OPERATING INSTRUCTIONS

# EnforceKey Single Door

## Functional safety system

SICK
Sensor Intelligence.

### Described product

EnforceKey Single Door

### Manufacturer

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

### Legal information



### Original document

This document is an original document of SICK AG.

CE

# Contents

# 1 About this document

## 1.1 Purpose of this document

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

These operating instructions are to be made available to all those who work with the functional safety system.

Please read these operating instructions carefully and make sure that you understand the content fully before working with the functional safety system.

## 1.2 Scope

These operating instructions apply to the EnforceKey Single Door functional safety system.

These operating instructions are included with SICK part number 8019917 (all available language versions of the operating instructions).

Further information can also be found in the following documents:

| Document | Title | Part number |
|---|---|---|
| Operating instructions | Flexi Soft Modular Safety Controller Hardware | 8012999 |
| Operating instructions | Flexi Soft in the Flexi Soft Designer Configuration Software | 8012998 |
| Competence brochure | Guide for Safe Machinery | 8008007 |

*Table 1: Available documents*

## 1.3 Target groups

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.

## 1.4 Further information

www.sick.com

The following information is available via the Internet:

- Other language versions
- Data sheets and application examples
- CAD data for drawings and dimensional drawings
- Certificates (such as the EU declaration of conformity)
- Guide for Safe Machinery (six steps to a safe machine)

## 1.5 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.

### LED symbols

These symbols indicate the status of an LED:

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

# 2 Safety information

## 2.1 Basic safety notes

This chapter contains general safety information for the functional safety system.

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

**DANGER**
Hazard due to lack of effectiveness of the protective device

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.

- ▶ Read this document carefully and ensure that you have fully understood the contents before you work with the device.
- ▶ Pay particular attention to all safety notes in this document.

## 2.2 Intended use

The functional safety system provides access protection for machines with one access door (see "Setup and function", page 10).

The functional safety system must only ever be used within the limits of the prescribed and specified technical data and operating conditions.

If the system is used improperly, modified inappropriately or tampered with in any way, any warranty provided by SICK AG shall be rendered void; furthermore, SICK AG shall not accept any responsibility or liability for any resulting damage and consequential damage.

### Foreseeable misuse

The functional safety system is **not** suitable for use (list is not exhaustive):

- Outdoors
- Underwater
- In explosion-hazardous areas

## 2.3 Requirements for the qualification of personnel

Only authorized qualified safety personnel are permitted to configure, install, connect, commission, and maintain the functional safety system.

### 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

For mechanical mounting, 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 that he/she can assess its operational safety status.

### Electrical installation

For electrical installation, 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 that he/she can assess its operational safety status.

### Configuration

For configuration, 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 that he/she can assess its work safety aspects.

### Commissioning

For commissioning, 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 that he/she can assess its operational safety status.

### 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.

# 3 Product description

## 3.1 Setup and function

The EnforceKey Single Door functional safety system is intended for accessing locked hazardous areas on a regular basis by allowing personnel to enter them safely for brief periods. It ensures that the hazardous area is monitored until the person exits. The machine/plant can only be restarted once the hazardous area has been securely locked again and the EnforceKey Single Door has been reset.

**Machine or plant requirements**

- Locked hazardous area that is secured by equipment such as physical guards
- Only one point of access via a safety door
- Machine issues a stop signal
  Alternatively: A machine on which the dangerous state can be brought to a standstill within five seconds
- The hazardous area is visible from the entry module.
  Alternatively:
  - Part of the hazardous area is visible from the clearance module before the operator checks out.
  - The rest of the hazardous area is visible from the entry module before the reset is performed.
  - The route from the clearance module to the entry module is designed in such a way that the operator cannot fail to see anyone entering the hazardous area.

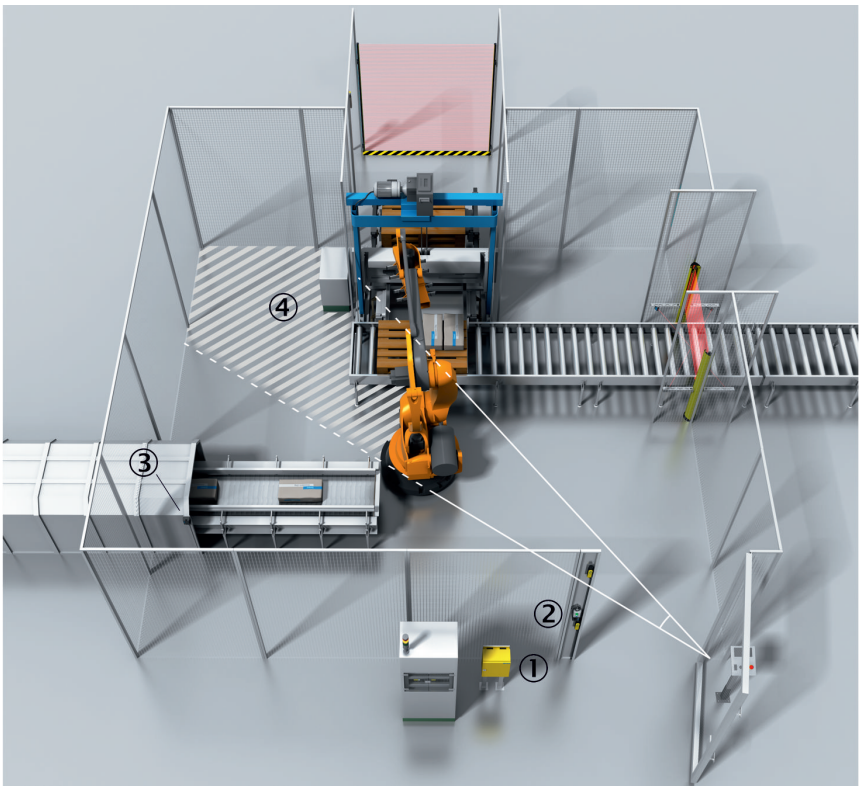



*Figure 1: Example of access protection with the EnforceKey Single Door*

① Control unit
② Entry module with reset button
③ Clearance module

④ Blind spot

In the example shown here, the location of the clearance module forces the operator to check the area that cannot be seen from the reset button position.

The functional safety system implements a monitored safety procedure. This safety procedure is made up of an access sequence and an exit sequence. The access sequence and the exit sequence are based on operator interaction with an entry module and a clearance module. The operator interacts with the modules via an electronic key (for detailed information, see "Entering the hazardous area, working in the hazardous area, and exiting the hazardous area", page 51).

### Access sequence

The functional safety system prevents anyone from accessing the hazardous area until the access sequence has been completed.

1 The operator removes the key from the entry module.
2 The safety relay switches to the OFF state.
3 As soon as the connected Standstill Monitor signals that the machine has stopped, the safety locking device is unlocked. [1)]
4 The hazardous area can now be entered safely without any risk of the machine accidentally restarting.

### Exit sequence

By means of the exit sequence, the functional safety system forces the operator to check that there is no one left inside the hazardous area before he or she exits.

1 The operator checks whether there is anyone inside the hazardous area. If the hazardous area is clear, the operator uses the key to check out on the clearance module.
2 The operator closes the access door and reinserts the key in the entry module.
3 The safety locking device connected to the functional safety system locks the door.
4 The operator checks whether there is anyone inside the hazardous area that is visible from the entry module. If the hazardous area is clear, the operator may reset the protective device.

**NOTE**
The machine can only be restarted once the safety procedure has been completed. The restart is not included as part of the functional safety system.

1) Alternatively, the system can be wired so that the safety locking device is unlocked after five seconds.

### 3.1.1 Structure of the EnforceKey Single Door

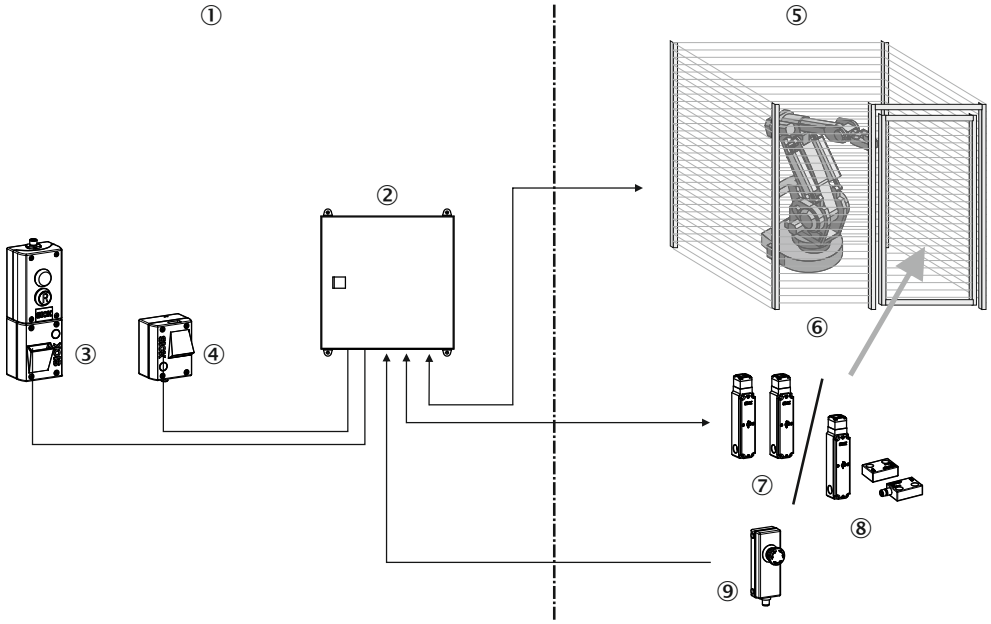



*Figure 2: Structure of the EnforceKey Single Door*

① Components of the functional safety system
② Control unit
③ Entry module
④ Clearance module
⑤ Application-dependent components
⑥ Hazardous area with access door
⑦ Safety locking devices (standard wiring option)
⑧ Safety locking device and safety switch (ECO wiring option)
⑨ Emergency stop pushbutton (optional)

### 3.1.2 Components of the EnforceKey Single Door

#### Control unit

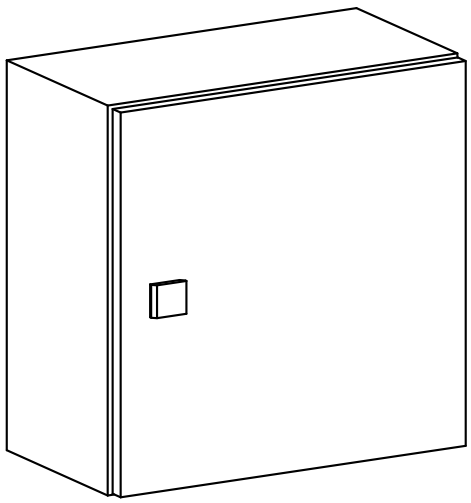


*Figure 3: Control unit*

The control unit contains:

- Power supply unit for all components and connected modules
- The safety controller with the logic for the functional safety system
- Safety relay
- Terminal strip for the voltage supply, sensors, and actuators

**Entry module**

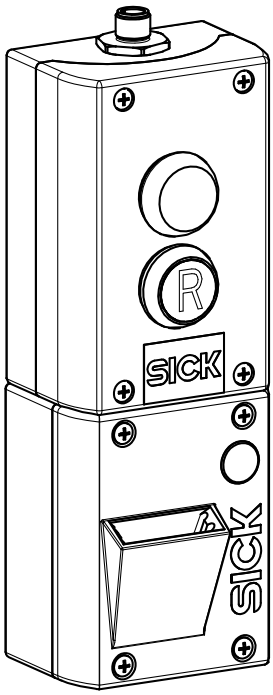



*Figure 4: Entry module*

The entry module contains:

- LED (green): Safety relay status
- Illuminated reset button (blue)
- LED (white): Safety sequence status
- Key reader
- 2 LEDs for status and diagnostics (located at bottom, not visible in figure)

**Clearance module**

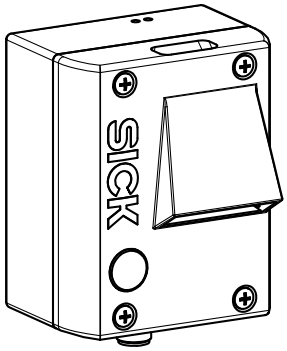



*Figure 5: Clearance module*

The clearance module contains:

- LED (white): Safety sequence status
- Key reader
- 2 LEDs for status and diagnostics

**Key**

The key is taught in at the entry module and the clearance module (see "Teaching in the key", page 47). This makes it unique and non-interchangeable.

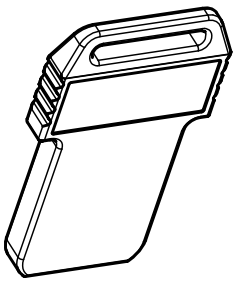


*Figure 6: Key*

### 3.1.3 Application-dependent components

The functional safety system requires further components to properly realize the safety functions. These are not included with delivery.

#### 3.1.3.1 Safety locking device and safety switch

**Standard wiring option**

For the standard wiring option, the functional safety system requires two safety locking devices (see figure 7, page 17).

Minimum requirements for each safety locking device:

- 1 positive opening normally closed contact for locking monitoring
- 1 positive opening normally closed contact for door monitoring
- Mechanical locking type

The functional safety system tests the positive opening normally closed contacts (for locking and door monitoring) for cross-circuits, short-circuits, and sequence errors.

We recommend using the i10 Lock or i110 Lock safety locking devices (see "Accessories", page 76).

**ECO wiring option**

For the ECO wiring option, the functional safety system requires one safety locking device and one safety switch (see figure 8, page 18).

Minimum requirements for the safety locking device:

- 2 positive opening normally closed contacts for locking monitoring
- 1 positive opening normally closed contact for door monitoring
- Mechanical locking type

The functional safety system tests the positive opening normally closed contacts (for locking and door monitoring) for cross-circuits, short-circuits, and sequence errors.

Minimum requirements for the safety switch:

- 1 N/O contact
- Logic:
  - Closed: Door closed
  - Open: Door open

The functional safety system tests the connected safety switch for short-circuits.

We recommend using the i10 Lock or i110 Lock safety locking devices and the RE1 safety switch (see "Accessories", page 76).

#### 3.1.3.2 Standstill Monitor (optional)

If an external Standstill Monitor is connected to the functional safety system with the default factory configuration, the following minimum requirements apply: [2)]

- 2 cut-off paths
- Output: Dual-channel equivalent electro-mechanical safety switch
- Logic:
  - Closed: Machine standstill detected
  - Open: No machine standstill detected

The functional safety system tests the connected Standstill Monitor for cross- and short-circuits, and also for discrepancy and sequence errors.

#### 3.1.3.3 Emergency stop pushbutton (optional)

If an emergency stop pushbutton is connected to the functional safety system with the default factory configuration, the following minimum requirements apply:

- 2 positive opening normally closed contacts

2) Alternatively, you can configure a fixed delay time.

The functional safety system tests the connected emergency stop pushbutton for cross- and short-circuits, and also for discrepancy and sequence errors.

We recommend using the ES11 emergency stop pushbutton (see "Accessories", page 76).

**NOTE**
If you do not connect an emergency stop pushbutton, you must configure the system accordingly (see "Configuring the emergency stop function", page 46).

#### 3.1.3.4 Connecting cables

For the entry module, you will need 8-pin cables. For the clearance module, you will need 5-pin cables (see "Accessories", page 76).

## 3.2 Product characteristics

### 3.2.1 Wiring options: With or without Standstill Monitor

The functional safety system can be operated with or without a Standstill Monitor.

**Wiring option: With Standstill Monitor**

When the operator removes the key from the entry module, the functional safety system waits for a stop signal from the machine. If the machine sends this signal, the functional safety system opens the safety locking devices.

This type of wiring is configured by default at the factory (see "Configuring standstill monitoring", page 46).

**Wiring option: Without Standstill Monitor, with delay time**

**DANGER**
Hazard due to lack of effectiveness of the protective device
Five seconds after you remove the key from the entry module, the functional safety system opens the safety locking devices.

- ▶ Make sure that the dangerous state of the machine is brought to a standstill within five seconds.
- ▶ Check that this is the case in all machine operating modes and operational statuses.

### 3.2.2 Safety locking device wiring

The functional safety system can be used as follows:

- On a door with two safety locking devices
- On a door with one safety locking device and one safety switch

**Standard wiring option**

With the standard wiring option, two safety locking devices with integrated door monitoring are connected to the system. Together, the safety locking devices create a dual-channel system for the locking and door monitoring functions.

If two safety locking devices are used, a **performance level** of up to **PL e** can be achieved for the locking function.

