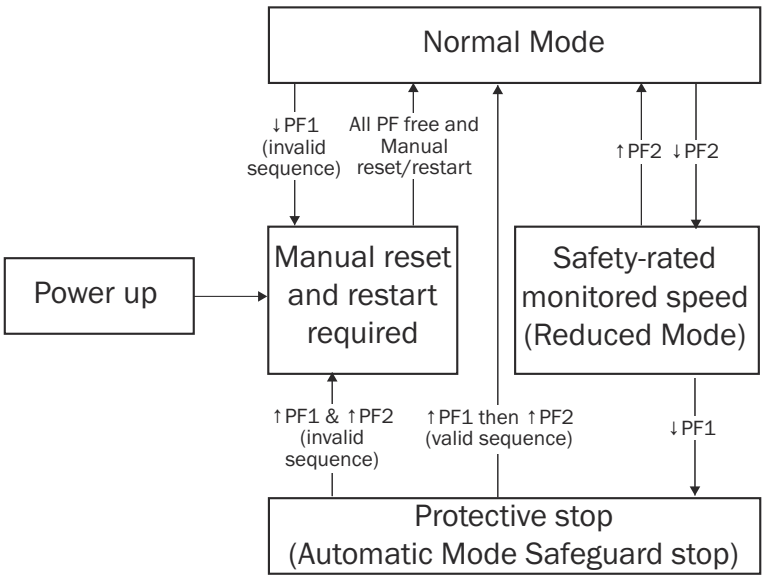


Figure 18: Software structure for configuration with automatic reset and automatic restart

↑ Protective field becomes clear.
↓ Protective field is interrupted.

In order to change to Normal mode after switching on or an invalid sequence, the operator must execute manual reset with manual restart. Both protective fields must be clear during reset and restart.

