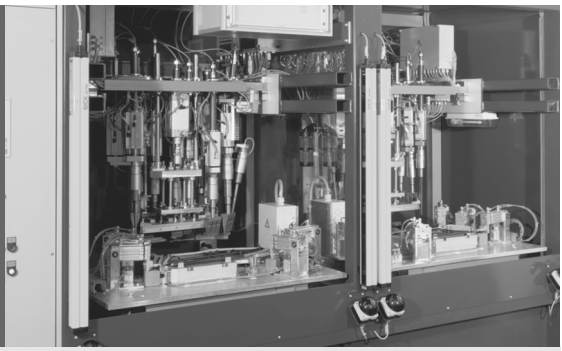
OPERATING INSTRUCTIONS

UE440/UE470



Compact Safety Controller

GB

SICK
Sensor Intelligence.

QUALITY SYSTEM

certified by DQS according to
DIN EN ISO 9001 Reg. No. 462-03

Contents

Contents

1 About this document

Please read this chapter carefully before working with the documentation and a compact safety controller UE440/470.

1.1 Function of this document

These operating instructions are designed to address *the technical personnel of the machine manufacturer or the machine operator* in regards to safe mounting, installation, configuration, electrical installation, commissioning, operation and maintenance of the compact safety controller UE440/470 in connection with other protective devices (e.g. safety light curtain C4000 or safety laser scanner S3000).

These operating instructions do not provide instructions for operating machines on which a compact safety controller is, or will be, integrated.

1.2 Target group

These operating instructions are addressed to planning engineers, machine designers and the operators of systems which are to be protected by one or more SICK protective devices in connection with a compact safety controller UE440/470. It also addresses people who integrate a UE440/470 into a machine, initialise its use, or who are in charge of servicing and maintaining the unit.

1.3 Scope

Note These operating instructions apply for the compact safety controllers UE440 and UE470 with the following type label entry in the *Operating Instructions* field: 8010426.

If sensors are connected via EFI, only those with the following type label entry for the minimum requirement on the software version are to be used:

Sensor	**Minimum requirement on the software version**
C4000 safety light curtain	V3.28
S3000 safety laser scanner	V2.26
M4000 multiple light beam safety device	V1.20
S300 safety laser scanner	V1.31
EFI gateways:	
UE1940 CANopen	V1.31
UE1140 PROFIBUS	V1.30
UE4140 PROFIsafe	V1.32
UE1840 Ethernet	V1.33

This document is part of SICK part number 8010426 (operating instructions "Compact Safety Controller UE440/470" in all available languages).

You will require a CDS (Configuration & Diagnostic Software) version V3.5.0 or greater for the configuration and diagnostics of these devices. To check the software version, select the **Module info** item from the **?** menu in the menu bar.

1.4 Depth of information

These operating instructions contain the following information on the compact safety controller UE440/470:

- Mounting
- Electrical installation
- Putting into operation and configuration
- Operation
- Error diagnositcs and remedying
- Part numbers
- Conformity and approval

Planning and using SICK protective devices also require specific technical skills which are not detailed in this documentation.

When operating a UE440/470, the national, local and statutory rules and regulations must be observed.

General information on health and safety using opto-electronic protective devices is contained in the brochure "Safe Machines with Opto-Electronic Protective Devices".

Note We also refer you to the SICK homepage on the Internet at

www.sick.com

Here you will find:

- Sample applications
- A list of common questions on compact safety controller UE440/470
- These operating instructions in different languages for viewing and printing

1.5 Abbreviations

ADO Application diagnostic output = configurable signal output that indicates a specific status

BDC Bottom dead centre = machine cycle contact. Indicates that the bottom dead centre has been reached on a press

ESPE Electro-sensitive protective equipment (e.g. C4000 or S3000)

C4000 C4000 safety light curtain

CDS SICK Configuration & Diagnostic Software = software for configuring your UE440/470 and devices connected via EFI