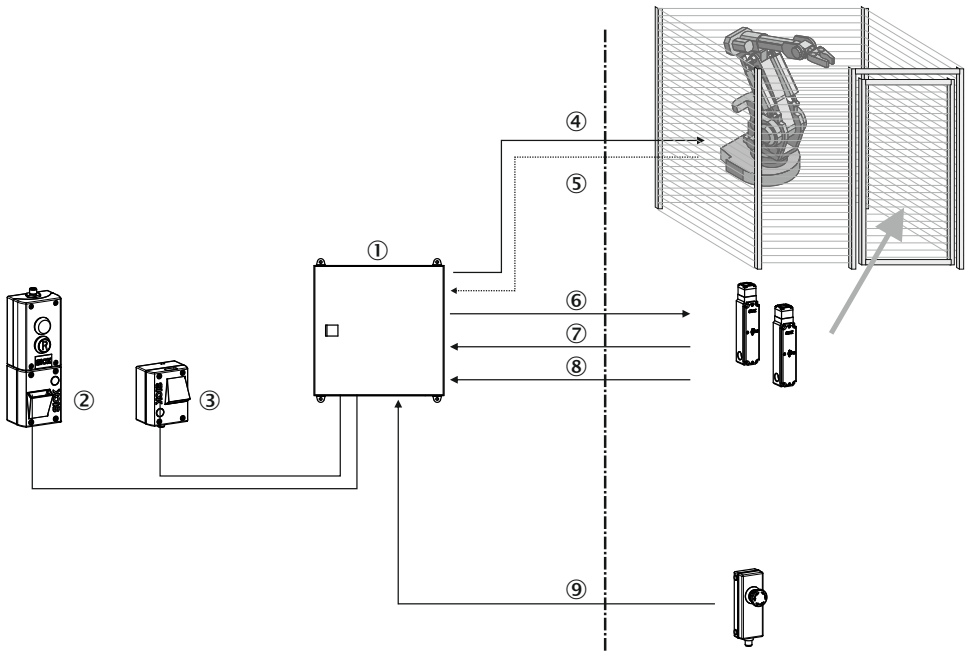



*Figure 7: Standard wiring option*

① Control unit
② Entry module
③ Clearance module
④ Machine cut-off path
⑤ Standstill Monitor (optional)
⑥ Locking function
⑦ Locking monitoring
⑧ Door monitoring (dual-channel)
⑨ Emergency stop (optional)

### ECO wiring option

With the ECO wiring option, one safety locking device and one safety switch are connected to the system. Together, the two positive opening normally closed contacts of the safety locking device create a dual-channel system from an electrical perspective (but from a mechanical perspective, it remains a single-channel system). For the door monitoring function, the safety locking device and the safety switch create a system that is dual-channel from both an electrical and a mechanical perspective.

If one safety locking device and one safety switch are used, a **performance level** of up to **PL d** can be achieved for the locking function.

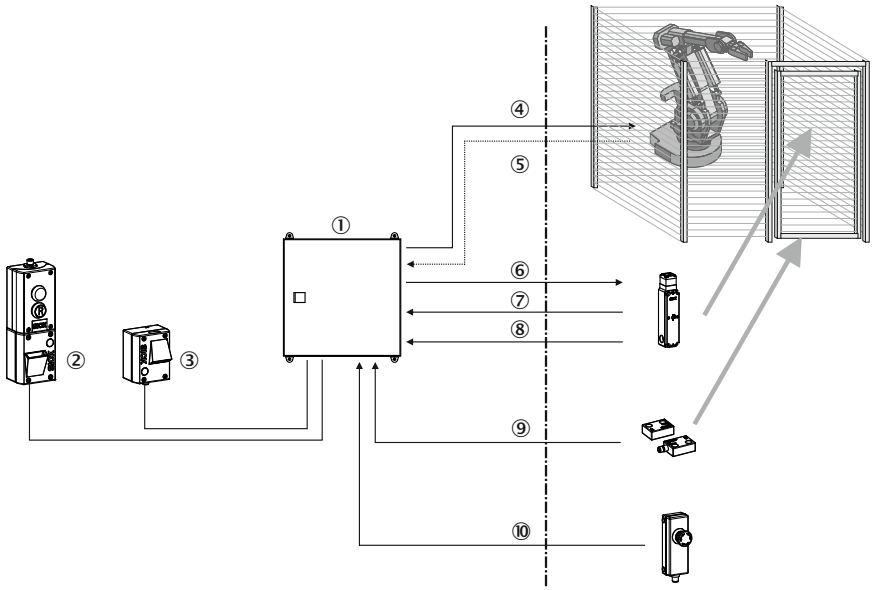



*Figure 8: ECO wiring option*

① Control unit
② Entry module
③ Clearance module
④ Machine cut-off path
⑤ Standstill Monitor (optional)
⑥ Locking function
⑦ Locking monitoring
⑧ Door monitoring (channel 1)
⑨ Door monitoring (channel 2)
⑩ Emergency stop (optional)

### 3.2.3 Status indicators

**Status indicators on the entry and clearance modules**

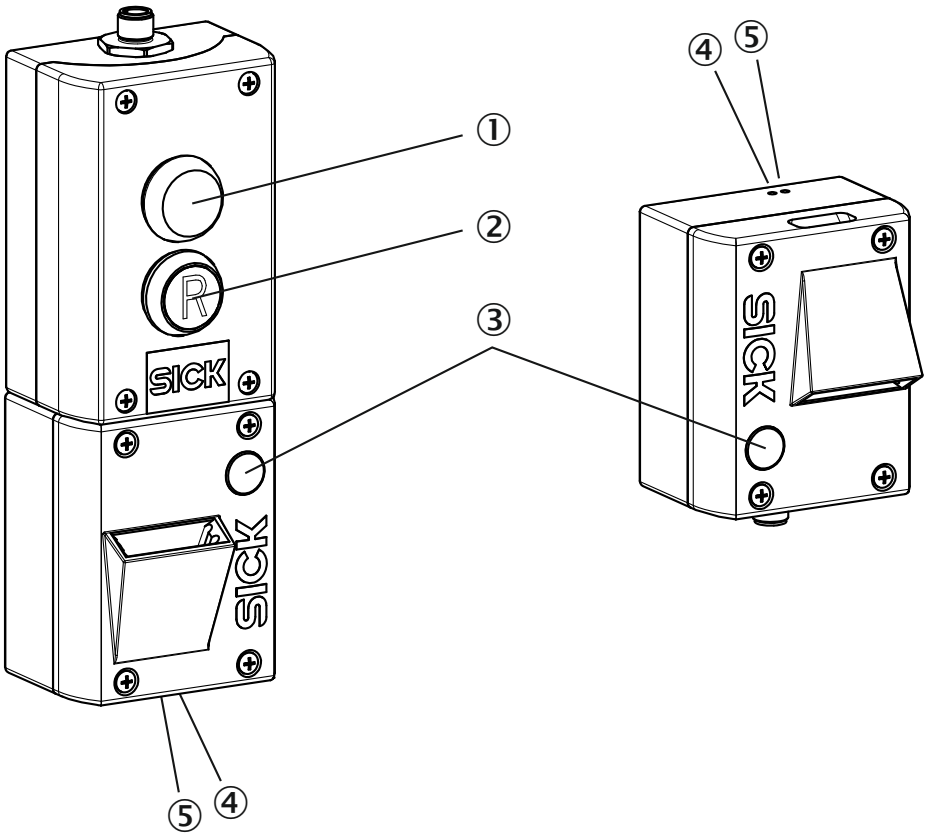



*Figure 9: Status indicators on the entry and clearance modules*

① Safety relay status LED (green)
② Reset required LED (blue)
③ Sequence status LED (white)
④ Diagnostics LED (for key teach-in)
⑤ Status LED (for key teach-in)

**NOTE**
The diagnostics and status LEDs can be found on the bottom of the entry module and on the top of the clearance module.

**Status indicators on the safety controller and the safety relay**

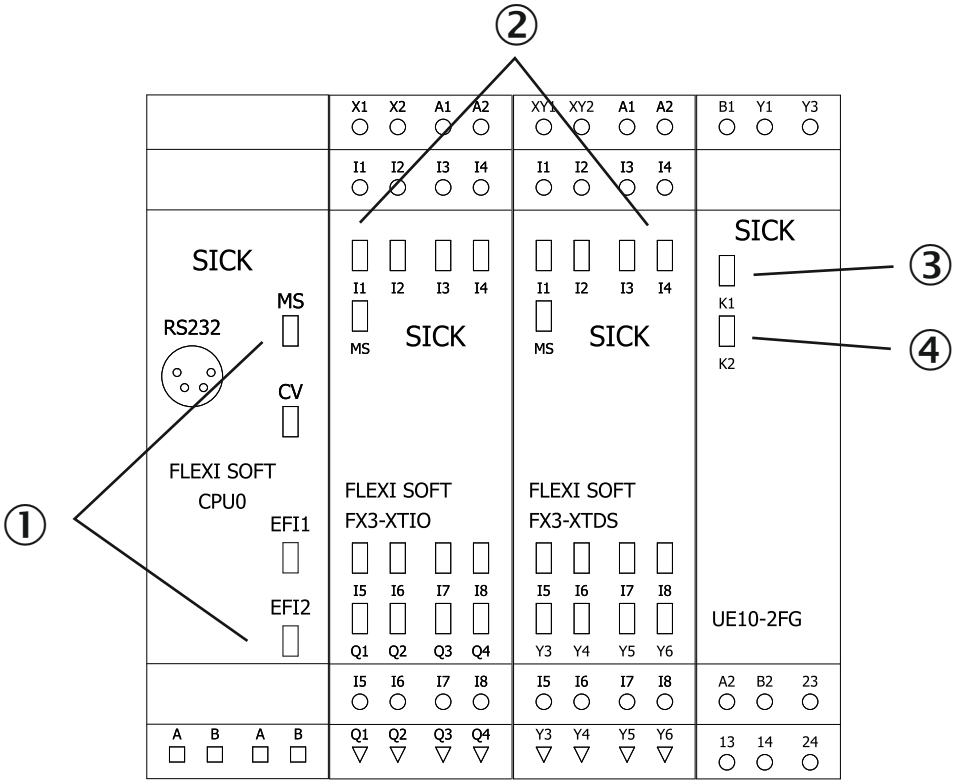



*Figure 10: Status indicators on the safety controller and the safety relay*

① LEDs on the Flexi Soft CPU
② LEDs on the Flexi Soft I/O modules
③ LED K1 (green) on safety relay
④ LED K2 (green) on safety relay

The safety controller and the safety relay are located inside the control cabinet.

## 3.3 Interfaces

### Internal interfaces

The functional safety system features the following internal interfaces:

- Entry module interface
- Clearance module interface

### External interfaces

The functional safety system features the following interfaces for external actuators and sensors:

- Actuator interface:
  This triggers the machine stop.
- Interface for machine Standstill Monitor: [3)]
  This confirms the machine stop.
- Door monitoring interface
- Interface for locking monitoring

3) As an alternative to using a Standstill Monitor, you can configure a fixed delay time.

- Interface for locking function:
  This opens or closes the locking device.
- Emergency stop interface

# 4 Project planning

## 4.1 Manufacturer of the machine

**DANGER**
Hazard due to lack of effectiveness of the protective device

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 of the functional safety system requires a risk assessment. Check whether additional protective measures are required.
- Apart from the procedures described in this document, the components of the functional safety system must not be opened.
- The components of the functional safety system must not be tampered with or modified.
- Improper repair of the protective device can lead to a loss of the protective function. Do not carry out any repairs on the device components.

## 4.2 Company operating the machine

**DANGER**
Hazard due to lack of effectiveness of the protective device

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.

- If changes are made to how the functional safety system is electrically integrated into the machine controller or if changes are made to the manner in which it is mechanically mounted, a new risk assessment must be carried out. 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 functional safety system must not be opened.
- The components of the functional safety system must not be tampered with or modified.
- Improper repair of the protective device can lead to a loss of the protective function. Do not carry out any repairs on the device components.

## 4.3 Requirements for the mounting locations

**Visibility of the hazardous area**

The following requirements must be met concerning the mounting locations for the entry and clearance modules:

- The entire hazardous area must be visible from the entry module before the reset is performed.
  **Or:**
- The following combined requirements must all be met:
  - Part of the hazardous area is visible from the clearance module before the operator checks out.
  - The rest of the hazardous area is visible from the entry module before the reset is performed.
  - The route from the clearance module to the entry module is designed in such a way that the operator cannot fail to see anyone entering the hazardous area.

#### Entry module

- The entry module must be mounted outside the hazardous area (on a physical guard around a machine zone, for example) and as close as possible to the access door.
- The entry module must be mounted in such a way that it cannot be operated from inside the hazardous area. For example, take steps to prevent the operator from reaching through the fence.

#### Clearance module

- The clearance module must be mounted inside the hazardous area.
- The clearance module must be mounted in such a way that it cannot be operated from outside the hazardous area.

#### Control unit

- The control unit must be mounted so that it is exposed to as few vibrations as possible.

## 4.4 Integrating the equipment into the electrical control

### 4.4.1 Cabling requirements

All electrical equipment must be installed in conformity with EN 60204-1.

### 4.4.2 Machine that is to be protected

#### Machine actuators

The safety relay used is a UE10-2FG.

Check that this is sufficient to switch off the machine contactors (see UE10-2FG and UE12-2FG operating instructions, SICK part no. 8012349).

#### With Standstill Monitor

By default, the functional safety system is configured and wired at the factory to wait for a dual-channel enable signal from a Standstill Monitor before it deactivates the door locking device.[4)]

Minimum requirements:

- 2 cut-off paths
- Output: Dual-channel equivalent electro-mechanical safety switch
- Logic:
  - Closed: Machine standstill detected
  - Open: No machine standstill detected

The functional safety system tests the connected Standstill Monitor for cross- and short-circuits, and also for discrepancy and sequence errors.

#### Without Standstill Monitor, with delay time

Alternatively, the functional safety system can be configured without a Standstill Monitor. However, in this case, a delay time must be configured (see "Configuring standstill monitoring", page 46). When the operator removes the key from the entry module, the functional safety system opens the safety locking devices after five seconds.

4) If a delay time is configured for the machine standstill, the interface with the Standstill Monitor is not monitored.

**DANGER**
Hazard due to lack of effectiveness of the protective device

Five seconds after you remove the key from the entry module, the functional safety system opens the safety locking devices.

- ▶ Make sure that the dangerous state of the machine is brought to a standstill within five seconds.
- ▶ Check that this is the case in all machine operating modes and operational statuses.

### 4.4.3 Safety locking devices

**DANGER**
Bypassing the protective device

In theory, it is possible for someone to obtain actuators for safety locking devices. They could then use these to tamper with the safety locking devices. In a worst-case scenario, a machine could start up while a door was still open.

- ▶ Put organizational measures in place to prevent anyone from tampering with the safety locking devices.

**Standard wiring for a locking function with a performance level of up to PL e**

The functional safety system features interfaces for two safety locking devices. Both safety locking devices must be mounted and installed in accordance with their operating instructions.

Minimum requirements for each safety locking device:

- 1 positive opening normally closed contact for locking monitoring
- 1 positive opening normally closed contact for door monitoring
- Mechanical locking type

The functional safety system tests the positive opening normally closed contacts (for locking and door monitoring) for cross-circuits, short-circuits, and sequence errors.

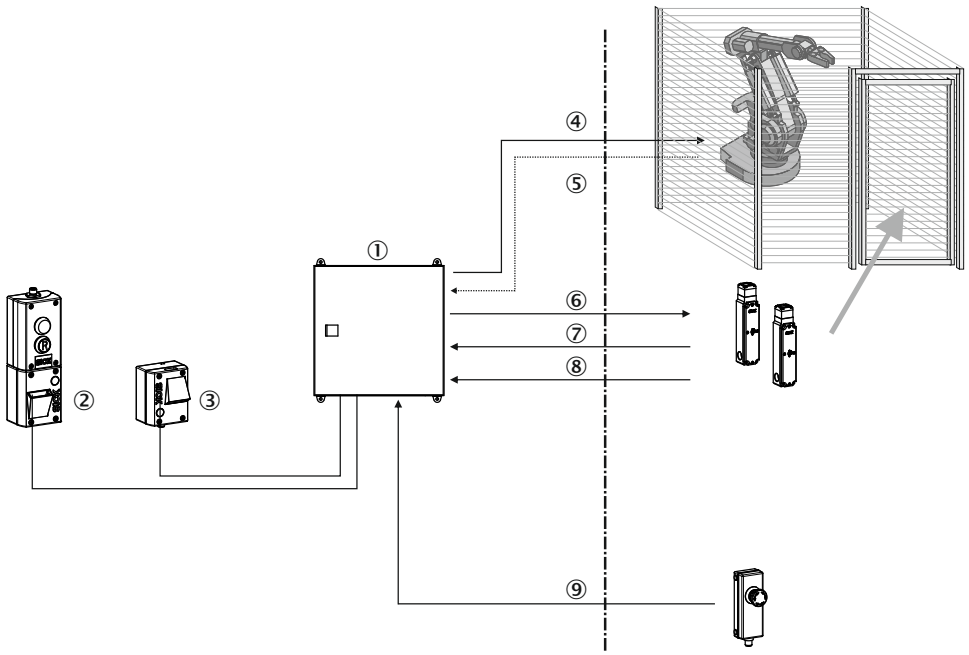



*Figure 11: Standard wiring option*

① Control unit
② Entry module
③ Clearance module
④ Machine cut-off path
⑤ Standstill Monitor (optional)
⑥ Locking function
⑦ Locking monitoring
⑧ Door monitoring (dual-channel)
⑨ Emergency stop (optional)

If two safety locking devices are used, a performance level of up to PL e can be achieved for the locking function.

**ECO wiring for a locking function with a performance level of up to PL d**

**NOTE**

In the case of the ECO wiring option, the locking function has a single channel for the mechanics (but a dual channel for the electrics). When assessing the machine as a whole, the manufacturer or entity operating the machine must decide whether faults can be satisfactorily ruled out as far as the mechanics of the safety locking device are concerned.

To prevent the locking bolt from being subjected to mechanical loads or overloads, suitable mechanical measures must be implemented.

With the ECO wiring option, only one safety locking device is used (see figure 8, page 18). However, a safety switch must also be connected. The safety locking device and the safety switch must be mounted and installed in accordance with their operating instructions.

Minimum requirements for the safety locking device:

- 2 positive opening normally closed contacts for locking monitoring
- 1 positive opening normally closed contact for door monitoring
- Mechanical locking type

The functional safety system tests the positive opening normally closed contacts (for locking and door monitoring) for cross-circuits, short-circuits, and sequence errors.