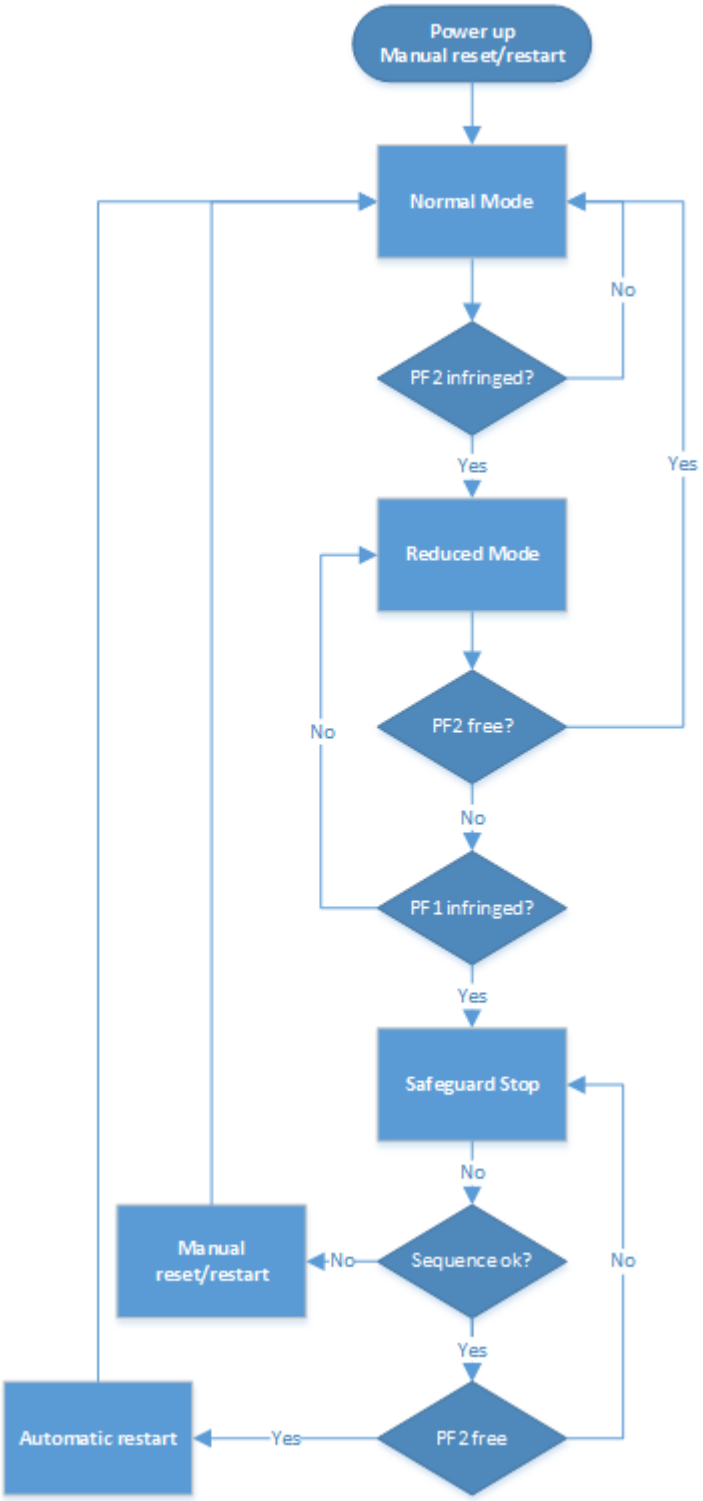


Figure 19: Software logic for configuration with automatic reset and automatic restart

7.3 Main module configuration

7.3.1 Adding a safety system in Flexi Soft Designer

Overview

When adding a safety system, the hardware configuration and logic configuration for the current project are imported into Flexi Soft Designer.

Procedure

Selecting the safety system

1. Open Flexi Soft Designer.
2. **Project** > **New** > **Standalone station project**
3. Dependant on the safety system, drag a suitable main module out of the **Modules** window into the **Configuration area**.
4. Click on the **Safety Systems** selection window in the bottom left.
5. In the **Available Safety System** list, select the desired safety system.

✓ A description of the selected safety system is displayed.

Checking the version of the safety system

ⓘ **NOTE** | The license applies only to the current version of the safety system. If you do not use the current version of the safety system, verification problems may arise. If Flexi Soft Designer hasn't been updated recently, a manual check of the version of the safety system is required.

6. If the version has been confirmed as current: Continue at step 15..
   To check, whether the version of the safety system is the current version: Continue at step 7..
7. Click on the **Description** tab and check the version number of the safety system in the **Version** field.
8. Click on **Find the latest safety systems**.

✓ The SICK website is opened.

9. On the **Downloads** > **Software** tab, search for the desired safety system and check the version of the safety system available online.
10. If the version in the configuration matches the version on the website, continue at step 15..

Importing the current version from the website

11. On the SICK website, click on **Download** for the desired safety system and save the SSA file locally.

✓ The SSA file of the safety system is downloaded.

12. In Flexi Soft Designer, click on the **Import Safety System and add to list** button.

13. Select the downloaded SSA file and click **OK** to confirm.
14. In the **Available Safety System** list, select the new version of the safety system.

Adding the safety system

15. Click on **Add Safety System** in the bottom left.

✓ The safety system is added to the project.

Further topics

- "Activating the license for the safety system", page 38

7.3.1.1 Checksums

Important information

NOTE
The specified checksums only apply at the time of delivery and after configuration of the safety system as described in this document. Individualized changes to the logic configuration, e.g. external signals for the safety functions, change the checksum.

Checksums for Flexi Soft CPU0

- After having been added to the configuration software: 0x1327C700
- After you have linked the safety outputs in the logic editor:
  Table 17: Checksums after completed configuration

Reset and restart	Number of safety laser scanners	
	1	2
Manual	0x1327C700	0x1327C700
Automatic	0xAF236988	0xAF236988

Checksums for Flexi Soft CPU1 and CPU2

- After having been added to the configuration software: 0xE1A48135
- After you have linked the safety outputs in the logic editor:
  Table 18: Checksums after completed configuration

Reset and restart	Number of safety laser scanners	
	1	2
Manually	0x77DF9CF8	0xF0EA32EC
Automatically	0xDA9581A9	0x5DA02FBD

Checksums for Flexi Soft CPU3

- After having been added to the configuration software: 0x6C7459F7
- After you have linked the safety outputs in the logic editor:
  Table 19: Checksums after completed configuration

Reset and restart	Number of safety laser scanners	
	1	2
Manually	0xFA0F443A	0x7D3AEA2E
Automatically	0x5745596B	0xD070F77F

Checksums for nanoScan3

- In the delivery condition: 0x5B1B6C9B

7.3.1.2 Jump addresses

Jump addresses consist of a source jump address and a destination jump address. The destination jump address assumes the same value (HIGH or LOW) as the associated source jump address without a delay.