EDM External device monitoring

EFI Enhanced function interface = secure SICK device communication

FGS FGS safety light curtain

EPLC Error-proof programmable logic controller

M4000 M4000 multiple light beam safety device

OSSD Output signal switching device = switching output which operates the safety circuit

PFD Probability of failure per hour

PSDI Presence sensing device initiation = PSDI mode

S3000 S3000 safety laser scanner

SCC Stop control contact = overrun monitoring. Indicates the end of the expected stopping path on a press

SDL Safety data link = SICK safety interface (connection for OSSD and EFI of ESPE)

SIL Safety integrity level

TDC Top dead centre = machine cycle contact. Indicates that the top dead centre has been reached on a press

V4000 V4000 sensor system

1.6 Symbols used

Recommendation Recommendations are designed to give you some assistance in your decision-making process with respect to a certain function or a technical measure.

Note Notes provide special information on the device.

Display indicators show the status of the 7-segment display:

- Constant display of characters, e.g. 8
- Flashing display of characters, e.g. 8
- Changing display of characters, e.g. A and 3

LED symbols describe the state of a diagnostics LED. Examples:

- ● The LED is illuminated constantly.
- ☼ The LED is flashing.
- ○ The LED is off.

➢ Take action ... Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

ATTENTION

Warning!

A warning indicates concrete or potential dangers. They save you from harm.

Read warnings carefully and abide by them!

The term "dangerous state"

In the figures in this document, the dangerous state of the machine is always represented as a movement of a machine part. In practical operation, there may be a number of different dangerous states, e.g.:

- Machine movements
- Electrical conductors
- Visible or invisible radiation
- A combination of several risks and hazards

2 On safety

This chapter deals with your own safety and the safety of the equipment operators.

➢ Please read this chapter carefully before working with a UE440/470 or with the machine protected by the UE440/470.

2.1 Specialist personnel

The compact safety controller UE440/470 must be installed, commissioned and serviced only by specialist personnel. Specialist personnel are defined as persons who...

- have undergone the appropriate technical training

and

- who have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines

and

- have access to the operating instructions of the UE440/470 and have read and familiarised themselves with them

and

- have access to the operating instructions for the protective devices (e.g. C4000) connected to the compact safety controller and have read and familiarised themselves with them.

2.2 Applications of the device

The compact safety controller UE440/470 is a configurable controller for comprehensive implementation of safety applications.

The device corresponds to category 4 according to EN 954-1; applications can reach SIL3 according to IEC 61508. The emergency stop function in the device corresponds to stop category 0 or 1 in accordance with EN 418.

Opto-electronic and tactile safety sensors (e.g. light curtains, laser scanners, reset devices, sensors, emergency stop devices and machine cycle contacts) are connected to the compact safety controller and are linked logically. The accompanying actuators of connected machines or systems are switched off safely via the switching outputs of the compact safety controller.

Connected pick-ups or safety sensors and the subsequent control, wiring and installation must correspond to the required category in accordance with EN 954-1.

Tab. 1: Suitability of the device variants

Suitability	**UE440**	**UE470**
Logical link of safety signals	■	■
Connection/integration of safety sensors and actuators	■	■
PSDI mode		■

2.3 Correct use

The compact safety controller UE440/470 may only be used as intended in Section 2.2 "Applications of the device". It may only be used by specialist personnel and only at the machine at which it was mounted and initially commissioned by specialist personnel in accordance with these operating instructions.

SICK AG accepts no claims for liability if the equipment is used in any other way or if modifications are made to the device, even in the context of mounting and installation.

2.4 General protective notes and protective measures

ATTENTION

Observe the protective notes and measures!

Please observe the following items in order to ensure proper use of the compact safety controller UE440/470.