Minimum requirements for the safety switch:

- 1 N/O contact
- Logic:
  - Closed: Door closed
  - Open: Door open

The functional safety system tests the connected safety switch for short-circuits.

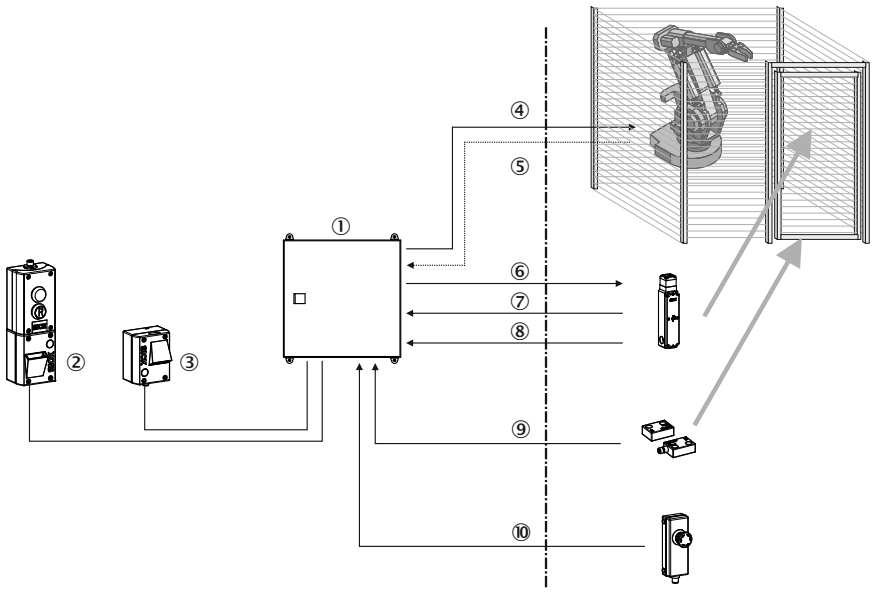



*Figure 12: ECO wiring option*

① Control unit
② Entry module
③ Clearance module
④ Machine cut-off path
⑤ Standstill Monitor (optional)
⑥ Locking function
⑦ Locking monitoring
⑧ Door monitoring (channel 1)
⑨ Door monitoring (channel 2)
⑩ Emergency stop (optional)

If one safety locking device and one safety switch are used, a performance level of up to PL d can be achieved for the locking function.

### 4.4.4 Preventing unexpected startup

**DANGER**
Hazard due to unexpected starting of the machine

- Do not use the reset function on the functional safety system as a restart interlock.
- A separate restart interlock must be provided for the machine.

# 5 Transport and storage

## 5.1 Transport

**WARNING**
The use of unsuitable means of transport may damage the control cabinet or cause personal injury.

The control cabinet is only designed for transport using a lifting truck with sufficient carrying capacity.

Please note the following when transporting the control cabinet:

- The control cabinet must be switched off.
- No cables must be connected to the control cabinet.
- The control cabinet door must be closed.
- The stipulated transport position must be observed:
  - The control cabinet must be standing upright or lying horizontally.
  - Do not transport the control cabinet on its head or on its sides.
  - Protective equipment must be used to secure the control cabinet on the lifting truck so that it cannot tilt or tip over.
  - If you are transporting several control cabinets, they must always be placed upright one behind the other.
  - Never stack control cabinets one on top of the other for the purpose of transporting them.
- As a safety precaution, the equipment must be prevented from slipping on the lifting truck (by using an anti-slip mat, for example).
- Avoid jolts and impacts during transport to prevent any damage from occurring.

## 5.2 Storage

Please observe the storage conditions that apply to the individual system components (see "Control unit data sheet", page 60, see "Entry module data sheet", page 61, see "Clearance module data sheet", page 63).

# 6 Mounting

## 6.1 Safety

**DANGER**
Hazard due to unexpected starting of the machine

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 dangerous state of the machine is and remains switched off.

**DANGER**
Hazard due to lack of effectiveness of the protective device

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.

- Eliminate any temptation to tamper with the safety locking device by implementing measures such as the following:
  - Attach safety switches with a cover or with shielding, or ensure they are out of reach.
  - Cover the safety switch and the actuator with additional equipment or protect them against access. Cover the sensor and the actuator with additional equipment or protect them against access.
  - If possible, avoid mounting the system in a way that makes it easy to detach. Instead, use a tamper-proof mounting method.

## 6.2 Unpacking

- Check the components for completeness and the integrity of all parts, see "Scope of delivery", page 74.
- Please contact your SICK subsidiary should you have any complaints.

## 6.3 Mounting the control unit

**CAUTION**
Risk of injury due to falling components

- Do not do mounting work alone.
- Ask a second person to hold the components during mounting.

The fixing screws are not included with delivery.

### Mounting sketch

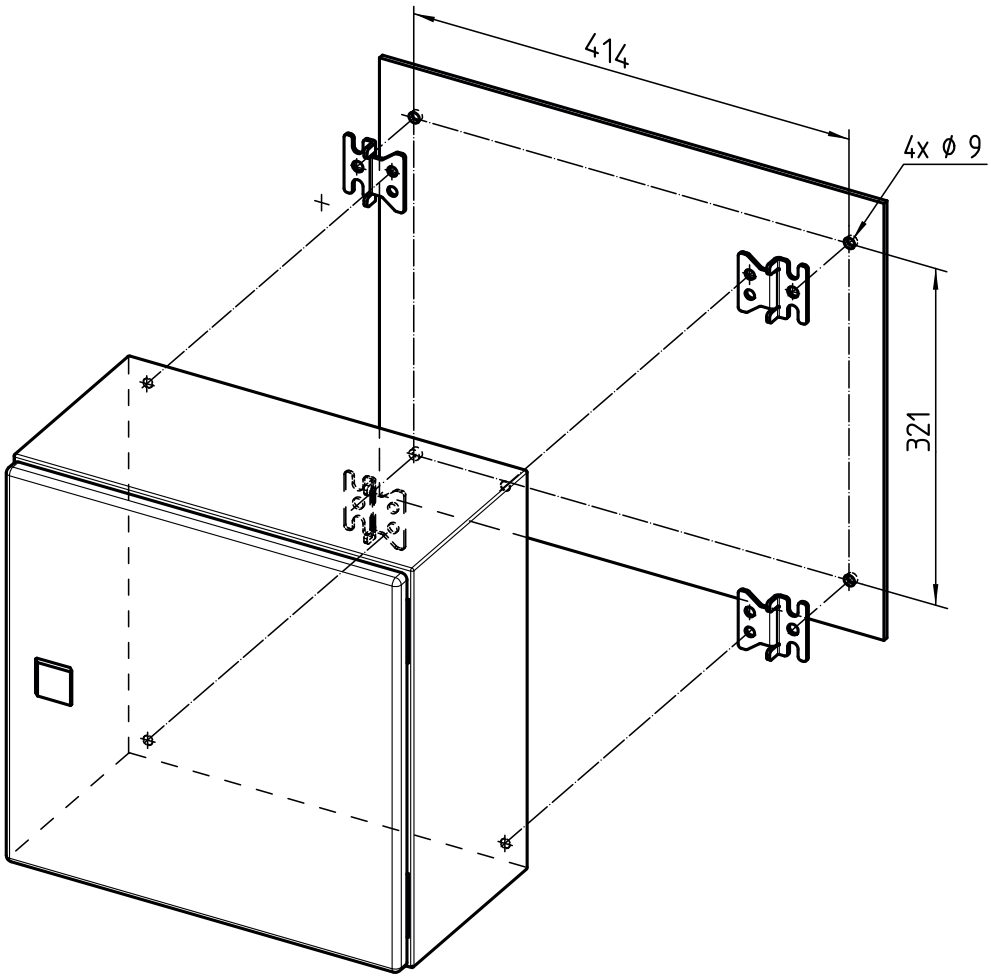



*Figure 13: Mounting sketch for the control unit (mm)*

### Mounting procedure

- Select a mounting location with minimum exposure to vibrations.
- Drill four holes Ø9 at the mounting location.
- Mount the bracket (4x M8 screws).
- Mount the control unit (control cabinet). Use at least four M8 screws.

## 6.4 Mounting the entry module

### Mounting sketch

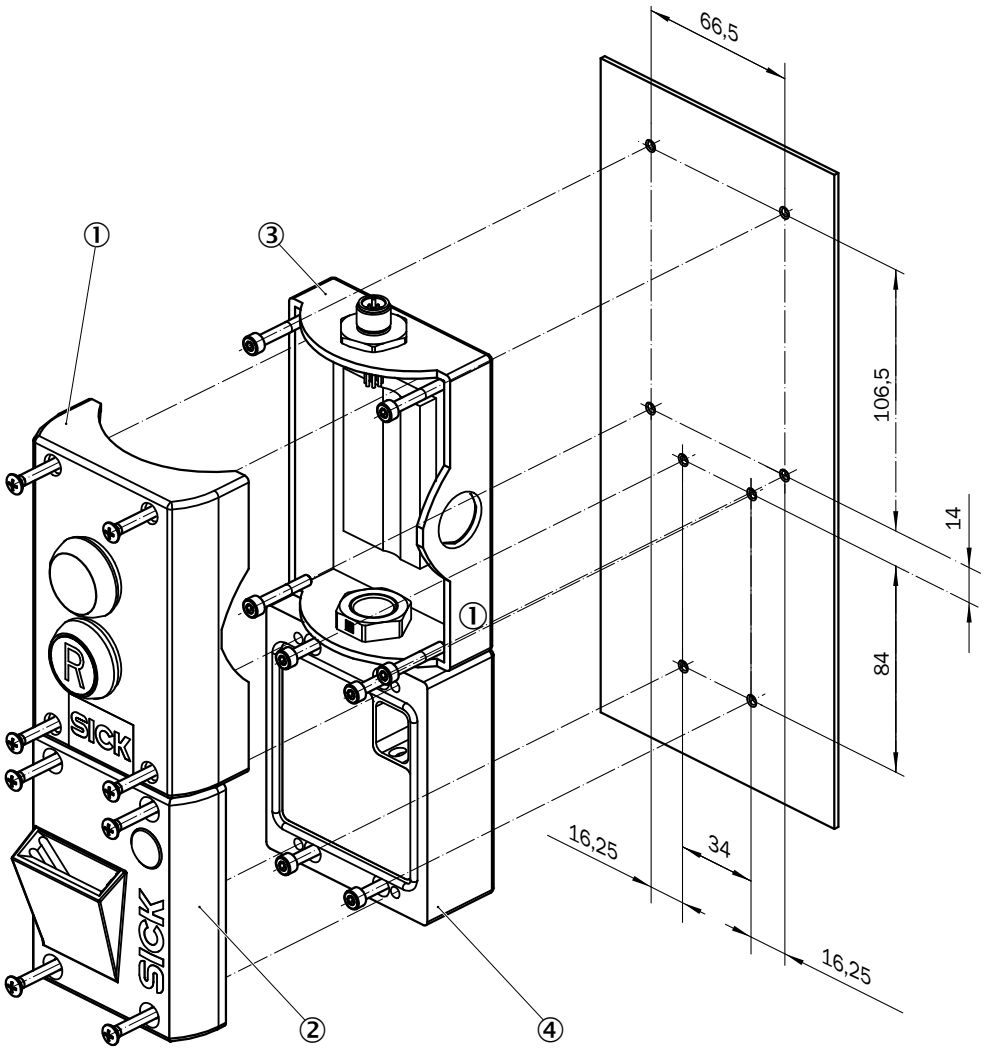



*Figure 14: Mounting sketch for the entry module (mm)*

### Mounting procedure

**NOTE**

The back of the housing is made up of two interconnected parts.

- ▶ Do not separate the parts that make up the back of the housing.
- ▶ Do not twist the parts that make up the back of the housing.

Eight M4 screws are required for the mounting. These are not included with delivery.

1. Drill the holes for the mounting (see figure 14).
2. Unscrew the top cover ① (4x M4 screws).
3. Carefully remove the top cover ①.
4. Unscrew the bottom cover ② (4x M4 screws).
5. Carefully remove the bottom cover ②. Do not pull off the cables.
6. Mount the back of the housing (③, ④) (8x M4 screws).
7. Mount the top cover ① (4x M4 screws).

8. Carefully reattach the bottom cover ② with the key holder. Place the cables in the designated slot without pinching them.
9. Mount the bottom cover ② (4x M4 screws).

## 6.5 Mounting the clearance module

### Mounting sketch

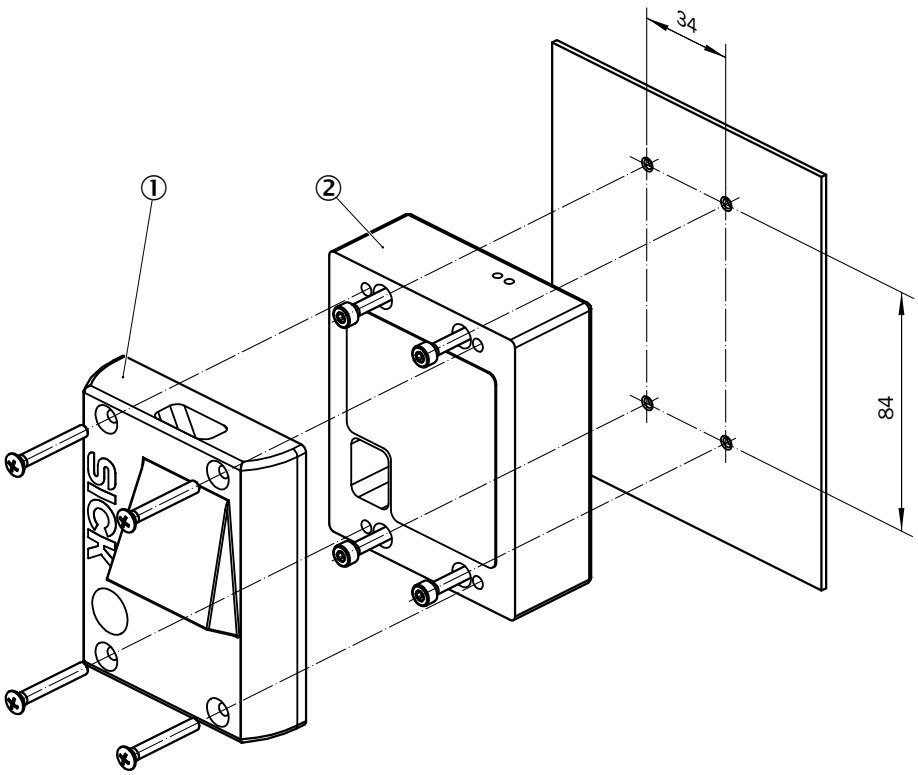



*Figure 15: Mounting sketch for the clearance module (mm)*

### Mounting procedure

**NOTE**
Four M4 screws are required for the mounting. These are not included with delivery.

1. Drill the holes for the mounting (see figure 15).
2. Unscrew the cover ① (4x M4 screws).
3. Carefully remove the cover ① with the key holder. Do not pull off the cables.
4. Mount the back of the housing ② (4x M4 screws).
5. Carefully reattach the cover ① with the key holder.
6. Place the cables in the designated slot without pinching them.
7. Mount the cover ① (4x M4 screws).

**NOTE**
If possible, mount the clearance module so that the opening of the key holder points downward. This means that the key cannot be left behind in the key holder, thereby preventing the system from switching to the safe state unnecessarily.

# 7 Electrical installation

## 7.1 Safety

**DANGER**
Hazard due to electrical voltage

Hazard due to unexpected starting of the machine

- Make sure that the functional safety system and the machine to which it is connected remain de-energized throughout the entire electrical installation work.
- Make sure that the dangerous state of the machine is and remains switched off.
- Make sure that the outputs of the safety relays have no effect on the machine during the electrical installation work.
- The functional safety system does not feature a power supply isolation device for the 230 V AC supply voltage. This must be provided by the manufacturer or entity operating the machine.