Among other things, jump addresses are used to connect the various pages of logic with each other.

7.3.1.2.1 Finding source and destination jump addresses that belong together

Procedure

1. Right-click on the source or destination jump address.
2. Click **Used on page**.
✓ A list of all pages containing elements of the jump address is displayed.
3. Click on the desired page.
✓ The desired page is displayed.

7.3.2 Completing configuration and testing logic

Overview

The logic for the restart behavior and the number of safety laser scanners is not yet configured at the time of delivery. The logic cannot be transmitted to the safety controller if configuration is not complete.

Procedure

► Complete configuration of the safety system.
► Check whether the logic meets the safety requirements of the application.

Further topics

- "In/out page", page 36

7.3.3 In/out page

Overview

This page contains all inputs and outputs of the safety controller.

You also configure the safety system to suit you application on this page.

Safety laser scanner network inputs

You configure the number of safety laser scanners used here.

Table 20: Elements for configuring the number of safety laser scanners

Input element	Must be connected with:
If 2 safety laser scanners are used:	
nS3 02 PF1 (OSSD1).XTIO[1].I5I6	**AND 0** function block **nanoScan3 02 PF1** input
nS3 02 PF2 (OSSD2).XTIO[1].I7I8	**AND 1** function block **nanoScan3 02 PF2** input
If 1 safety laser scanner is used:	
Static 1	**AND 0** function block **nanoScan3 02 PF1** input AND **AND 1** function block **nanoScan3 02 PF2** input

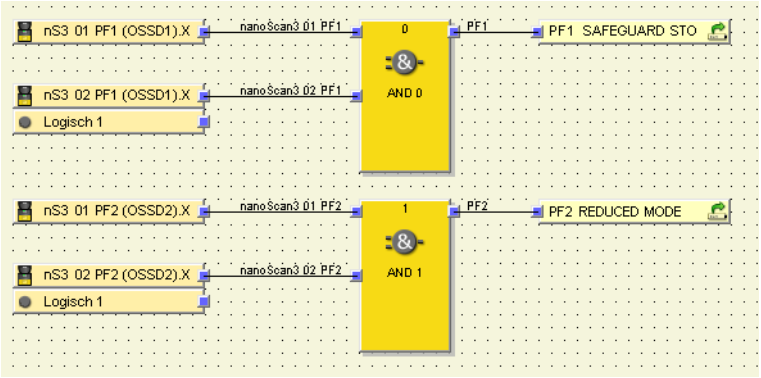


Figure 20: Configuration with 2 safety laser scanners

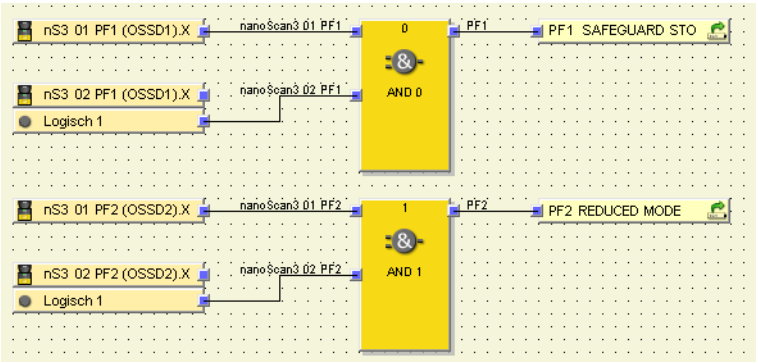


Figure 21: Configuration with 1 safety laser scanner

Network selection of manual or automatic reset/restart

Here you can configure whether reset and restart are performed manually or automatically.

Table 21: Element for configuration of reset and restart

Input element	Must be connected with:
Manual reset and manual restart	
Static 0	**Reset/Restart type** function block **Input**
Automatic reset and manual restart	
Static 1	**Reset/Restart type** function block **Input**