- When mounting, installing and using the UE440/470, observe the standards and directives applicable in your country.
- The national/international rules and regulations apply to the installation, use and periodic technical inspection of the compact safety controller UE440/470, in particular:
  - Machinery Directive 98/37/EC
  - Provision and use of Directive 89/655/EEC
  - Low-Voltage Directive 73/23/EEC
  - Work safety regulations/safety rules
  - Other relevant health and safety regulations
- Manufacturers and owners of the machine on which a UE440/470 is used are responsible for obtaining and observing all applicable safety regulations and rules.
- The notes, in particular the test notes (see Chapter 8 "Commissioning" on Page 84) of these operating instructions (e.g. on use, mounting, installation or integration into the existing machine controller) must be observed.
- The tests must be carried out by specialist personnel or specially qualified and authorised personnel and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time by third parties.
- The operating instructions must be made available to the user of the machine where the UE440/470 is fitted. The machine operator is to be instructed in the use of the device by specialist personnel and must be instructed to read the operating instructions.
- The external voltage supply of the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204. Suitable power supplies are available as accessories from SICK (Siemens type series 6 EP 1).

2.5 Environmental protection

The compact safety controller UE440/470 has been designed to minimise environmental impact. It uses only a minimum of power and natural resources.

➢ At work, always act in an environmentally responsible manner.

2.5.1 Disposal

Disposal of unusable or irreparable devices should always occur in accordance with the applicable country-specific waste-disposal regulations
(e.g. European Waste Code 16 02 14).

Note We would be pleased to be of assistance on the disposal of this device. Contact your local SICK representative.

2.5.2 Material separation

ATTENTION

Material separation may only be performed by specialist personnel!

Exercise care when disassembling the devices. The danger of injury is present.

Before you can turn over the devices for environmentally-friendly recycling, you must separate the different materials of the UE440/470 from one another.

➢ Separate the housing from the remaining components (especially the PCB).

➢ Turn over the separated components to their respective recycling centres (see Tab. 2).

Tab. 2: Overview of disposal by component type

Components	Disposal
Product	
Housing	Metal recycling (steel sheeting)
PCBs, cables, plugs and electrical connection pieces	Electronics recycling
Packaging	
Cardboard, paper	Paper/cardboard recycling
Polyethylene packaging	Plastic recycling

3 Product description

This chapter provides information on the special features and properties of the UE440/470. It describes the structure and operating principle of the device.

➢ It is imperative that you read this chapter before you mount, install and commission the device.

3.1 Special features

Properties of UE440/470

- 2 EFI connections for the attachment of corresponding SICK protective devices (e.g. C4000 Standard/Advanced or S3000)
- Automatic recognition of the replacement of a device and prompt to configure the new device. This property can be de-activated. Please observe Section 8.1.1 "System self-check after switching on" on Page 84.
- 15 inputs for the connection ...
  - of single- or dual-channel standard sensors and input devices such as reset and EDM.
  - of single- or dual-channel safety sensors and input devices such as emergency stop, two-hand control, bypass etc.
  - of a program selector switch for the changeover between up to five different operating modes or programs.
- 8 outputs, which can be used ...
  - as single-channel control or signal outputs for downstream controllers (e.g. EPLC or others).
  - as dual-channel OSSDs (for the connection of e.g. actuators or EPLC).
  - for the connection of signal lamps.
  - as outputs for test signals for single- or dual-channel sensors or input devices, such as emergency stop.
- Configurable logic modules, e.g. logical AND/OR/NAND/NOT gates for linking of input signals
- Configurable release modules for evaluation of release criteria e.g. reset, external device monitoring (EDM) and two-hand control
- Configurable software function module for protective operation for simple configuration of safety applications, e.g. with emergency stop or bypass
- Diagnostics via 7-segment display and LEDs
- RS-232 interface for configuration and diagnostics with the Configuration & Diagnostic Software (CDS)

Special features of compact safety controller UE470 for PSDI applications

- Configurable PSDI mode software function modules for single or double break PSDI mode (also hydraulic or eccentric presses) with and without overrun monitoring
- Configurable software function module for protective operation with evaluation of machine cycle contacts
- Inputs for machine cycle contacts (TDC, BDC, SCC)