## 7.2 Block diagram

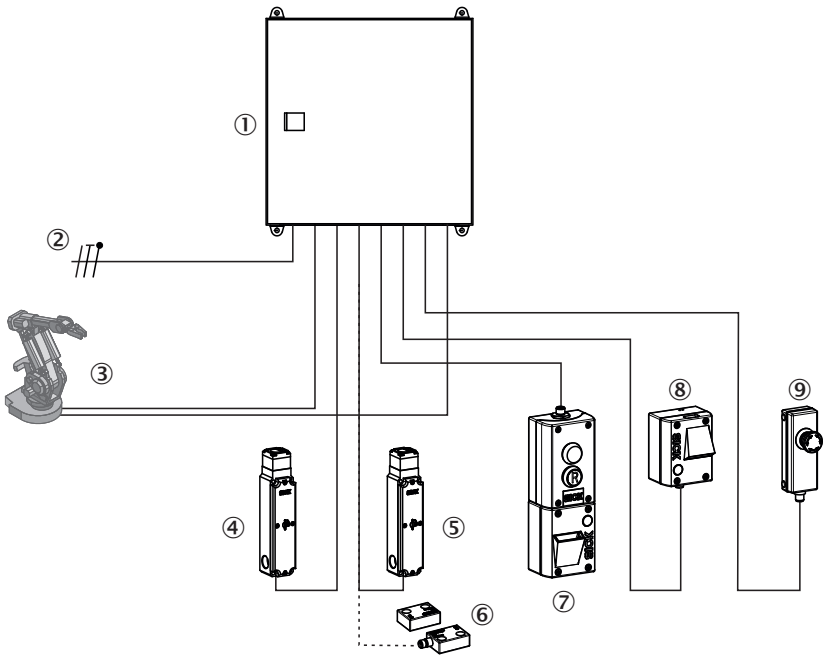



*Figure 16: Block diagram*

① Control unit
② 230 V AC/50 Hz supply voltage
③ Machine (actuators, EDM, Standstill Monitor)
④ Safety locking device 1
⑤ Safety locking device 2
⑥ Safety switch (alternative to safety locking device 2 with the ECO wiring option)
⑦ Entry module
⑧ Clearance module
⑨ Emergency stop pushbutton (optional)

## 7.3 Connecting the control unit to the system

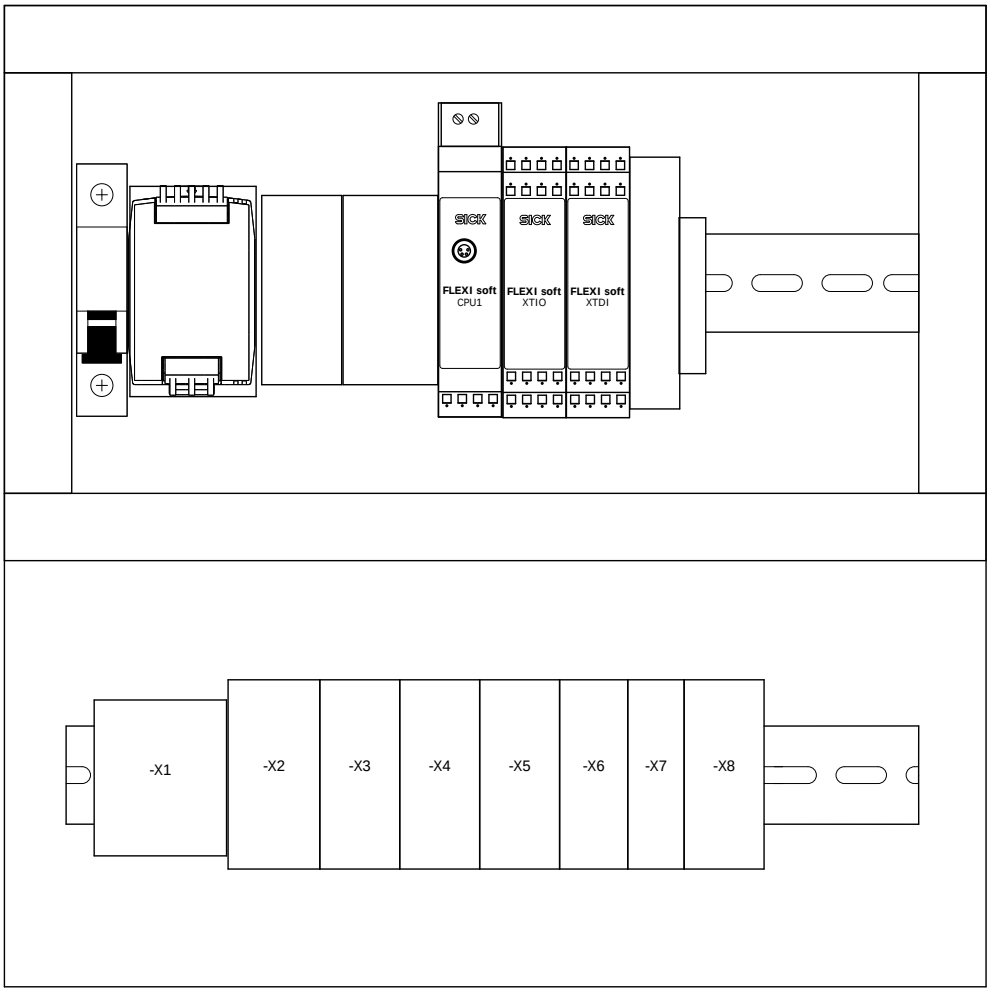



*Figure 17: Control unit terminal strips*

### Control unit terminal strips

| Terminal | Description |
|---|---|
| X1 | 230 V AC/50 Hz supply voltage |
| X2 | Connection for contactor, EDM, and application diagnostic outputs |
| X3 | Connection for safety locking device 1 |
| X4 | Connection for safety locking device 2 [1)] |
| X5 | Connection for entry module |
| X6 | Connection for clearance module |
| X7 | Connection for emergency stop pushbutton |
| X8 | Connection for machine stop signal (Standstill Monitor) |

*Table 2: Control unit terminal strips*

1) With the ECO wiring option, a dual-channel safety switch can be connected to X4 instead of the second safety locking device. In this case, the second locking device monitor of safety locking device 1 must be connected (see table 5, page 36).

### Terminal strip X1 – Supply voltage 230 V AC

**DANGER**
Hazard due to electrical voltage
Hazard due to unexpected starting of the machine

- Make sure that the functional safety system and the machine to which it is connected remain de-energized throughout the entire electrical installation work.
- The functional safety system does not feature a power supply isolation device for the 230 V AC supply voltage. This must be provided by the manufacturer or entity operating the machine.

| Terminal | Signal | I/O | Function |
|---|---|---|---|
| 1 | L | – | Line conductor 230 V AC |
| 2 | N | – | Neutral conductor 0 V AC |
| 3 | PE | – | Protective conductor |

*Table 3: Terminal strip X1 – Supply voltage 230 V AC for the control unit*

### Terminal strip X2 – Connection for contactor, EDM, and application diagnostic outputs

| Terminal | Signal | I/O [2] | Function |
|---|---|---|---|
| 1 | Relay_13 | I/O | Machine enabling current path 1 (N/O) |
| 2 | Relay_14 | I/O | Machine enabling current path 1 (N/O) |
| 3 | Relay_23 | I/O | Machine enabling current path 2 (N/O) |
| 4 | Relay_24 | I/O | Machine enabling current path 2 (N/O) |
| 5 | EDM_out | O | EDM output, for integrating the feedback contacts of the external contactors [2] |
| 6 | EDM_in | I | EDM input, for integrating the feedback contacts of the external contactors [2] |
| 7 | Error_seq | O | Application diagnostic output for sequence errors |
| 8 | Error_hw | O | Application diagnostic output for hardware errors |
| 9 | 0 V | – | GND supply voltage |
| 10 | 0 V | – | GND supply voltage |

*Table 4: Terminal strip X2 – Connection for contactor, EDM, and application diagnostic outputs*

1) I/O = Input/Output, always from the perspective of the control unit
2) If EDM is not used, connections X2.5 and X2.6 must be connected by means of a jumper link.

### Terminal strip X3 – Connection for safety locking device 1

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | Door_Sw1_Ch1_test | O | Test output for door switch 1 [3] of safety locking device 1 | White |
| 2 | Door_Sw1_Ch1_in | I | Input for door switch 1 [3] of safety locking device 1 | Brown |
| 3 | Door_Lock1_Ch2_test | O | Test output for locking device monitor 1 [3] of safety locking device 1 | Green |
| 4 | Door_Lock1_Ch2_in | I | Input for locking device monitor 1 [3] of safety locking device 1 | Yellow |
| 5 | Door_Unlock_Ch1 | O | Output for controlling the unlocking solenoids of safety locking device 1 | Gray |
| 6 | 0 V | – | GND supply voltage for the unlocking solenoids of safety locking device 1 | Pink |
| 7 | n.c. | – | Not assigned (used for wire no. 7 if an 8-pin supply cable is used) | Blue |
| 8 | n.c. | – | Not assigned (used for wire no. 8 if an 8-pin supply cable is used) | Red |

*Table 5: Terminal strip X3 – Connection for safety locking device 1*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories
3) Normally closed

### Terminal strip X4 with the standard wiring option – Connection for safety locking device 2

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | Door_Sw2_Ch2_test | O | Test output for door switch 1 [3] of safety locking device 2 | White |
| 2 | Door_Sw2_Ch2_in | I | Input for door switch 1 [3] of safety locking device 2 | Brown |
| 3 | Door_Lock2_Ch1_test | O | Test output for locking device monitor 1 [3] of safety locking device 2 | Green |
| 4 | Door_Lock2_Ch1_in | I | Input for locking device monitor 1 [3] of safety locking device 2 | Yellow |
| 5 | Door_Unlock_Ch2 | O | Output for controlling the unlocking solenoids of safety locking device 2 | Gray |
| 6 | 0 V | – | GND supply voltage for the unlocking solenoids of safety locking device 2 | Pink |
| 7 | n.c. | – | Not assigned (used for wire no. 7 if an 8-pin supply cable is used) | Blue |
| 8 | n.c. | – | Not assigned (used for wire no. 8 if an 8-pin supply cable is used) | Red |

*Table 6: Terminal strip X4 – Standard wiring option*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories
3) Normally closed

**NOTE**

With the ECO wiring option, a safety switch can be used instead of the second safety locking device (e.g., an RE1 magnetic safety switch see "Accessories", page 76). In this case, the second locking device monitor of safety locking device 1 must be connected.

### Terminal strip X4 with the ECO wiring option – Connection for safety switch and safety locking device 1

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | Door_Sw2_Ch2_test | O | Test output for door switch 1 [3] of safety switch | Brown |
| 2 | Door_Sw2_Ch2_in | I | Input for door switch 1 [3] of safety switch | White |
| 3 | Door_Lock2_Ch1_test | O | Test output for locking device monitor 2 [3] of safety locking device 1 | Blue |
| 4 | Door_Lock2_Ch1_in | I | Input for locking device monitor 2 [3] of safety locking device 1 | Red |
| 5 | Door_Unlock_Ch2 | O | Do not use | – |
| 6 | 0 V | – | Do not use | – |
| 7 | n.c. | – | Not assigned | – |
| 8 | n.c. | – | Not assigned | – |

*Table 7: Terminal strip X4 – ECO wiring option*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories
3) Normally closed

### Terminal strip X5 – Connection for entry module

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | Reset | I | Reset input | White |
| 2 | +24 V DC | – | 24 V supply voltage for entry module | Brown |
| 3 | L_Entrance_Run | O | Signal for green LED that indicates the safety relay status | Green |
| 4 | L_Entrance_Reset | O | Signal for blue LED that indicates when a reset is required | Yellow |
| 5 | Key_Entrance_Ch1 | I | Input for OSSD1 | Gray |
| 6 | Key_Entrance_Ch2 | I | Input for OSSD2 | Pink |
| 7 | 0 V | – | GND supply voltage for entry module | Blue |
| 8 | L_Entrance_Status | O | Signal for white LED that indicates the sequence status | Red |

*Table 8: Terminal strip X5 – Connection for entry module*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories

### Terminal strip X6 – Connection for clearance module

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | 24 VDC | – | 24 V supply voltage for clearance module | Brown |
| 2 | Key_Clearance_Ch1 | I | Input for OSSD1 | White |
| 3 | 0 V | – | GND supply voltage for clearance module | Blue |
| 4 | Key_Clearance_Ch2 | I | Input for OSSD2 | Black |
| 5 | L_Clearance_Status | O | Signal for white LED that indicates the sequence status | Gray |
| 6 | n.c. | – | Not assigned | – |

*Table 9: Terminal strip X6 – Connection for clearance module*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories

### Terminal strip X7 – Connection for emergency stop pushbutton

| Terminal | Signal | I/O [1] | Function | Wire color [2] |
|---|---|---|---|---|
| 1 | E-Stop_Ch1_test | O | Test output for emergency stop pushbutton, channel 1 | Brown |
| 2 | E-Stop_Ch1_in | I | Input for emergency stop pushbutton, channel 1 | White |
| 3 | E-Stop_Ch2_test | O | Test output for emergency stop pushbutton, channel 2 | Blue |
| 4 | E-Stop_Ch2_in | I | Input for emergency stop pushbutton, channel 2 | Black |

*Table 10: Terminal strip X7 – Connection for emergency stop pushbutton*

1) I/O = Input/Output, always from the perspective of the control unit
2) Applies to the cables recommended as accessories

**NOTE**

If you do not connect an emergency stop pushbutton to the functional safety system, you must install one jumper link between terminals X7.1 and X7.2 and another one between terminals X7.3 and X7.4.

### Terminal strip X8 – Connection for selecting wiring option and machine Standstill Monitor

| Terminal | Signal | I/O [1] | Function |
|---|---|---|---|
| 1 | +24 V DC | – | 24 V supply voltage |
| 2 | 1of2_select_Mode0 | I | Operation with delay time [2] |
| 3 | 1of2_select_Mode1 | I | Operation with Standstill Monitor [2] |
| 4 | M_Standstill_Ch1_test | O | Test output for Standstill Monitor, channel 1 |
| 5 | M_Standstill_Ch1_in | I | Input for Standstill Monitor, channel 1 |
| 6 | M_Standstill_Ch2_test | O | Test output for Standstill Monitor, channel 2 |
| 7 | M_Standstill_Ch2_in | I | Input for Standstill Monitor, channel 1 |
| 8 | n.c. | – | Not assigned |

*Table 11: Terminal strip X8 – Connection for selecting wiring option and machine Standstill Monitor*

1) I/O = Input/Output, always from the perspective of the control unit
2) The equipment is delivered with a jumper link already connected between X8.1 and X8.3. This activates the “with Standstill Monitor” wiring option. To switch to the “with delay time” wiring option, you must remove the jumper link and connect it between X8.1 and X8.2 instead (so that X8.3 becomes free).

## 7.4 Entry module device connection

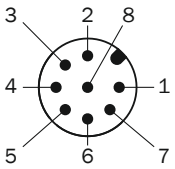
| Male 8-pin connector | Pin | Signal | I/O [1] | Meaning | Wire color [2] |
|---|---|---|---|---|---|
|  | 1 | Reset | I | Reset signal | White |
| | 2 | 24 V DC | – | 24 V supply voltage for entry module | Brown |
| | 3 | L_Run | O | Signal for green LED that indicates the safety relay status | Green |
| | 4 | L_Reset | O | Signal for blue LED that indicates when a reset is required | Yellow |
| | 5 | OSSD1 | I | Output OSSD1 | Gray |
| | 6 | OSSD2 | I | Output OSSD2 | Pink |
| | 7 | GND | – | GND supply voltage for entry module | Blue |
| | 8 | L_Status | O | Signal for white LED that indicates the sequence status | Red |

*Table 12: Pin assignment for the entry module device connection*

1) I/O = Input/Output, from the perspective of the control unit
2) Applies to the cables recommended as accessories

## 7.5 Clearance module device connection

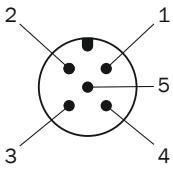
| Male 5-pin connector | Pin | Signal | I/O [1] | Meaning | Wire color [2] |
|---|---|---|---|---|---|
|  | 1 | 24 V DC | – | 24 V supply voltage for clearance module | Brown |
| | 2 | OSSD1 | I | Output OSSD1 | White |
| | 3 | GND | – | GND supply voltage for clearance module | Blue |
| | 4 | OSSD2 | I | Output OSSD2 | Black |
| | 5 | L_Status | O | Signal for white LED that indicates the sequence status | Gray |

*Table 13: Pin assignment for the clearance module device connection*

1) I/O = Input/Output, from the perspective of the control unit
2) Applies to the cables recommended as accessories

## 7.6 Connection diagrams

**NOTE**

The connection diagrams shown below are merely examples. The manufacturer or entity operating the machine is responsible for ensuring that the functional safety systems is integrated into the machine correctly (see "Project planning", page 22).