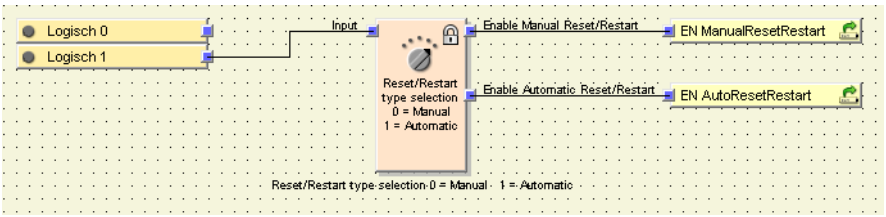


Figure 22: Configuration with automatic reset and automatic restart

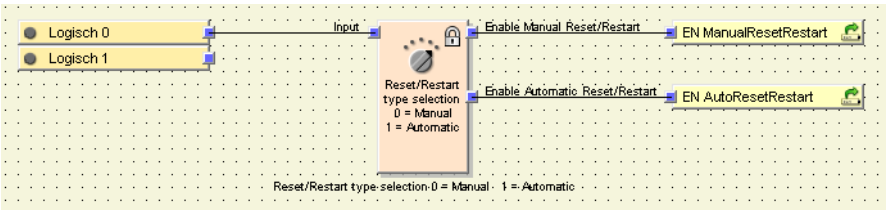


Figure 23: Configuration with manual reset and manual restart

Network input and output signals for reset and restart pushbutton

The input and output signals of the reset pushbutton and the restart pushbutton are found here.

Only the available jump addresses with the outputs of the function blocks are used for the flashing frequency of the indicator lamps. Generating the flashing frequency in any other way is not permitted (e.g. via clock generators).

Robot safety signal network

The output signals for triggering the safety functions on the robot controller are found here.

You can use the external safety signals to directly trigger the safety functions on the robot controller (e.g. via additional safety switches). The functionality of the safety system described in this document is not impeded by this. The safety functions with external safety signals are not a part of this safety system and are the responsibility of the manufacturer.

Table 22: Jump addresses for external safety signals

Jump address	Safety function	Description
External safeguard stop	Trigger protective stop	Signal state LOW triggers the protective stop on the robot controller.
External Reduced mode	Trigger safety-rated monitored speed	Signal state LOW triggers the safety-rated monitored speed on the robot controller.

To connect a jump address to an external safety signal, you must replace the corresponding **Static 1** signal on the **Routing 1:n** function block with the safety signal.

7.3.4 SafetyFunctions page

This page contains user-defined function blocks for the following safety functions:

- Manual reset and manual restart
- Automatic reset and automatic restart
- Safe sequence monitoring

This page does not require any configuration by the user. All function blocks and the page itself are password protected.

7.3.5 Activating the license for the safety system

Overview

A project can only be verified if a license is activated.

Procedure

1. In the **Extras** menu, select the **Software licenses** command.
2. In the **Software licenses** dialog box, click on the **Activate** button.
3. Enter the Ticket ID and confirm with **OK**.

✓ The CodeMeter License Central WebDepot opens in your browser.

4. Select the binding for the licenses:
   - Binding to a PC
   - Binding to a dongle
5. Select the desired licenses.

   NOTE | Note the specified number of licenses. If you have purchased a license package and only want to activate specific licenses in it, you need to first distribute the licenses.
6. Activate the licenses by clicking the **Now activate the selected licenses** button.
7. Click on **Close** to apply the changes and close the **Software licenses** window.

Complementary information

- It is also possible to activate a license offline. To do so, following the **File-based license transfer** instructions in the WebDepot.
- Licenses are only marked as used after being transfered to the controller.
- Licenses cannot be copied or transferred. It is not possible, for example, to transfer it back to the PC.
- For details on managing licenses, see the operating instructions for the configuration software: 8012998.

7.4 Configuring the safety laser scanner

7.4.1 Opening a file

1. Start the Safety Designer.
2. Click on **Project**.
3. Click on **Open**.
4. Select the file.
5. Click on **Open**.

✓ The file opens. The **Settings** view appears.

6. Click on **Configuration**.

✓ The device overview view opens.

Double-click on a device to configure that device.

7.4.2 Resolution of the safety laser scanner

You can find the settings for the resolution under **Navigation** > **Configuration** > **Monitoring plane**.

A resolution of 70 mm is configured for the safety laser scanner. You must check whether the resolution is suitable for your application.

You can find information on calculating the minimum resolution in the operating instructions 8021911.

7.4.3 Field sets and cut-off paths

You can find the settings for the field sets and cut-off paths under **Navigation** > **Configuration** > **Monitoring cases**.

1 field set with 2 protective fields are configured for the safety laser scanner. Each protective field is assigned to a cut-off path.