3.2 Operating principle of the device

3.2.1 Principle of the device

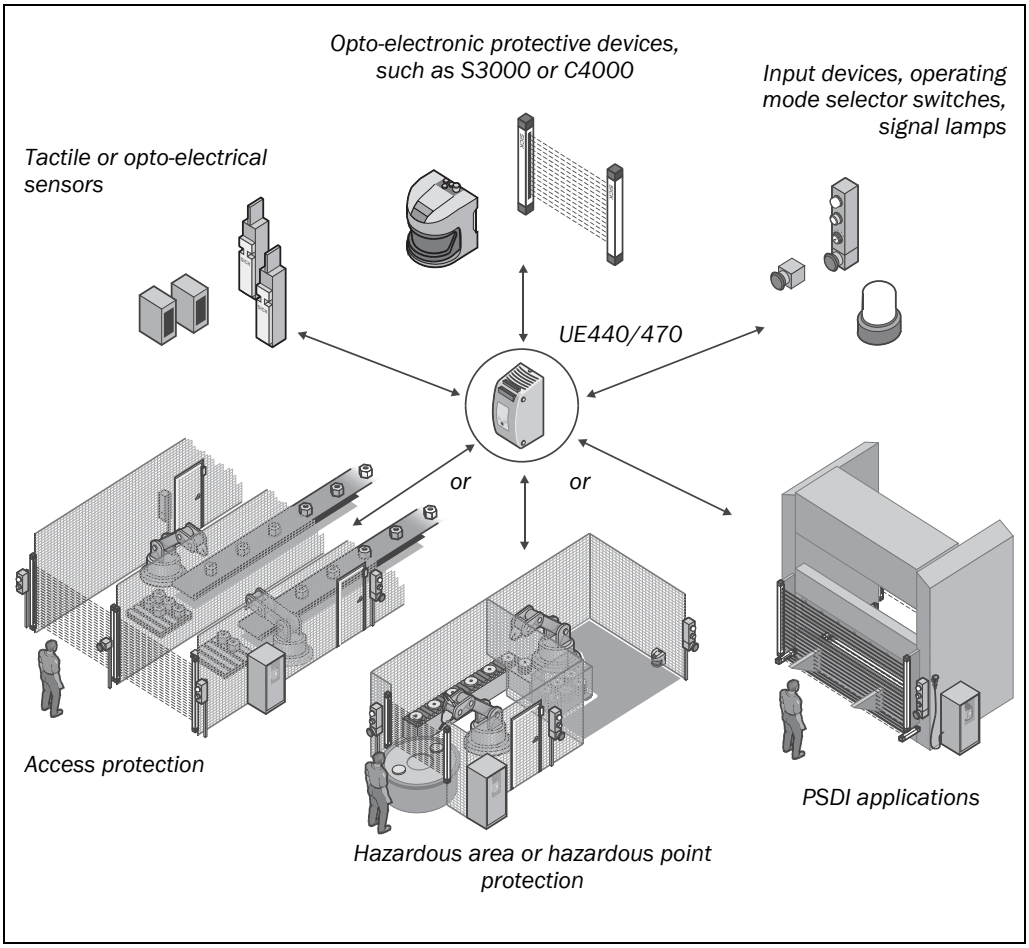
The compact safety controller UE440/470 enables easy integration of several safety and standard sensors or input devices, or actuators in a safety application. With this, you can ...

- implement individual safety applications
- implement two independent safety applications
- implement two safety applications bound to one another

Within a safety application, the compact safety controller processes specific signals of optical and tactile sensors.

The compact safety controller also expands the functions of connected systems, such as C4000 or S3000 (PSDI mode, simultaneous protective field monitoring).

Fig. 1: Principle of the device



Using the Configuration & Diagnostics Software (CDS), you can link the connected components to one another. Predefined software function modules used to implement your safety application are available in the CDS for this purpose.