### 7.6.1 Standard wiring option

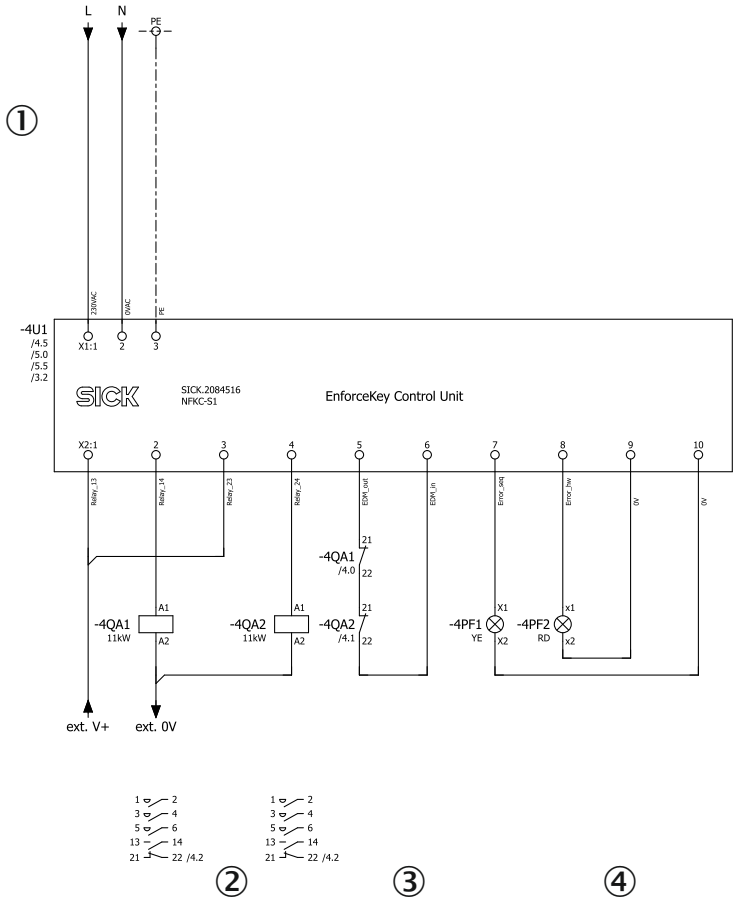



*Figure 18: Connection diagram for voltage supply, safety relay, and application diagnostic outputs*

① 230 V AC supply voltage
② OSSDs
③ EDM
④ Application diagnostic outputs

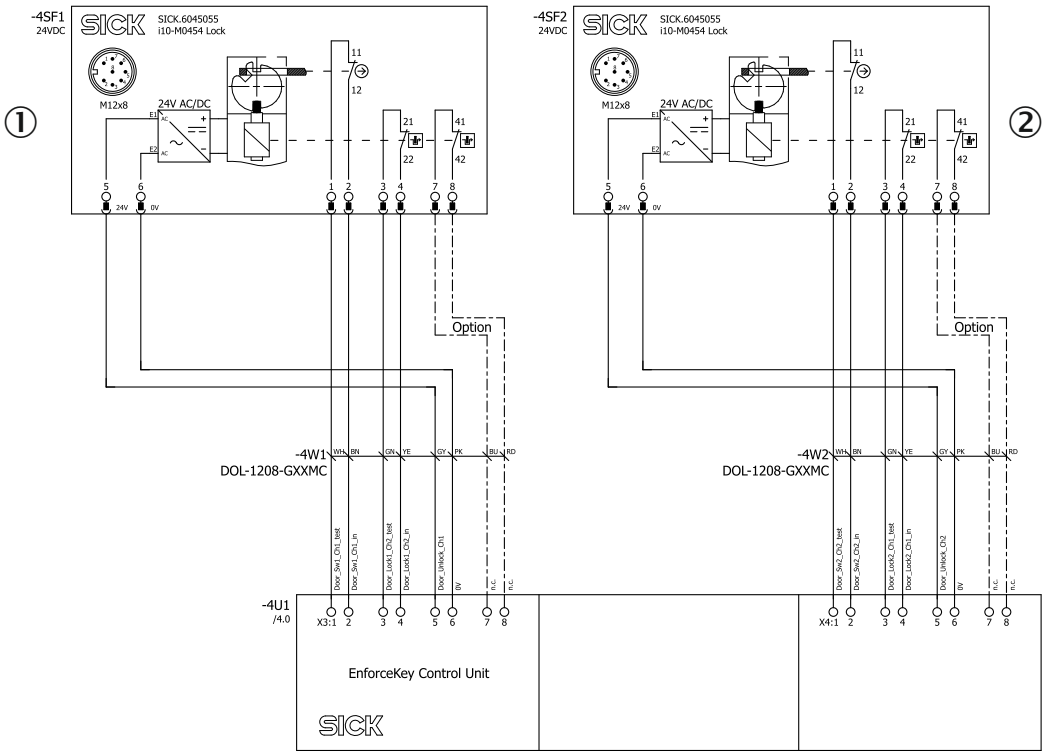



*Figure 19: Connection diagram for safety locking devices*

① Safety locking device 1

② Safety locking device 2

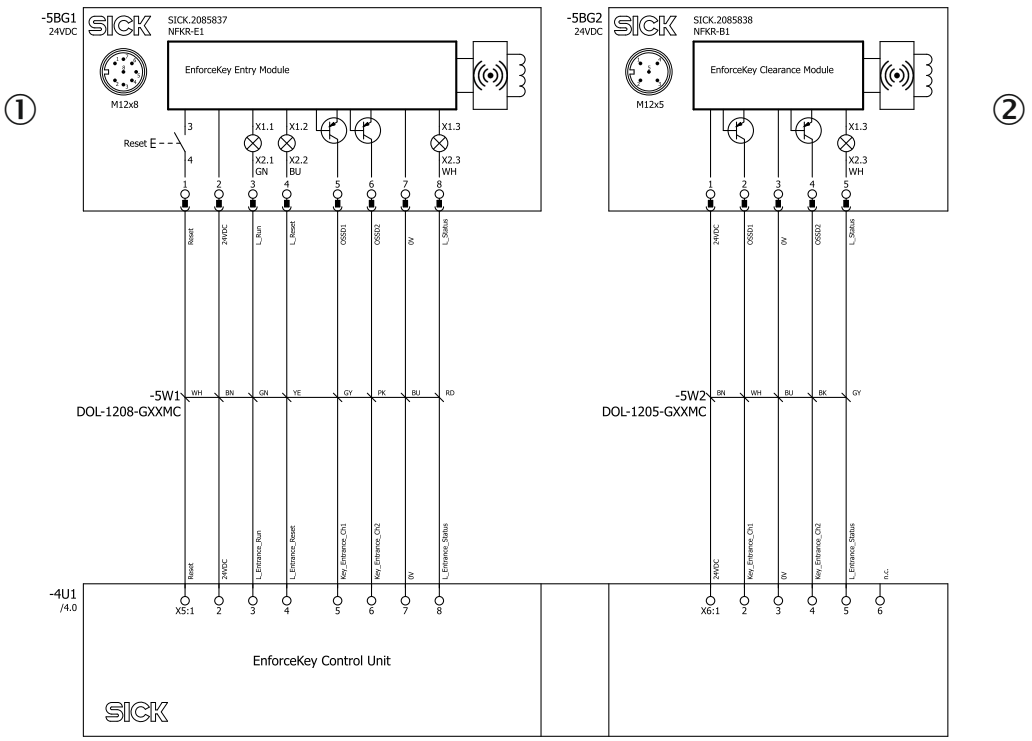



*Figure 20: Connection diagram for entry and clearance modules*

① Entry module

② Clearance module

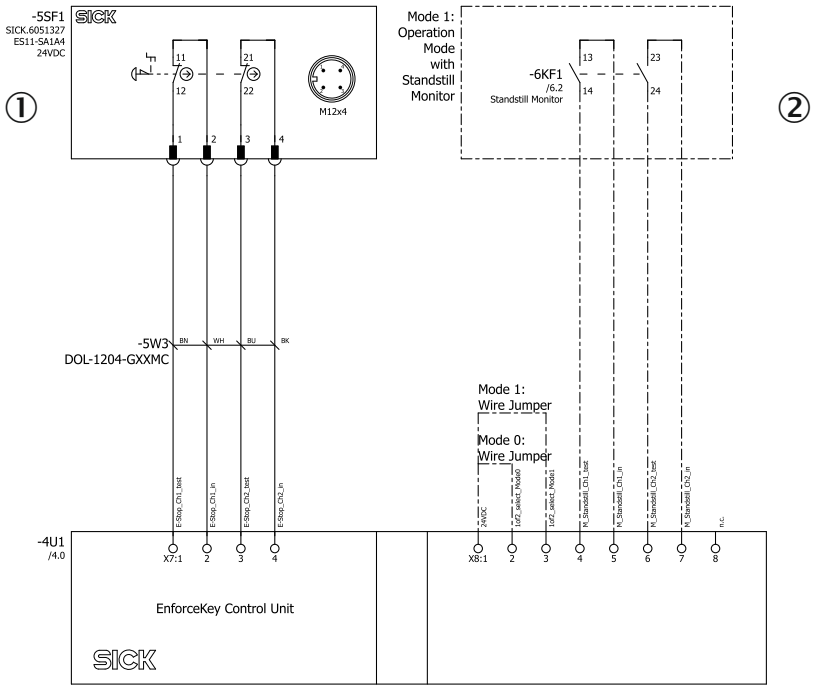



*Figure 21: Connection diagram for emergency stop pushbutton and Standstill Monitor*

① Emergency stop pushbutton

② Standstill Monitor

### 7.6.2 ECO wiring option

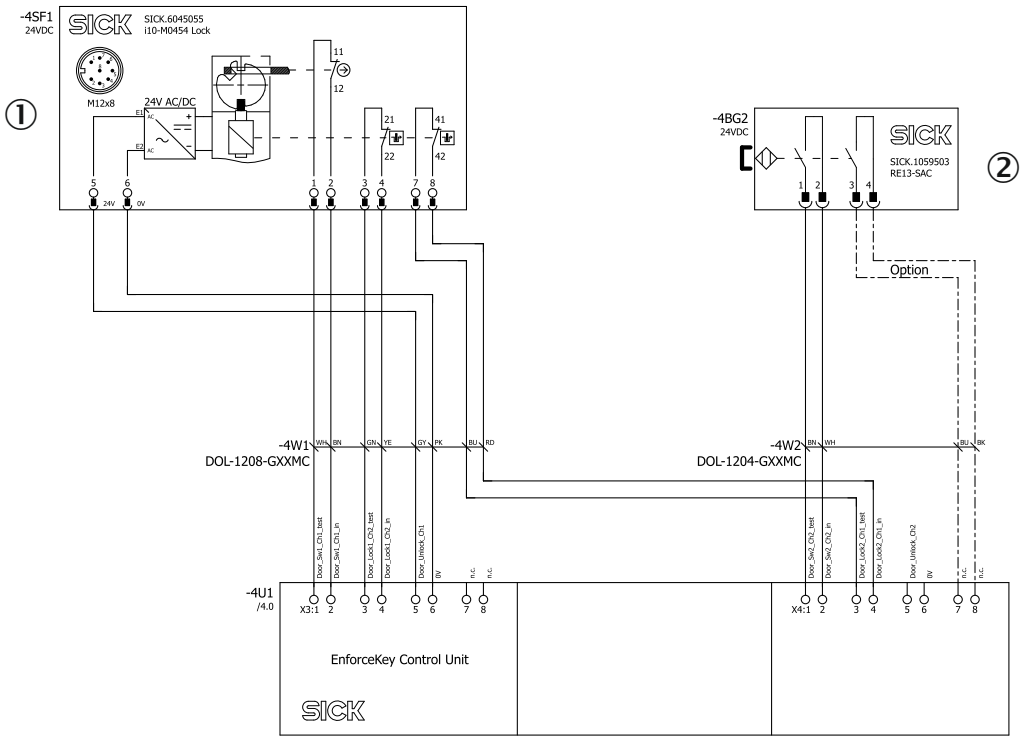



*Figure 22: Connection diagram for safety locking device and safety switch*

① Safety locking device

② Safety switch

# 8 Configuration

## 8.1 Safety

**DANGER**
Hazard due to electrical voltage

Hazard due to unexpected starting of the machine

- Make sure that the functional safety system and the machine to which it is connected remain de-energized throughout the entire configuration process.
- Make sure that the dangerous state of the machine is and remains switched off.
- Make sure that the outputs of the safety relays have no effect on the machine during the electrical configuration work.

## 8.2 Configuring standstill monitoring

To configure whether the functional safety system (see table 11, page 39) is to be operated with or without a Standstill Monitor, you should install jumper links on the control unit accordingly.

### 8.2.1 Wiring option: Without Standstill Monitor, with delay time

**DANGER**
Hazard due to lack of effectiveness of the protective device

Five seconds after you remove the key from the entry module, the functional safety system opens the safety locking devices.

- Make sure that the dangerous state of the machine is brought to a standstill within five seconds.
- Check that this is the case in all machine operating modes and operational statuses.

- Remove the jumper link that was installed between terminals X8.1 and X8.3 at the factory.
- Install a jumper link between terminals X8.1 and X8.2.
- Terminal X8.3 is not used.

### 8.2.2 Wiring option: With Standstill Monitor

- Inside the control unit, there is a jumper link that was installed between terminals X8.1 and X8.3 at the factory.
- Terminal X8.2 is not used.

## 8.3 Configuring the emergency stop function

With the default factory configuration, an emergency stop pushbutton has to be connected to the functional safety system. To change the configuration so that the functional safety system can be operated without an emergency stop button, you should install jumper links on the control unit accordingly (see table 10, page 38).

- Install a jumper link between terminals X7.1 and X7.2.
- Install a jumper link between terminals X7.3 and X7.4.

# 9 Commissioning

## 9.1 Safety

**DANGER**
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.

**DANGER**
Hazard due to lack of effectiveness of the protective device

When changes are made to the machine, the effectiveness of the protective device may be affected unintentionally.

Whenever changes are made to the machine, to how the functional safety system is integrated, or to the operational and general conditions of the system, proceed as follows:

- ▶ Check the effectiveness of the protective device.
- ▶ Perform commissioning again in accordance with the information provided in this chapter.

Before initial commissioning can be performed, project planning, mounting, electrical installation and configuration must be completed in accordance with the following chapters:

- Project planning, page 22
- Mounting, page 29
- Electrical installation, page 33
- Configuration, page 46

In addition, initial commissioning can only be carried out once all the application-dependent components (such as the safety locking devices) have been fully mounted, connected, and put into operation.

## 9.2 Teaching in the key

**DANGER**
Key teach-in is a safety-related operation.

1. To prevent tampering, document the teach-in process.
2. Carry out regular checks to make sure that the original key is still being used.

**NOTE**

- Exactly the same key is taught in on both the entry module and the clearance module. This means that only one key is ever active and valid for a particular functional safety system.
- The entry or clearance module will only recognize a key if it is inserted into the key holder completely.
- The key must not be removed from the key holder during the teach-in process.
- Only the most recently taught-in key is valid.
- Once keys have been taught in, they cannot be taught in again.
- The key teach-in process can be performed up to eight times. After that, the entry module or clearance module will not accept any more new keys.

There are two LEDs on the bottom and top of the entry module and clearance module respectively. These indicate the status during the teach-in process (see "Status indicators", page 19).

### 9.2.1 Teach-in sequence on entry module

| Step | Status LED | Diagnostics LED |
|---|---|---|
| Switch on the voltage supply for the entry module. | ● Red | ○ |
| Insert the new key into the key holder of the entry module. The module reads in the key. | ☀ Green | ☀ Yellow |
| After approx. 10 seconds:<br>The key has been read in. | ☀ Green | ● Yellow |
| Switch off the voltage supply for the entry module within five minutes. | ○ | ○ |
| When the entry module is switched back on, it will recognize the key, which has now been taught in and is ready for use. | | |

*Table 14: Teach-in sequence on entry module*

### 9.2.2 Teach-in sequence on clearance module

| Step | Status LED | Diagnostics LED |
|---|---|---|
| Switch on the voltage supply for the clearance module. | ● Red | ○ |
| Insert the new key into the key holder of the clearance module. The module reads in the key. | ☀ Green | ☀ Yellow |
| After approx. 10 seconds:<br>The key has been read in. | ☀ Green | ● Yellow |
| Switch off the voltage supply for the clearance module within five minutes. | ○ | ○ |
| When the clearance module is switched back on, it will recognize the key, which has now been taught in and is ready for use. | | |

*Table 15: Teach-in sequence on clearance module*

### 9.2.3 Possible errors during the teach-in sequence

**NOTE**

The “Teach-in sequence failed” error will occur under the following conditions:

- If the key is removed from the key holder during the first 10 seconds of the teach-in process.
  **Or:**
- If the key is removed from the key holder while the module is waiting for the voltage supply to be switched off.
  **Or:**
- If the voltage supply is not switched off within five minutes of the teach-in process.

| Status LED | Diagnostics LED | Meaning |
|---|---|---|
| ☼● Red/green | ○ | ✓ Teach-in sequence failed. The teach-in operation can be repeated.<br>1. Reset the entry or clearance module. To do this, interrupt the voltage supply for at least three seconds.<br>2. Reinsert the key in the key holder.<br>3. Resume the teach-in sequence. |
| ☼● Red/green | ☼● Yellow | Maximum number of keys taught in; no further teach-in operations allowed |
| ☼● Red/green | ● Yellow | Key has already been taught in on this module once and cannot be taught in again |

*Table 16: Errors that may be indicated by the LEDs during teach-in*

## 9.3 Starting the EnforceKey Single Door

When you switch on the EnforceKey Single Door, it indicates the “sequence error” sequence status.

| Action/Result | Key | Safety locking device | Entry module | Clearance module |
|---|---|---|---|---|
| Sequence error after switch-on | – | Open | ☼● 4 Hz | ☼● 4 Hz |
| Confirm that the hazardous area is clear. Briefly insert the key into the holder of the clearance module (for at least 0.5 s but no more than 2 s). | In the clearance module | Open | ☼● White | ● White |
| Exit the hazardous area quickly (within 60 s),<br>ensuring that no one else enters.<br>Close the door correctly. Make sure that the latch is able to engage. | With the operator | Open | ☼● White | ● White |
| Reinsert the key into the key holder of the entry module. | In the entry module | Open | ○ White | ○ White |
| The latch closes. | In the entry module | Locked | ☼● Blue | |
| Make sure that the hazardous area is still clear.<br>Press the reset button on the entry module. | In the entry module | Locked | ○ Blue | |
| The safety relay switches to the ON state.<br>The machine can now be restarted. | In the entry module | Locked | ● Green | |

*Table 17: Exiting the hazardous area*

## 9.4 Checks

- Check the protective device as described below and in accordance with the applicable standards and regulations.
- Using the checklist in the appendix, check that the protective device on the machine is effective in all the operating modes that can be selected on the machine.
- If substantial alterations have been made to the machine or protective device, or if components have been changed or repaired, check the effectiveness of the protective device again.

**DANGER**

Hazard due to unexpected starting of the machine

Death or serious injury

- Before carrying out the functional test, make sure that there is no one inside the hazardous area.

## 9.5 Validation

Do not put the machine into operation unless the validation process has been completed successfully. Only appropriately trained personnel are allowed to carry out final acceptance.

The following points must be checked as part of the validation process:

- Check that all the safety-related parts of the machine (wiring, connected sensors and control devices, configuration) conform to the relevant safety standards (e.g., EN 60204-1, EN 62061, or EN ISO 13849-1).
- Check the devices connected to the control unit in accordance with the notes provided by the checklist in the appendix.
- Uniquely identify all the connections on the control unit (connecting cables and plug connectors) clearly to prevent mix-ups.
- Fully document the results of the safety inspection (e.g., switch-off times and correct switching behavior in the case of every relevant operational status).