Table 23: Protective field assignment

Protective field	Cut-off path	OSSD pair
PF1 SAFEGUARD STOP	1	1
PF2 REDUCED MODE	2	2

7.4.4 Configuring fields

Configuring fields

At the time of delivery, protective fields PF1 and PF2 are configured with the maximum scanning range of 3 m. You have to configure the fields in accordance with the requirements of your application and risk assessment.

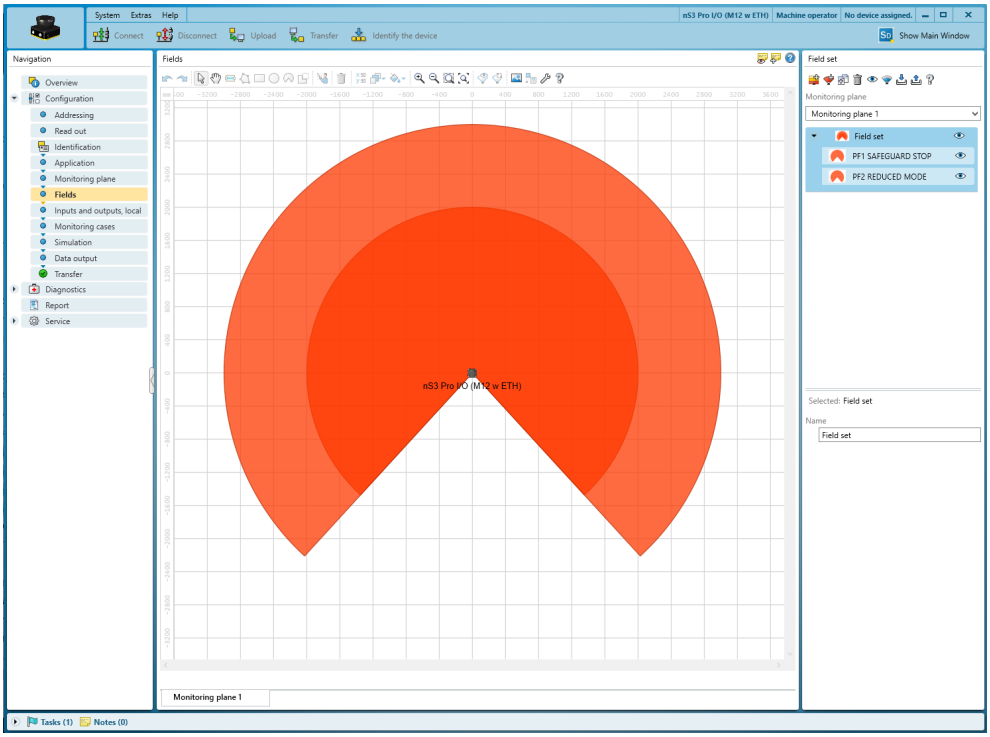


Figure 24: Example configuration of the protective fields

Further topics

- "Calculating minimum distance of protective field PF1", page 22
- "Difference between the minimum distances to the hazardous area", page 21

7.5 Configuration of the robot controller

7.5.1 Setting password for switching operating modes

Procedure

1. Click on the Hamburger icon.
2. Under **Password**, select the **Mode** menu item.
3. In the **New password** and **Confirm new password** fields, enter the desired password.
4. Click on **Apply**.

✓ You can switch between the operating modes using the icon at the top right. You must enter the password defined above to change to Manual operating mode.

7.5.2 Configuring inputs in the robot controller

Prerequisites

Robot is in Manual operating mode.

Procedure

1. Select **Installation** in the robot controller.
2. Under **Safety**, select the **I/O** menu item.

3. Assign the functions to the inputs.

Input signal	Function assignment
config_in[0], config_in[1]	Automatic mode safeguard stop
config_in[2], config_in[3]	Reduced mode
config_in[4], config_in[5]	3-position switch

Example:

✓ After assigning the functions to the inputs, the result should be as follows:

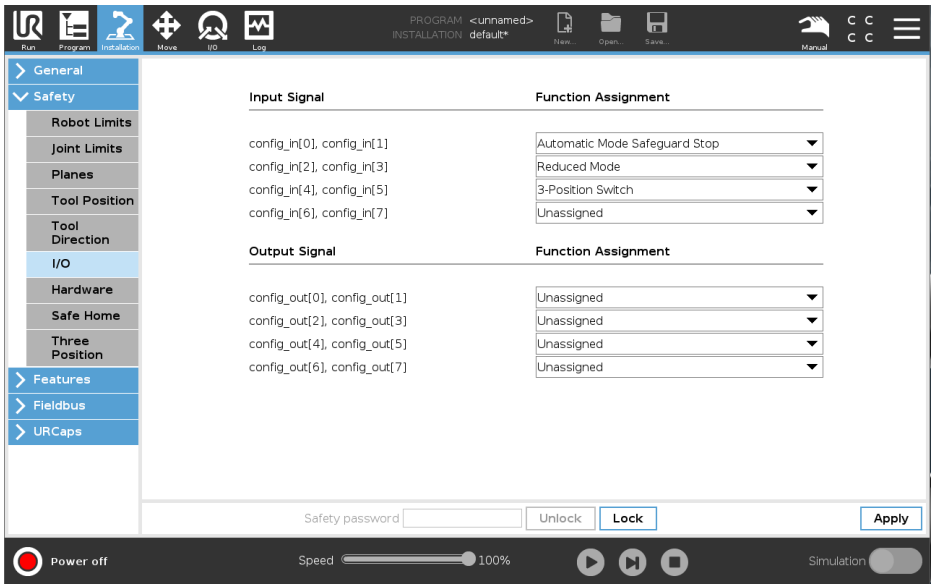


Figure 25: Configuration of inputs

8 Commissioning

8.1 Safety

WARNING
Hazard due to lack of effectiveness of the protective device

- ► Before commissioning the machine, make sure that the machine is first checked and released by qualified safety personnel.
- ► Only operate the machine with a perfectly functioning protective device.

DANGER
Dangerous state of the machine

During commissioning, the machine or the protective device may not yet behave as you have planned.

- ► Make sure that there is no-one in the hazardous area during commissioning.

Before commissioning can be performed, project planning, mounting, electrical installation and configuration must be completed in accordance with this document.

8.2 Overview of commissioning

Overview

The safety system is configured using the Flexi Soft Designer configuration software. The safety system files include a file for configuring the safety laser scanner in the Safety Designer configuration software. You also need to configure some settings in the robot controller.

Prerequisites

- All cables are connected (signals and voltage supply).
- The Flexi Soft Designer and Safety Designer configuration software are installed on the computer.

Procedure

1. Connect safety controller, safety laser scanner, and robot controller to the power supply.
2. Add the desired main module in the Flexi Soft Designer configuration software. Next add the safety system.
   "Adding a safety system in Flexi Soft Designer", page 34
3. Configure the number of safety laser scanners and the type of reset and restart in the safety system logic.
   "In/out page", page 36
4. Transmit configuration to the safety controller (see operating instructions 8012998).
5. Activate the software license for the safety system.
   "Activating the license for the safety system", page 38
6. Open the file for the safety laser scanner using the Safety Designer configuration software.
   "Opening a file", page 39
7. Configure the protective fields for the safety laser scanner (see operating instructions 8024594).
8. Transmit configuration to the safety laser scanner (see operating instructions 8024594).
9. Configure the robot controller.

"Configuration of the robot controller", page 40

10. Verify and validate the safety functions.
"Checklists", page 51

8.3 Check during commissioning and modifications

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

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

9 Operation

9.1 Operating the components

NOTE
Information is included in the operating instructions for the components.

9.2 Regular thorough check

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

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

10 Maintenance

10.1 Maintenance of the components

NOTE
Information is included in the operating instructions for the components.

11 Troubleshooting

11.1 Troubleshooting the components

NOTE
Information is included in the operating instructions for the components.

12 Technical data

12.1 Data sheet

Table 24: sBot Speed – URe data sheet

Performance level	d
SIL claim limit	2
Supply voltage V_S	24 V DC (16,8 V DC ... 28,8 V DC) (PELV) [1]
Ambient operating temperature	–10 °C ... 50 °C
Storage temperature	–25 °C ... 70 °C
Air humidity	90% at 50 °C (EN 61131-2)
Permissible operating height	2000 m
Safe state	The safety-related semiconductor outputs are in the OFF state.

1) The external supply voltage must jumper a brief power failure of 20 ms as specified in IEC 60204-1. Suitable power supply units are available as accessories from SICK.