Available software function modules are e.g.:

- Logical link of input signals
- Function modules for protective operation
- Function modules for PSDI mode, overrun monitoring (UE470)

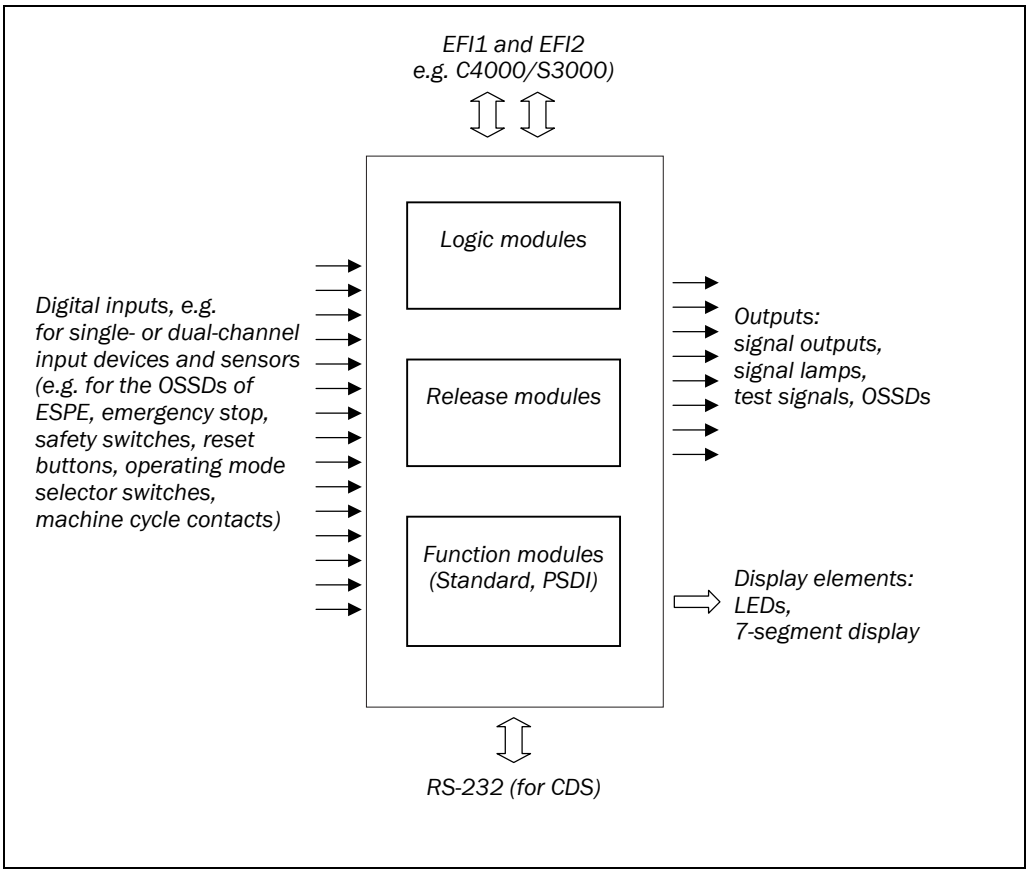


Fig. 2: Linking of inputs and outputs

3.2.2 Connectable devices

- Contact-based sensors and input devices e.g.:
  - Single- or dual-channel emergency stop input device
  - Single- or dual-channel input devices
  - Two-hand input device, dual-channel
  - Key-operated switch for bypass
  - Reset button
  - External device monitoring
  - operating mode selector switch/program selector switch
  - Switch for switching monitoring fields at S3000 and for operating mode switching at C4000
  - Teach-in key-operated switch for teaching in blanked areas with C4000
  - Machine cycle contacts TDC, BDC, SCC (with UE470)

Note Sensors must be active HIGH.