# 10 Operation

## 10.1 Safety

**NOTE**
This document does not provide instructions for operating the machine in which the functional safety system is integrated.

## 10.2 Regular inspection of the protective device by qualified safety personnel

- Check the machine following the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes to the machine or tampering with the protective device are detected after initial commissioning.
- Check that the functional safety system is functioning properly at regular intervals and whenever a fault has occurred.
- If substantial alterations have been made to the machine or protective device, or if the safety switch has been changed or repaired, check the machine again.
- Check whether the machine always stops when a safety door is opened.
- Check all the cables of the functional safety system for damage.
- Check the protective device for signs of misuse or tampering.

**DANGER**
Bypassing the protective device
In theory, it is possible for someone to obtain actuators for safety locking devices. They could then use these to tamper with the safety locking devices. In a worst-case scenario, a machine could start up while a door was still open.

- Put organizational measures in place to prevent anyone from tampering with the safety locking devices.

## 10.3 Entering the hazardous area, working in the hazardous area, and exiting the hazardous area

**DANGER**
Hazard due to lack of effectiveness of the protective device
Hazard due to unexpected starting of the machine
The safety sequence could be completed even though you have not left the hazardous area.
Someone else could be inside the hazardous area when you initiate the machine restart.

- On removing the key from the entry module, you are responsible for ensuring that the steps described below are followed.
- Keep the key with you at all times.
- Never give the key to anyone else.

**Starting point**

- The machine is operational and running.
- The access point is securely locked by means of the safety locking device.
- The key is in the entry module.

- The green LED on the entry module is lit continuously.
- The white LED on the entry module is OFF.

### Entering the hazardous area

| Action/Result | Key | Safety locking device | Entry module | Clearance module |
|---|---|---|---|---|
| The machine is operational and running. | In the entry module | Locked | ● Green<br>○ White | ○ White |
| Remove the key.<br>The safety relay switches to the OFF state. | With the operator | Locked | ☼ Green<br>○ White | ○ White |
| The dangerous state of the machine is stopped. | With the operator | Locked | ☼ Green<br>○ White | ○ White |
| The latch opens. | With the operator | Open | ○ Green<br>☼ White 2 × at 1 Hz<br>○ White 2 s | ● White |
| Open the door.<br>Take the key with you. This guards against loss or misuse of the key. | With the operator | Open | ○ Green<br>● White | ☼ White |

*Table 18: Entering the hazardous area*

### Working in the hazardous area

| Action/Result | Key | Safety locking device | Entry module | Clearance module |
|---|---|---|---|---|
| It is now possible to work inside the hazardous area. The machine is unable to start up, even if the door is closed. | With the operator | Open | ● White | ☼ White |

*Table 19: Working in the hazardous area*

### Exiting the hazardous area

| Action/Result | Key | Safety locking device | Entry module | Clearance module |
|---|---|---|---|---|
| Make sure there is no one left inside the hazardous area. | With the operator | Open | ● White | ☼ White |
| Confirm that the hazardous area is clear. Briefly insert the key into the key holder of the clearance module (for at least 0.5 s but no more than 10 s). | In the clearance module | Open | ☼ White | ● White |
| Exit the hazardous area quickly (within 60 s), ensuring that no one else enters. | With the operator | Open | ☼ White 2 × at 1 Hz<br>○ White 2 s | ● White |
| Close the door correctly. Make sure that the latch is able to engage. | With the operator | Open | ☼ White | ● White |
| Reinsert the key into the key holder of the entry module. | In the entry module | Open | ○ White | ○ White |
| The latch closes. | In the entry module | Locked | ☼ Blue | |
| Make sure that the hazardous area is still clear. Press the reset button on the entry module. | In the entry module | Locked | ○ Blue | |

*Table 20: Exiting the hazardous area*

| Action/Result | Key | Safety locking device | Entry module | Clearance module |
|---|---|---|---|---|
| The safety relay switches to the ON state.<br>The machine can now be restarted. | In the entry module | Locked | ● Green | |

*Table 20: Exiting the hazardous area*

A machine start/restart can then be triggered. This step is not included as part of the functional safety system.

## 10.4 Possible errors during operation

**DANGER**

Hazard due to lack of effectiveness of the protective device

Cease operation if the cause of a malfunction has not been clearly identified.

- ▶ Take the machine out of operation if an error cannot be clearly identified and safely remedied.

| Error, incorrect operation | Entry module | Clearance module | Solution |
|---|---|---|---|
| Key was accidentally removed. The door was **not** [1] opened. | ☼● White 2 × at 1 Hz<br>○ White 2 s | ● White | ▶ Reinsert the key into the key holder of the entry module. |
| | ☼● Blue | | ▶ Press the reset button.<br>✓ A machine restart can now be initiated. |
| The operator has not checked out on the clearance module. The checkout process has not been completed correctly. | ● White | ☼● White | ▶ Repeat the entire process of exiting the hazardous area (see "Exiting the hazardous area", page 52). |
| The operator took more than 60 seconds to leave the hazardous area after checking out on the clearance module. | ☼● White at 4 Hz | ☼● White at 4 Hz | ▶ Repeat the entire process of exiting the hazardous area (see "Exiting the hazardous area", page 52). |
| The safety locking device cannot be closed. | ☼● White 4 × at 4 Hz,<br>then<br>○ 2 s | ● White | ▶ Close the door correctly.<br>▶ Make sure that the actuators of the safety locking devices can engage. |
| Key not recognized. | | | ▶ Check whether the key can be fully inserted into the key holder.<br>▶ If necessary, clean the key to remove any chips or other forms of contamination. |

*Table 21: Possible errors*

| Error, incorrect operation | Entry module | Clearance module | Solution |
|---|---|---|---|
| Key removed, but safety locking device does not open | Green | | ▶ No stop signal received from Standstill Monitor<br>▶ Call service personnel |
| Key removed, but machine does not stop | | | ▶ Call service personnel |
| The door is open, but the machine keeps running. | | | ▶ Call service personnel |

*Table 21: Possible errors*

1) Once the door has been opened, the complete sequence must be performed.

# 11 Troubleshooting

## 11.1 Safety

This chapter describes how you can identify and remedy faults that interrupt the function.

**DANGER**
Hazard due to lack of effectiveness of the protective device
Cease operation if the cause of a malfunction has not been clearly identified.

- ▶ Take the machine out of operation if an error cannot be clearly identified and safely remedied.

## 11.2 LEDs

The component LEDs indicate statuses and faults.

### Entry module

| LEDs | Status | Meaning |
|---|---|---|
| Safety relay status (green) | ● | Safety relay set to the ON state, machine running |
| | ☼ 1 Hz | Safety relay set to the OFF state, machine stopping |
| | ○ | Safety relay set to the OFF state, machine is in the safe state |
| Reset required (blue) | ○ | No reset required |
| | ☼ 1 Hz | Reset required |
| Sequence status (white) | ○ | Safety sequence not active |
| | ● | Safety sequence active |
| | ☼ 2 × at 1 Hz, ○ 2 s | Waiting for door to be opened or closed |
| | ☼ 1 Hz | Key can be inserted into key holder |
| | ☼ 4 Hz | Sequence error or hardware error [1] |
| | ☼ 4 × at 4 Hz then ○ 2 s | Fault on door locking device |

*Table 22: Meaning of the LEDs on the entry module*

[1] You can tell whether it is a sequence error or a hardware error by referring to the Error_seq and Error_hw output signals (see table 4, page 35).

### Clearance module

| LEDs | Status | Meaning |
|---|---|---|
| Sequence status (white) | ○ | Safety sequence not active |
| | ● | Safety sequence active |

*Table 23: Meaning of the LEDs on the clearance module*

| LEDs | Status | Meaning |
|---|---|---|
| | 1 Hz | Key can be inserted into key holder in order to check out |
| | 4 Hz | Sequence error or hardware error [1] |

*Table 23: Meaning of the LEDs on the clearance module*

1) You can tell whether it is a sequence error or a hardware error by referring to the Error_seq and Error_hw output signals (see table 4, page 35).

### Safety relay in the control unit

| LEDs | Status | Meaning |
|---|---|---|
| K1 (green) | ○ | Channel 1 not connected |
| | ● | Channel 1 connected |
| K2 (green) | ○ | Channel 2 not connected |
| | ● | Channel 2 connected |

*Table 24: Meaning of the safety relay LEDs*

### Flexi Soft safety controller

The meanings of the LEDs on the Flexi Soft safety controller are explained in the “Flexi Soft Modular Safety Controller Hardware” operating instructions (SICK part no. 8012477).

## 11.3 Status and processes

The diagram below shows the different statuses and the processes that trigger them.

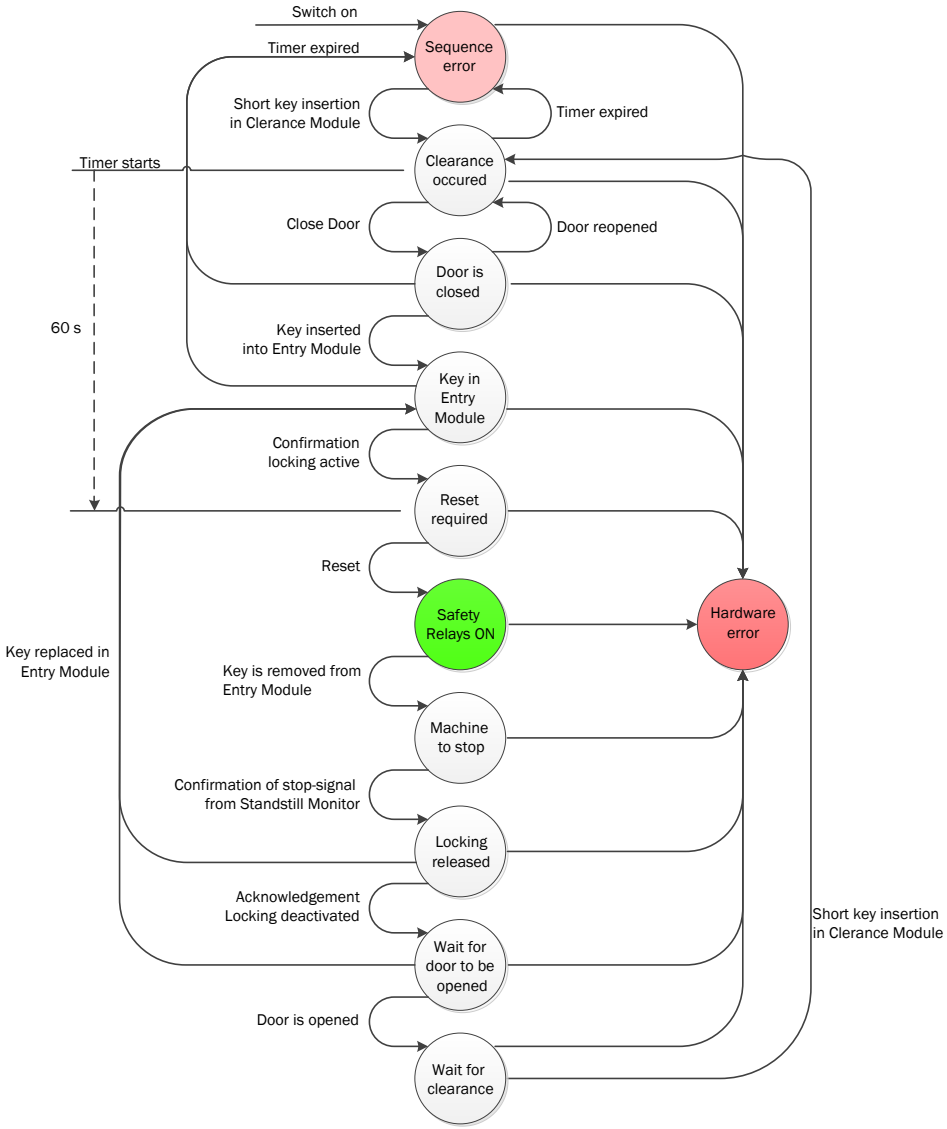



*Figure 23: Status and processes*

## 11.4 Advanced diagnostics

For information about Flexi Soft Designer diagnostics, please see the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions (SICK part no. 8012479).

## 11.5 Replacing individual components

### Individual components

The entry module must be replaced in its entirety. It must not be opened.

The clearance module must be replaced in its entirety. It must not be opened.

The key must be replaced in its entirety and the new one taught in.

### Control unit

The Flexi Soft modules in the control unit can be replaced with modules of the same type. The configuration is saved in the system plug.

The system plug cannot be replaced.

The safety relay can be replaced with a safety relay of the same type.

# 12 Decommissioning

## 12.1 Disposal

Always dispose of serviceableness devices in compliance with local/national rules and regulations with respect to waste disposal.

**NOTE**
We would be pleased to be of assistance on the disposal of this device. Contact us.

# 13 Technical data

## 13.1 Data sheet for the EnforceKey Single Door

| | EnforceKey Single Door |
|---|---|
| **Safety-related parameters** [1] | |
| SIL claim limit | SILCL3 (EN 62061) [2] |
| Performance level | PL e (EN ISO 13849-1) [2] [4] |
| Category | Category 4 (EN ISO 13849-1) [2] |
| $PFH_D$ [3] | $1.85 \times 10^{-8}$ (EN ISO 13849) |
| $T_M$ (mission time) | 20 years (EN ISO 13849) |
| **Response times** [3] | |
| Safe stop (opening of door/latch) | 60 ms |
| Safe Stop (removal of key) | 100 ms |
| Maximum time for exiting the hazardous area after checking out | 60 s |

*Table 25: Data sheet for the EnforceKey Single Door*

1) For detailed information on the safety configuration of your machine, please consult your relevant SICK subsidiary.
2) The achievable safety-related parameter is dependent on the application.
3) Without external components (such as safety locking devices, emergency stop pushbutton, Standstill Monitor)
4) In the case of the ECO wiring option, where there is only one safety locking device, PL d is the maximum performance level that can be achieved for the locking function.

**NOTE**

Subsequent sections of this chapter contain some example calculations for working out what performance level can be achieved (see "Example calculations for safety functions", page 66).

## 13.2 Control unit data sheet

| | Control unit |
|---|---|
| **Electrical data** | |
| Supply voltage $V_S$ | 100 V AC ... 240 V AC<br>50 Hz ... 60 Hz/1 phase |
| Power consumption | 50 VA |
| Power output | |
| $P_{Sum1}$ [1] | ≤ 32 W |
| $P_{Sum2}$ [2] | ≤ 32 W |
| Terminals (voltage supply and PE) | |
| Usable wire cross-section, flexible | 0.08 $mm^2$ ... 4 $mm^2$<br>AWG 28 ... AWG 10 |
| Usable wire cross-section, rigid | 0.08 $mm^2$ ... 6 $mm^2$ |
| Terminals (other) | |
| Usable wire cross-section | 0.25 $mm^2$ ... 1.5 $mm^2$<br>AWG 26 ... AWG 16 |
| Length of cable – modules, safety locking devices, emergency stop pushbutton | ≤ 30 m |

*Table 26: Control unit data sheet*

| | Control unit |
|---|---|
| **Inputs** | |
| Filter time | 12 ms |
| Discrepancy time monitoring (only in the case of Standstill Monitor, emergency stop pushbutton, entry module, and clearance module) | 32 ms |
| **Flexi Soft outputs** | See “Flexi Soft Modular Safety Controller Hardware” operating instructions (SICK part no. 8012477) |
| **Safety relay outputs** | |
| Enabling current paths (N/O), safety-related | 2 |
| Contact type | Positively guided |
| Contact rating for enabling current path (13, 14) (23, 24) | |
| AC switching voltage | 10 V ... 250 V |
| DC switching voltage | 10 V ... 250 V |
| Switching current | 10 mA ... 6 A |
| AC switching capacity | 3 VA ... 1,500 VA |
| DC switching capacity | 3 W ... 200 W |
| Utilization category in compliance with EN 60947-5-1 | |
| AC-15 | $U_e$ = 230 V AC, $I_e$ = 3 A |
| DC-13 | $U_e$ = 24 V DC, $I_e$ = 4 A |
| gL contact fuse or circuit breaker with characteristic B or C | 6 A |
| Mechanical service life | $10^7$ Switching operations |
| Electrical service life (at 230 V AC, cos Z = 1) | $10^5$ Switching operations |
| Rated impulse withstand voltage $U_{imp}$ | 4 kV |
| Overvoltage category | II |
| Rated voltage | 300 V AC |
| Test voltage $U_{eff}$ 50 Hz | 1.2 kV |
| **Ambient data** | |
| Ambient operating temperature | 0 °C ... +45 °C |
| Enclosure rating | IP 65 (EN 60529) |
| Storage temperature | -25 °C ... +70 °C |
| Air humidity (non-condensing) | 10% ... 75% (95% < 24 h) |
| EMC | According to EN 61000-6-4 |

*Table 26: Control unit data sheet*

1) Sum1 = sum of power consumed by safety locking device 1 + safety locking device 2 + sequence error output
2) Sum2 = sum of power consumed by sequence error output + hardware error output