12.2 Response time of safety system

Composite response time

The response time of safety system $t_{safetysystem}$ is calculated as follows:

$t_{safetysystem} = t_{safetylaserscanner} + t_{input} + t_{logic} + t_{output}$

Table 25: Response time

$t_{safetysystem}$	89 ms[1]
$t_{safetylaserscanner}$	Response time of the safety laser scanner n × 30 ms + 10 ms The following applies: n = set multiple sampling (default: n = 2) 70 ms
t_{input}	Safety controller input response time 6.5 ms
t_{logic}	2 × logic response time of the safety controller 8 ms
t_{output}	Safety controller output response time 4.5 ms

1) Value at time of delivery. The actual value depends on the set multiple sampling of the safety laser scanner and the logic execution time.

Complementary information

Changing the components of the safety system or the logic program of the safety controller can affect the response time of the safety system. You may have to recalculate the response time of the safety system.

You must also take into account other times when calculating the stopping time of the complete system. The following times are always relevant for the stopping time of the complete system:

- Robot controller response time
- Response time of the robot
- Robot stopping/run-down time

13 Ordering information

13.1 Ordering information and scope of delivery

Table 26: Ordering information and scope of delivery sBot Speed – URe

	Hardware and software			Soft-ware only
Part number	**1117267**	**1117268**	**1121078**	**1614885**
Hardware				
Flexi Soft safety controller				
CPU0 main module	1 ×	1 ×	–	–
System plug for CPU0	1 ×	1 ×	–	–
CPU3 main module	–	–	1 ×	–
System plug for CPU3	–	–	1 ×	–
XTIO expansion module (8 inputs, 4 outputs)	2 ×	2 ×	–	–
Safety laser scanner				
nanoScan3 Pro I/O	1 ×	2 ×	2 ×	–
Software				
Ticket ID for software license	1 ×	1 ×	1 ×	1 ×
Files	• Logic configuration (example) • SISTEMA file • Circuit diagram • Operating instructions The files are available free of charge in the configuration software. see "Adding a safety system in Flexi Soft Designer", page 34			

14 Accessories

14.1 sBot Speed – URe accessories

Table 27: Reset pushbutton

Description	Type code	Part number
Dual pushbutton (for reset and restart)	ER12-SD5E8	6051321

Table 28: Brackets for safety laser scanner

Description	Part number
Mounting kit 1b (with protection for optics cover)	2111768

Table 29: Plug connectors and cables

Description	Type code	Part number
Connecting cable, 10 m, female connector, M12, 8-pin, straight, A-coded, flying leads For Connection of dual pushbutton	YF2A18-100UA5XLEAX	2095654
Connecting cable, 15 m, female connector, M12, 8-pin, straight, A-coded, flying leads For Connection of dual pushbutton	YF2A18-150UA5XLEAX	2095679
Connecting cable, 5 m, M12, 17-pin, straight For Connection of safety laser scanner	YF2ASD-050XXXXLECX	2075220
Connecting cable, 10 m, M12, 17-pin, straight For Connection of safety laser scanner	YF2ASD-100XXXXLECX	2070427
Network cable, 2.5 m, male connector, M12, 4-pin, straight, D-coded, male connector, RJ45, 8-pin, straight	YM2D24-020PN1MRJA4	2106182
Network cable, 5 m, male connector, M12, 4-pin, straight, D-coded, male connector, RJ45, 8-pin, straight	YM2D24-050PN1MRJA4	2106184
Network cable, 10 m, male connector, M12, 4-pin, straight, D-coded, male connector, RJ45, 8-pin, straight	YM2D24-100PN1MRJA4	2106185
Configuration cable, M8, USB-A, 2 m	DSL-8U04G02M025KM1	6034574
Configuration cable, M8, USB-A,10 m	DSL-8U04G10M025KM1	6034575

15 Spare parts

15.1 sBot Speed – URe spare parts

Table 30: Ordering data for sBot Speed – URe spare parts

Product	Type code	Part number
Flexi Soft safety controller main module CPU0	FX3-CPU000000	1043783
Flexi Soft safety controller main module CPU3	FX3-CPU320002	1059305
Flexi Soft safety controller expansion module - I/O module (8 inputs, 4 outputs)	FX3-XTIO84002	1044125
Flexi Soft safety controller system plug CPU0	FX3-MPL000001	1043700
Flexi Soft safety controller system plug CPU3	FX3-MPL100001	1047162
nanoScan3 Pro I/O safety laser scanner	NANS3-CAAZ30AN1	1100334
nanoScan3 Pro I/O system plug	NANSX-AAACAEZZ1	2104860

16 Annex

16.1 Checklists

16.1.1 Checklist for initial commissioning and commissioning

Important information

NOTE

This checklist should be retained and kept with the machine documentation to serve as a reference during recurring thorough checks.