## 13.3 Entry module data sheet

| | Entry module |
|---|---|
| **Safety-related characteristic data** [1] | |

*Table 27: Entry module data sheet, safety-related characteristic data*

| | Entry module |
|---|---|
| SIL claim limit | SILCL3 (EN 62061) |
| Performance level | PL e (EN ISO 13849-1) |
| Category | Category 4 (EN ISO 13849-1) |
| $PFH_D$ for key recognition | $14 \times 10^{-9}$ (EN ISO 13849) |
| $T_M$ (mission time) | 20 years (EN ISO 13849) |
| Type | Type 4 (EN ISO 14119), actuator with high coding level |
| Safe state when a fault occurs | At least one safe output (OSSD) is in the OFF state. |
| **Electrical safety** | |
| Rated impulse withstand voltage $U_{imp}$ | 1,500 V |
| Contamination rating | 3 |
| Rated insulation voltage $U_I$ | 32 V |
| Cable capacitance | 400 nF (Out A and Out B) |
| Device fuse | 2 A |

*Table 27: Entry module data sheet, safety-related characteristic data*

1) For detailed information on the safety configuration of your machine/plant, please consult your SICK subsidiary.

| | Entry module |
|---|---|
| **Operating data** | |
| Current consumption (without load) | 65 mA |
| Supply voltage $V_S$ | 19.2 V DC ... 28.8 V DC |
| Voltage supply | Class 2 SELV |
| Response time (removal of key) | 40 ms |
| Response time in the event of internal errors | 40 ms |
| Risk time | 80 ms |
| Time delay before availability | 2.5 s |
| Minimum distance between two devices | 200 mm |
| Material | |
| Housing | PVC, PC |
| Key | PVC |
| Dimensions | See dimensional drawing |
| **Inputs** | |
| Green LED | ≤ 15 mA |
| Blue LED | ≤ 15 mA |
| White LED | ≤ 15 mA |
| **Outputs** | |
| 2 OSSDs (OSSD1 and OSSD2) | 2 × PNP, 100 mA max., protected against short-circuits and overloads |
| Switching current | |
| ON state | 100 mA |
| OFF state | < 500 µA |

*Table 28: Entry module data sheet*

| | Entry module |
|---|---|
| Switching voltage | |
| ON state | 21 V DC ... 24 V DC |
| OFF state | 0 V DC ... 2 V DC |
| **Ambient data** | |
| Ambient operating temperature | –10 °C ... +70 °C |
| Enclosure rating | IP 67 (EN 60529) |
| Air humidity (non-condensing) | 10% ... 75% (95% < 24 h) |
| Vibration resistance | 0.35 mm/10–55 Hz (IEC 60068-2-6) |
| Shock resistance | |
| Continuous shock | 10 g, 16 ms (IEC 60068-2-27) |
| Single shock | 30 g, 11 ms (IEC 60068-2-27) |
| EMC | According to EN 61000-6-4 |
| **System connection** | |
| Connection type | M12 plug connector (8-pin) |
| Length of cable | ≤ 30 m |

*Table 28: Entry module data sheet*

## 13.4 Clearance module data sheet

| | Clearance module |
|---|---|
| **Safety-related characteristic data** [1] | |
| SIL claim limit | SILCL3 (EN 62061) |
| Performance level | PL e (EN ISO 13849-1) |
| Category | Category 4 (EN ISO 13849-1) |
| $PFH_D$ for key recognition | $14 \times 10^{-9}$ (EN ISO 13849) |
| $T_M$ (mission time) | 20 years (EN ISO 13849) |
| Type | Type 4 (EN ISO 14119), actuator with high coding level |
| Safe state when a fault occurs | At least one safe output (OSSD) is in the OFF state. |
| **Electrical safety** | |
| Rated impulse withstand voltage $U_{imp}$ | 1,500 V |
| Contamination rating | 3 |
| Rated insulation voltage $U_i$ | 32 V |
| Cable capacitance | 400 nF (Out A and Out B) |
| Device fuse | 2 A |

*Table 29: Clearance module data sheet, safety-related characteristic data*

[1] For detailed information on the safety configuration of your machine/plant, please consult your SICK subsidiary.

| | Clearance module |
|---|---|
| **Operating data** | |
| Current consumption (without load) | 65 mA |
| Supply voltage $V_S$ | 19.2 V DC ... 28.8 V DC |

*Table 30: Clearance module data sheet, operating data*

| | Clearance module |
|---|---|
| Voltage supply | Class 2 SELV |
| Response time (removal of key) | 40 ms |
| Response time in the event of internal errors | 40 ms |
| Risk time | 80 ms |
| Time delay before availability | 2.5 s |
| Minimum distance between two devices | 200 mm |
| Material | |
| Housing | PVC |
| Key | PVC |
| Dimensions | See dimensional drawing |
| **Inputs** | |
| White LED | ≤ 15 mA |
| **Outputs** | |
| 2 OSSDs (OSSD1 and OSSD2) | 2 × PNP, 100 mA max., protected against short-circuits and overloads |
| Switching current | |
| ON state | 100 mA |
| OFF state | < 500 µA |
| Switching voltage | |
| ON state | 21 V DC ... 24 V DC |
| OFF state | 0 V DC ... 2 V DC |
| **Ambient data** | |
| Ambient operating temperature | –10 °C ... +70 °C |
| Enclosure rating | IP 67 (EN 60529) |
| Air humidity (non-condensing) | 10% ... +75% (95% < 24 h) |
| Vibration resistance | 0.35 mm/10–55 Hz (IEC 60068-2-6) |
| Shock resistance | |
| Continuous shock | 10 g, 16 ms (IEC 60068-2-27) |
| Single shock | 30 g, 11 ms (IEC 60068-2-27) |
| EMC | According to EN 61000-6-4 |
| **System connection** | |
| Connection type | M12 plug connector (5-pin) |
| Length of cable | ≤ 30 m |

*Table 30: Clearance module data sheet, operating data*

## 13.5 Control unit dimensional drawing

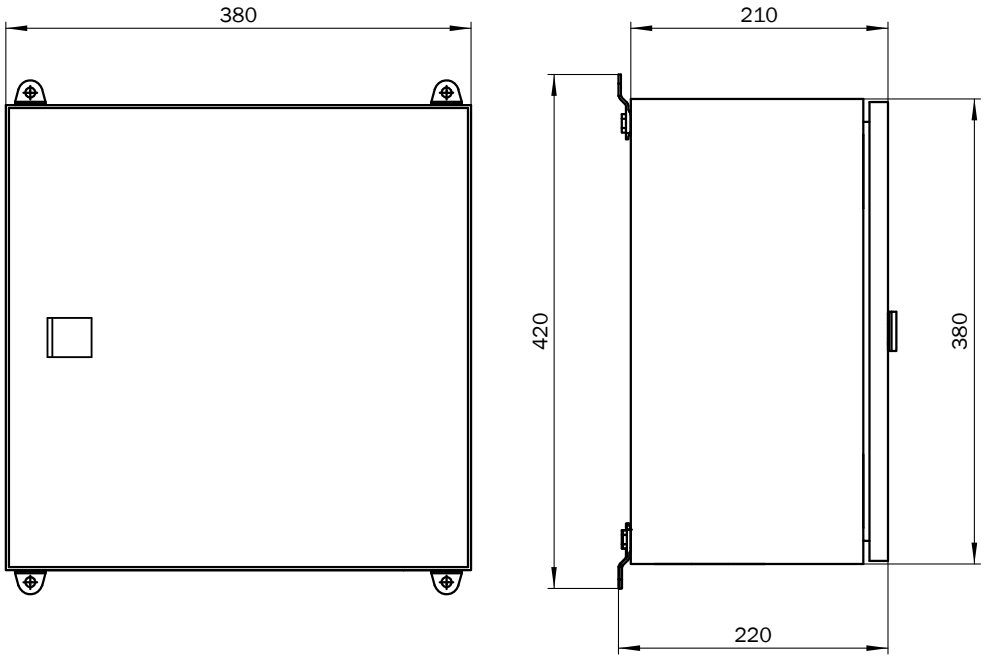



*Figure 24: Control unit dimensional drawing (mm)*

## 13.6 Entry module dimensional drawing

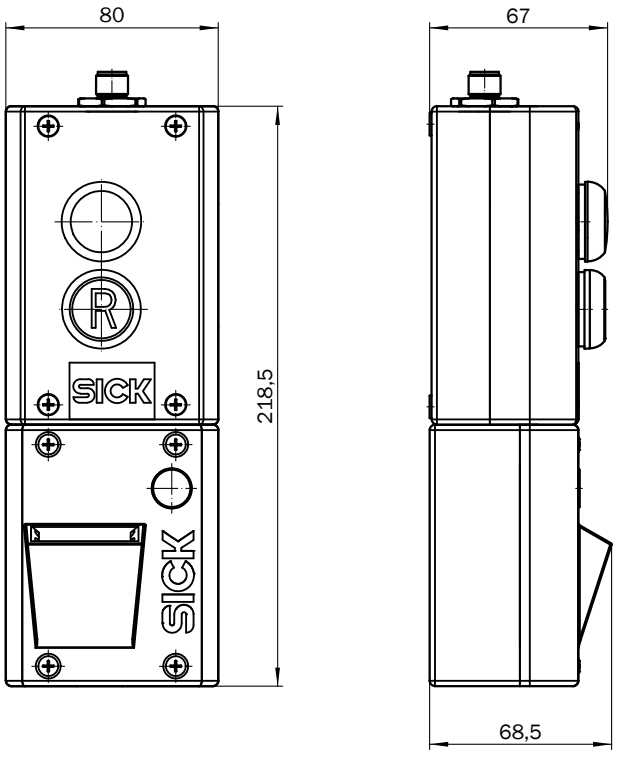



*Figure 25: Entry module dimensional drawing (mm)*

## 13.7 Clearance module dimensional drawing

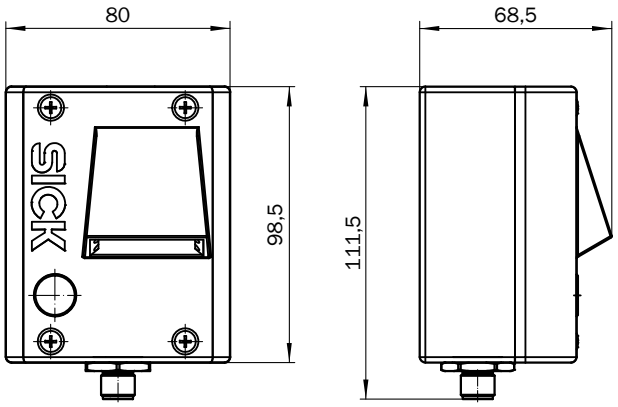



*Figure 26: Clearance module dimensional drawing (mm)*

## 13.8 Key dimensional drawing

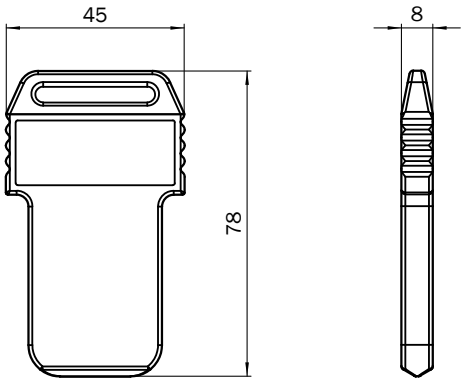



*Figure 27: Key dimensional drawing (mm)*

## 13.9 Example calculations for safety functions

**NOTE**

The example calculations illustrate how to calculate characteristic safety values for the functional safety system, including the external components. The example calculations are merely an aid to understanding and are not definitive.

To obtain definitive values, you must perform your own calculations for the application concerned.

### 13.9.1 Initiating a stop

Below is an example of how to calculate the performance level for the **initiating a stop** safety function when the following situations apply:

- Locking function failed
- Unplanned opening of the door

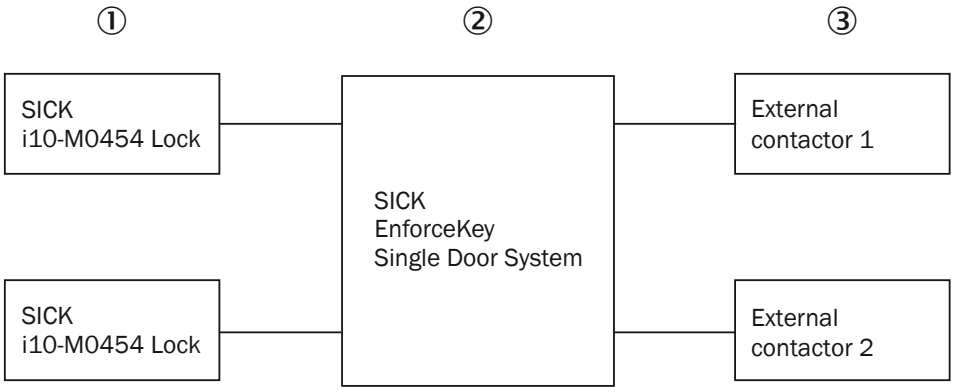



*Figure 28: Diagram showing the "initiating a stop" safety function*

① Locking function section
② Logic section
③ Actuator section (contactors according to EN ISO 13849-1:2008 Table C.1: Nominal load)

**Locking function section**

The $PFH_D$ value for the locking function section must be calculated on the basis of the characteristic values for the SICK i10-M0454 safety locking devices.

| Characteristic value | Value | Comments |
|---|---|---|
| $B10_d$ | 3,000,000 cycles | |
| $n_{op}$ | 4,200 cycles/year | 12 cycles/day, 350 days/year (depending on application) |
| Category | 4 | 2 channels, test pulses |
| DC | 99% | Cross checking, dynamic testing, discrepancy time |
| CCF | 75 | Dependent on application |

*Table 31: Characteristic values for the SICK i10-M0454 safety locking devices (excerpt)*

**Calculating the $PFH_D$ value for the locking function section:**

$$MTTF_D = \frac{B_{10d}}{0{,}1 \times n_{op}} = 7.143 \text{ Years, per channel}$$

$$MTTF_D = \frac{2}{3}\left[ MTTF_{D,CH1} + MTTF_{D,CH2} - \frac{1}{\frac{1}{MTTF_{D,CH1}} + \frac{1}{MTTF_{D,CH2}}} \right] = 7.143 \text{ Years}$$

Limited to 2,500 years:

$MTTF_D$ = 2,500 years

In accordance with "DGUV Test: Test Body Info 926 A4 Table K.2", the following applies:

$PFH_{D1} = 9.06 \times 10^{-10} = 0.906$ FIT

### Logic section

The $PFH_D$ value for the logic section can be taken from the characteristic values for the EnforceKey Single Door.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D2}$ | $1.85 \times 10^{-8}$ | = 18.5 FIT |
| Category | 4 | |

*Table 32: Characteristic values for the EnforceKey Single Door (excerpt)*

### Actuator section

The $PFH_D$ value for the actuator section must be calculated on the basis of the characteristic values for the contactors according to EN ISO 13849-1:2008 Table C.1: Nominal load.

| Characteristic value | Value | Comments |
|---|---|---|
| $B10_d$ | 2,000,000 cycles | |
| $n_{op}$ | 4,200 cycles/year | = 12 cycles/day, 350 days/year (depending on application) |
| Category | 4 | 2 channels, test pulses |
| DC | 99% | EDM used: redundant cut-off path with drive elements monitored by the logic and the test device. Positively guided contacts required |
| CCF | 75 | Dependent on application |

*Table 33: Characteristic values for the actuator section (contactors according to EN ISO 13849-1:2008 Table C.1: Nominal load)*

**Calculating the $PFH_D$ value for the actuator section:**

$$MTTF_D = \frac{B_{10d}}{0{,}1 \times n_{op}} = 4.761 \text{ Years, per channel}$$

$$MTTF_D = \frac{2}{3}\left[ MTTF_{D,CH1} + MTTF_{D,CH2} - \frac{1}{\frac{1}{MTTF_{D,CH1}} + \frac{1}{MTTF_{D,CH2}}} \right] = 4.761 \text{ Years, total}$$

Limited to 2,500 years:

$MTTF_D$ = 2,500 years

In accordance with “DGUV Test: Test Body Info 926 A4 Table K.2”, the following applies:

$PFH_{D3} = 9.06 \times 10^{-10} = 0.906$ FIT

**Calculating the overall $PFH_D$ value for the safety function:**

The overall $PFH_D$ value is calculated by adding together the $PFH_D$ values for the following sections:

- Locking function: $PFH_{D1}$
- Logic: $PFH_{D2}$
- Actuators: $PFH_{D3}$

$$PFH_D = \sum PFH_{D1,2,3} = 20{,}3\ FIT = 2{,}03 \times 10^{-8}$$

According to EN ISO 13849-1:2008 Table 3, this results in **performance level e**.

### 13.9.2 Temporarily preventing access with the standard wiring option

Below is an example of how to calculate the performance level for the **temporarily prevent access** safety function when the following situation applies:

The standstill signal is monitored once the key is removed. The locking function is not deactivated until this signal is present.

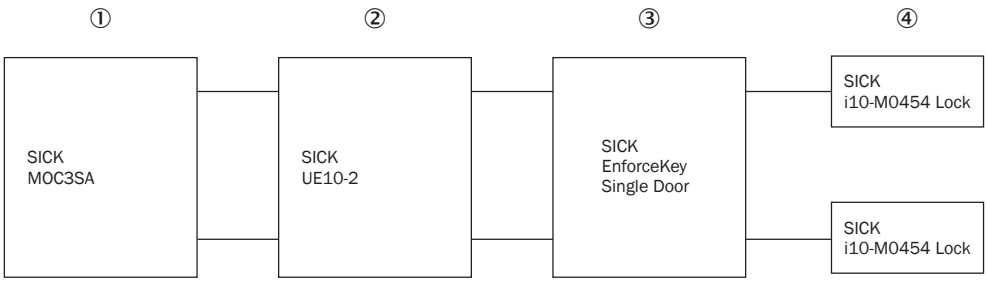



*Figure 29: Diagram showing the "temporarily prevent access" safety function (standard wiring option)*

① Standstill Monitor section
② Safety relay section
③ Logic section
④ Locking function section

**Standstill Monitor section**

The $PFH_D$ value for the Standstill Monitor section can be taken from the characteristic values for the SICK MOC3SA Standstill Monitor.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D1}$ | $5 \times 10^{-9}$ | = 5 FIT |
| Category | 4 | From data sheet |

*Table 34: Characteristic values for the SICK MOC3SA Standstill Monitor (excerpt)*

**Safety relay section**

The $PFH_D$ value for the safety relay section can be taken from the characteristic values for the SICK UE10-2 safety relay.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D2}$ | $7 \times 10^{-10}$ | = 0.7 FIT |
| Category | 4 | From data sheet, EDM connected |

*Table 35: Characteristic values for the SICK UE10-2 safety relay*

### Logic section

The $PFH_D$ value for the logic section can be taken from the characteristic values for the EnforceKey Single Door.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D3}$ | $1.85 \times 10^{-8}$ | = 18.5 FIT |
| Category | 4 | |

*Table 36: Characteristic values for the EnforceKey Single Door (excerpt)*

### Locking function section

The $PFH_{D4}$ value for the locking function section must be calculated on the basis of the characteristic values for the SICK i10-M0454 safety locking devices.

| Characteristic value | Value | Comments |
|---|---|---|
| $B10_d$ | 3,000,000 cycles | |
| $n_{op}$ | 4,200 cycles/year | = 12 cycles/day, 350 days/ year (depending on application) |
| Category | 4 | 2 channels, test pulses |
| DC | 99% | Cross checking, dynamic testing, discrepancy time |
| CCF | 75 | Dependent on application |

*Table 37: Characteristic values for the SICK i10-M0454 safety locking devices (excerpt)*

**Calculating the $PFH_D$ value for the locking function section:**

$$MTTF_D = \frac{B_{10d}}{0{,}1 \times n_{op}} = 7.143 \text{ Years, per channel}$$

$$MTTF_D = \frac{2}{3}\left[ MTTF_{D,CH1} + MTTF_{D,CH2} - \frac{1}{\frac{1}{MTTF_{D,CH1}} + \frac{1}{MTTF_{D,CH2}}} \right] = 7.143 \text{ Years}$$

Limited to 2,500 years:

$MTTF_D$ = 2,500 years

In accordance with "DGUV Test: Test Body Info 926 A4 Table K.2", the following applies:

$PFH_{D4} = 9.06 \times 10^{-10} = 0.906$ FIT

**Calculating the overall $PFH_D$ value for the safety function:**

The overall $PFH_D$ value is calculated by adding together the $PFH_D$ values for the following sections:

- Standstill Monitor: $PFH_{D1}$
- Safety relay: $PFH_{D2}$
- Logic: $PFH_{D3}$
- Locking function: $PFH_{D4}$

$$PFH_D = \sum PFH_{D1,2,3,4} = 25{,}1 \text{ FIT} = 2{,}51 \times 10^{-8}$$

According to EN ISO 13849-1:2008 Table 3, this results in **performance level e**.

### 13.9.3 Temporarily preventing access with the ECO wiring option

Below is an example of how to calculate the performance level for the **temporarily prevent access** safety function when the following situation applies:

The standstill signal is monitored once the key is removed. The locking function is not deactivated until this signal is present.

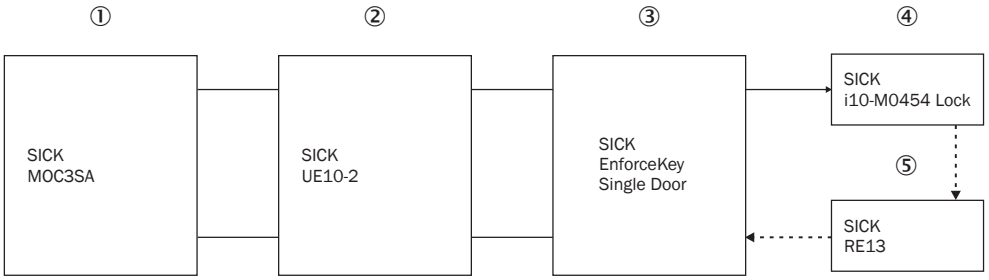



*Figure 30: Diagram showing the "temporarily prevent access" safety function (ECO wiring option)*

① Standstill Monitor section
② Safety relay section
③ Logic section
④ Locking function section
⑤ Test channel for door monitoring

#### Standstill Monitor section

The $PFH_D$ value for the Standstill Monitor section can be taken from the characteristic values for the SICK MOC3SA Standstill Monitor.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D1}$ | $5 \times 10^{-9}$ | = 5 FIT |
| Category | 4 | From data sheet |

*Table 38: Characteristic values for the SICK MOC3SA Standstill Monitor (excerpt)*

#### Safety relay section

The $PFH_D$ value for the safety relay section can be taken from the characteristic values for the SICK UE10-2 safety relay.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D2}$ | $7 \times 10^{-10}$ | = 0.7 FIT |
| Category | 4 | From data sheet, EDM connected |

*Table 39: Characteristic values for the SICK UE10-2 safety relay (excerpt)*

#### Logic section

The $PFH_D$ value for the logic section can be taken from the characteristic values for the EnforceKey Single Door.

| Characteristic value | Value | Comments |
|---|---|---|
| $PFH_{D3}$ | $1.85 \times 10^{-8}$ | = 18.5 FIT |
| Category | 4 | |

*Table 40: Characteristic values for the EnforceKey Single Door (excerpt)*

### Safety locking device section (including test channel for door switch)

The $PFH_D$ value for the safety locking function section must be calculated on the basis of the characteristic values for the SICK i10-M0454 safety locking device and for the SICK RE13 safety switch.

| Characteristic value | Value | Comments |
|---|---|---|
| $B10_d$ | 3,000,000 cycles | |
| $n_{op}$ | 4,200 cycles/year | = 12 cycles/day, 350 days/ year (depending on application) |

*Table 41: Characteristic values for the SICK i10-M0454 safety locking device (excerpt)*

### Calculating the $MTTF_D$ value for the safety locking device

$$MTTF_{D,CH1} = \frac{B_{10d}}{0{,}1 \times n_{op}} = 7.143 \text{ Years, channel 1}$$

| Characteristic value | Value | Comments |
|---|---|---|
| $B10_d$ | 20,000,000 cycles | |
| $n_{op}$ | 4,200 cycles/year | = 12 cycles/day, 350 days/ year (depending on application) |

*Table 42: Characteristic values for the SICK RE13 safety switch (excerpt)*

### Calculating the $MTTF_D$ value for the door switch test channel

$$MTTF_{D,TE} = \frac{B_{10d}}{0{,}1 \times n_{op}} = 47.619 \text{ Years, test channel}$$

The test channel is limited to 100 years:

$MTTF_{D,TE}$ = 100 years

### Calculating the $MTTF_D$ value for the locking function section

$$MTTF_D = \frac{2}{3}\left[ MTTF_{D,CH1} + MTTF_{D,TE} - \frac{1}{\frac{1}{MTTF_{D,CH1}} + \frac{1}{MTTF_{D,TE}}} \right] = 7.144 \text{ Years}$$

Limited to 100 years:

$MTTF_D$ = 100 years

| Characteristic values | Value | Comments |
|---|---|---|
| Category | 2 | 1 channel, test channel |
| DC | 90% | Monitored indirectly via position switch |

*Table 43: Characteristic values for the locking function section*

| Characteristic values | Value | Comments |
|---|---|---|
| CCF | 75 | Dependent on application |

*Table 43: Characteristic values for the locking function section*

In accordance with “DGUV Test: Test Body Info 926 A4 Table K.1”, the following applies:

$PFH_{D4} = 2.29 \times 10^{-7} = 229$ FIT

**Calculating the overall $PFH_D$ value for the safety function:**

The overall $PFH_D$ value is calculated by adding together the $PFH_D$ values for the following sections:

- Standstill Monitor: $PFH_{D1}$
- Safety relay: $PFH_{D2}$
- Logic: $PFH_{D3}$
- Locking function: $PFH_{D4}$

$$PFH_D = \sum PFH_{D1,2,3,4} = 253{,}2 \text{ FIT} = 2{,}53 \times 10^{-7}$$

According to EN ISO 13849-1:2008 Table 3, this results in **performance level d**.

# 14 Ordering information

## 14.1 Scope of delivery

- 1 control unit
- 1 entry module
- 1 clearance module
- 1 key

## 14.2 EnforceKey Single Door

| Name | Type code | Part number |
|---|---|---|
| EnforceKey Single Door | NFKS-S1 | 1081038 |

*Table 44: Ordering information for the EnforceKey Single Door*

# 15 Spare parts

## 15.1 Modules and spare parts

| Description | Type code | Part number |
|---|---|---|
| Entry module | NFKR-E1 | 2085837 |
| Clearance module | NFKR-B1 | 2085838 |
| Key | NFKK-B1 | 2085839 |
| Control unit | NFKC-S1 | 2084516 |

*Table 45: Ordering information for modules and spare parts*

## 15.2 System plug and modules of the Flexi Soft safety controller

| Description | Type code | Part number |
|---|---|---|
| System plug for FX3-CPU0 or FX3-CPU1<br>Screw terminals | FX3-MPL000001 | 1043700 |
| Main module | FX3-CPU000000 | 1043783 |
| I/O module<br>8 safe inputs, 4 safe outputs, plug-in dual-level spring terminals | FX3-XTIO84002 | 1044125 |
| I/O module<br>8 safe inputs, 4 / 6 non-safe outputs, plug-in dual-level spring terminals | FX3-XTDS84002 | 1061777 |
| Safety relay<br>Plug-in screw terminals | UE10-2FG3D0 | 1043916 |

*Table 46: Ordering information for the system plug and modules of the Flexi Soft safety controller*

# 16 Accessories

## 16.1 Accessories

| Part | Type | Part number |
|---|---|---|
| i10 Lock safety locking devices | i10-M0454 Lock | 6045055 |
| i110 Lock safety locking devices | i110-M0454 | 6051602 |
| RE1 non-contact safety switches – Magnetic safety switch | RE13-SAC | 1059503 |
| ES11 safety command devices – Emergency stop pushbutton | ES11-SA1A4 | 6051327 |

*Table 47: Ordering information for accessories*

## 16.2 Connectivity

| Part | Type code | Part number |
|---|---|---|
| Female connector straight, 2.5 m cable, open end | DOL-1208-G2M5C | 6058863 |
| Female connector straight, 5 m cable, open end | DOL-1208-G05MC | 6035621 |
| Female connector straight, 7.5 m cable, open end | DOL-1208-G7M5C | 6058864 |
| Female connector straight, 10 m cable, open end | DOL-1208-G10MC | 6035622 |
| Female connector straight, 15 m cable, open end | DOL-1208-G15MC | 6038559 |
| Female connector straight, 20 m cable, open end | DOL-1208-G20MC | 6038560 |
| Female connector straight, 30 m cable, open end | DOL-1208-G30MC | 6058865 |
| Female connector angled, 2 m cable, open end | DOL-1208-W02MC | 6035623 |
| Female connector angled, 5 m cable, open end | DOL-1208-W05MC | 6035624 |
| Female connector angled, 10 m cable, open end | DOL-1208-W10MC | 6035625 |

*Table 48: Ordering information for M12 connecting cable, 8-pin (0.25 $mm^2$) [5)]*

| Part | Type code | Part number |
|---|---|---|
| Female connector straight, 2 m cable, open end | DOL-1205-G02MC | 6025906 |
| Female connector straight, 5 m cable, open end | DOL-1205-G05MC | 6025907 |
| Female connector straight, 10 m cable, open end | DOL-1205-G10MC | 6025908 |
| Female connector straight, 15 m cable, open end | DOL-1205-G15MC | 6051946 |
| Female connector straight, 20 m cable, open end | DOL-1205-G20MC | 6050247 |

*Table 49: Ordering information for M12 connecting cable, 5-pin (0.34 $mm^2$) [5)]*

5) *Ambient operating temperature: Down to -30 °C with fixed installation*

| Part | Type code | Part number |
|---|---|---|
| Female connector straight, 30 m cable, open end | DOL-1205-G30MC | 6050248 |

*Table 49: Ordering information for M12 connecting cable, 5-pin (0.34 mm²) [6]*

| Part | Type code | Part number |
|---|---|---|
| Female connector straight, 2 m cable, open end | DOL-0804-G02MC | 6025894 |
| Female connector straight, 5 m cable, open end | DOL-0804-G05MC | 6025895 |
| Female connector straight, 10 m cable, open end | DOL-0804-G10MC | 6025896 |
| Female connector straight, 15 m cable, open end | DOL-0804-G15MC | 6038622 |
| Female connector straight, 20 m cable, open end | DOL-0804-G20MC | 6051148 |

*Table 50: Ordering information for M8 connecting cable, 4-pin (0.34 mm²) [6]*

5) *Ambient operating temperature: Down to -30 °C with fixed installation*

# 17 Annex

## 17.1 Compliance with EU directives

**EU declaration of conformity (excerpt)**

The undersigned, representing the following 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 respective standards and/or technical specifications are taken as the basis.

**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).

## 17.2 Checklist for initial commissioning and commissioning

**Checklist for manufacturers/installers when installing the functional safety system**

The details relating to the items listed below must be available no later than when the system is commissioned for the first time. However, these depend on the specific application (the requirements of which must be reviewed by the manufacturer/installer).

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

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

| Inspection step | |
|---|---|
| Is access to the hazardous area/hazardous point only possible via the access door that is being secured by this system? | Yes ☐ No ☐ |
| Have the safety locking devices/safety switches connected to the functional safety system been mounted in accordance with their respective operating instructions? And have they been protected to prevent manipulation? | Yes ☐ No ☐ |
| Have all the following requirements been met?<br>• Part of the hazardous area is visible from the clearance module.<br>• The rest of the hazardous area is visible from the entry module.<br>• The route from the clearance module to the entry module is designed in such a way that the operator cannot fail to see anyone entering the hazardous area. | Yes ☐ No ☐ |
| Have the components of the functional safety system and the connected safety locking devices/safety switches been properly mounted? And, once adjusted, have they been secured to prevent movement? | Yes ☐ No ☐ |
| Is the entry module for resetting the protective device present and correctly installed? | Yes ☐ No ☐ |
| Is the machine equipped with its own restart interlock and is this effective? | Yes ☐ No ☐ |
| Have the outputs of the functional safety system been integrated as per the required PL/SILCL in accordance with EN ISO 13849-1/EN 62061? And does the integration method correspond to the circuit diagrams? | Yes ☐ No ☐ |
| Have the enabling current paths of the safety relay been correctly integrated into the machine controller? | Yes ☐ No ☐ |

*Table 51: Checklist for the manufacturer/installer*

**Checklist for initial commissioning and periodic thorough checks**

All the items on this checklist must be successfully checked off as part of the initial commissioning process (see "Validation", page 50) before the machine is put into operation.

Prerequisites:

- The voltage supply of the functional safety system has been switched off.
- The machine is switched off.
- The access door is closed and locked.
- There is no key inserted in the entry or clearance module.
- The jumper link inside the control cabinet has been installed correctly (to configure the device with/without a Standstill Monitor).

| Step number | Inspection step | |
|---|---|---|
| 1 | ▶ Switch on the voltage supply of the functional safety system.<br>▶ Open the access door. | |
| | ✓ The white LEDs on both modules flash at 4 Hz (sequence error active).<br>✓ The safety relay is in the OFF state. | Yes ☐ No ☐ |
| 2 | ▶ Insert the key into the key holder of the clearance module briefly (for two to five seconds). | |
| | ✓ The white LED on the clearance module lights up continuously.<br>✓ The white LED on the entry module flashes twice at 1 Hz with a break of two seconds. | Yes ☐ No ☐ |
| You must complete the next three steps within 60 seconds; otherwise, a sequence error will occur. You will then have to start again from step 2. | | |
| 3 | ▶ Lock the machine access door from the outside. | |
| | ✓ The white LED on the entry module flashes at 1 Hz. | Yes ☐ No ☐ |
| 4 | ▶ Insert the key into the key holder of the entry module and leave it there. | |
| | ✓ The safety locking device locks the door.<br>✓ The blue LED on the entry module starts to flash (at 1 Hz). | Yes ☐ No ☐ |
| 5 | ▶ Use the blue reset button to reset the functional safety system. | |
| | ✓ The blue LED on the entry module goes out.<br>✓ The green LED on the entry module lights up continuously.<br>✓ The safety relay is in the ON state and the machine can now be started by the machine controller.<br>✓ The door is still locked. | Yes ☐ No ☐ |
| 6 | ▶ Remove the key from the entry module. | |
| | ✓ The green LED on the entry module starts to flash (at 1 Hz).<br>✓ The safety relay switches to the OFF state and the machine stops.<br>✓ The green LED on the entry module goes out.<br>✓ The white LED on the entry module flashes twice at 1 Hz with a break of two seconds.<br>✓ The white LED on the clearance module lights up continuously. | Yes ☐ No ☐ |
| 7 | ▶ Open the access door. | |
| | ✓ The white LED on the entry module lights up continuously.<br>✓ The white LED on the clearance module flashes at 1 Hz. | Yes ☐ No ☐ |

*Table 52: Checklist for initial commissioning and periodic thorough checks*

# 18 List of figures

# 19 List of tables

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