This checklist is not a substitute for initial commissioning or periodic thorough checks by qualified safety personnel.

Tests for the “Protective stop” safety function

Table 31: Tests for the “Protective stop” safety function

Test sequence	Expected result	Result OK?
1. Start the robot in “Automatic” operating mode. 2. Interrupt protective field PF1. 3. With protective field PF1 interrupted, change to “Manual” operating mode. 4. Actuate the enabling device. 5. Start robot program via teach panel.	The robot carries out a protective stop when protective field PF1 is interrupted. A yellow icon is shown at the bottom left in the teach panel. In the “Manual, reduced speed” operating mode, the robot can also move when the enabling device is actuated while protective field PF1 is interrupted.	Yes ☐ No ☐

Tests for “Manual reset and manual restart” safety function

These tests are only necessary for configuration with manual reset and manual restart.

Table 32: Tests for “Manual reset and manual restart” safety function

Actuate ResetPushbuttonTestSequence.	Expected result	Result OK?
1. Start the robot in “Automatic” operating mode. 2. First interrupt protective field PF2, then protective field PF1. Protective field PF1. Maintain interruption. 3. Actuate the reset pushbutton. 4. Actuate the restart pushbutton. ✓ The robot does not start. 5. Approve protective field PF2, but continue to interrupt protective field PF2. 6. Actuate the reset pushbutton. 7. Actuate the restart pushbutton. ✓ The robot does not start. 8. Approve protective field PF2. 9. Actuate the restart pushbutton. ✓ The robot does not start. 10. Actuate the reset pushbutton. 11. Actuate the restart pushbutton. ✓ The robot starts.	Restarting the robot is not possible as long as protective field PF1 or PF2 is interrupted. As long as protective field PF1 is interrupted, the robot cannot not restart without resetting. After actuating the reset pushbutton and the restart pushbutton, the robot starts up.	Yes ☐ No ☐

Actuate ResetPushbuttonTestSequence.	Expected result	Result OK?
Comments:		

Tests for the “Automatic reset and restart with safe sequence monitoring” safety function

These tests are only necessary for configuration with automatic reset and automatic restart.

Table 33: Tests for the “Automatic reset and restart with safe sequence monitoring” safety function

Test sequence	Expected result	Result OK?
1. Ensure that the protective fields are clear. 2. Start the robot in “Automatic” operating mode. 3. Interrupt protective field PF2. 4. Interrupt protective field PF1. 5. Approve protective field PF1, but continue to interrupt protective field PF2. 6. Approve protective field PF2.	If protective field PF2 is interrupted, the robot reduces its speed. If protective field PF1 is interrupted, the robot stops. If protective field PF2 becomes clear again, an automatic restart takes place.	Yes ☐ No ☐
1. Start the robot in “Automatic” operating mode. 2. Interrupt protective field PF1 without having first interrupted protective field PF2. 3. Approve protective field PF1, but continue to interrupt protective field PF2. 4. Approve protective field PF2.	The robot stops during interruption of protective field PF1. An automatic restart is not performed. Restarting is only possible when all protective fields are clear and the reset pushbutton has been actuated.	Yes ☐ No ☐
1. Start the robot in “Automatic” operating mode. 2. Interrupt protective field PF2. 3. Interrupt protective field PF1. 4. Protective fields PF1 and PF2 are approved at the same time.	The robot stops during interruption of protective field PF1. Restarting is only possible when all protective fields are clear and the reset pushbutton has been actuated.	Yes ☐ No ☐
Comments:		

Tests for “Triggering safety-rated monitored speed” safety function

Table 34: Tests for “Triggering safety-rated monitored speed” safety function

Test sequence	Expected result	Result OK?
1. Start the robot in “Automatic” operating mode. 2. Interrupt protective field PF2.	The robot reduces the speed. You can use the icon at the bottom left in the teach panel to observe how the robot changes from **Normal mode** to **Reduced mode**.	Yes ☐ No ☐
Note the settings for the safety-rated monitored speed function (values in Reduced mode) here:		

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