- ESPE e.g.:
  Can be connected via OSSD:
  - S300 and S3000 safety laser scanners
  - PLS safety laser scanner
  - C4000 safety light curtain
  - FGS safety light curtain
  - C2000 safety light curtain

– M4000, M2000 or MSL multiple light beam safety devices[1)]
– V4000 sensor system

As from CDS 3.5.0 and firmware V3.00 the following devices can additionally be connected via EFI:

– UE4140 (PROFIsafe)
– UE1840 (Ethernet)
– UE1140 (PROFIBUS)
– UE1940 (CANopen)
– M4000 multiple light beam safety device
– S300 safety laser scanner

Sensors that can be tested:

– WSWE12-2D460
– WSWE27-2F460

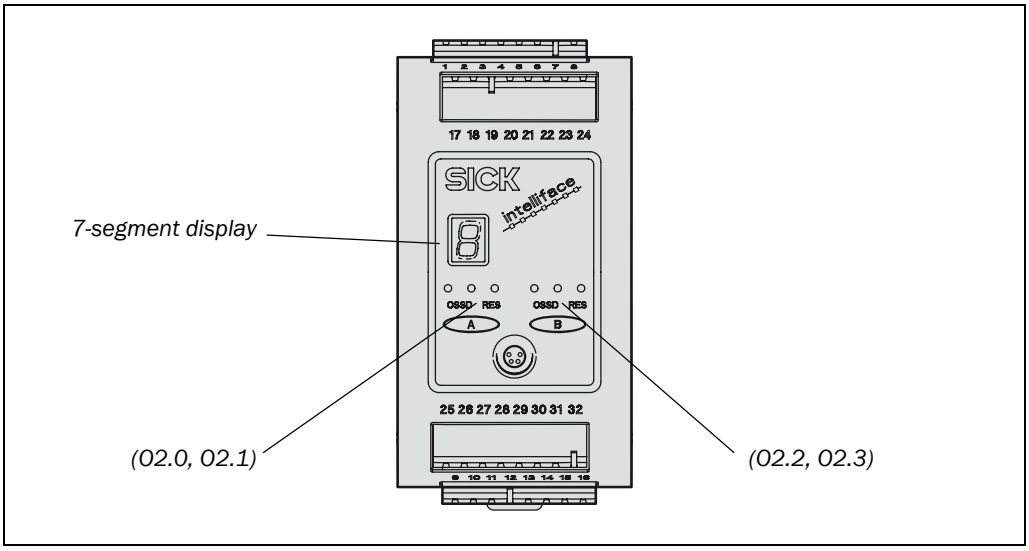
- Signal lamps e.g.:
  – for "Waiting for PSDI interruption"
  – for "Reset required"

3.3 Display elements

3.3.1 LEDs and 7-segment display

The LEDs and 7-segment display indicate the operational status of the UE440/470. They are found on the front of the compact safety controller.

Fig. 3: Status indicators of the UE440/470



The LEDs are grouped into two blocks. The left block indicates the conditions of outputs 02.0 and 02.1, and the right block deals with outputs 02.2 and 02.3. If the dual-channel outputs are used as OSSDs, they have the following meaning:

[1)] If an MSL-Z or MSL is connected uncoded to the safety controller, the input delay has to be set to at least 10 ms. Please note that this results in a change of the response time of the UE440/470 (also refer to Section 11.1 "Response times of OSSDs A and B" on Page 96).

Tab. 3: Meaning of the LEDs of the left block (A)

Display	Meaning
● **red**	OSSD (02.0 AND 02.1) switched off
● **green**	OSSD (02.0 AND 02.1) switched on
☼ **yellow**	Reset of the application configured above in the CDS required

Tab. 4: Meaning of the LEDs of the right block (B)

Display	Meaning
● **red**	OSSD (02.2 AND 02.3) switched off
● **green**	OSSD (02.2 AND 02.3) switched on
☼ **yellow**	Reset of the application configured below in the CDS required

ATTENTION

Avoid confusion by using the appropriate configuration!

Ensure that you configure the applications in the CDS in such a way that the respective yellow LED is assigned to the corresponding OSSDs and that confusion cannot occur during a reset.

If the outputs are used as control or signal outputs in a single-channel mode, they have the following meaning:

Tab. 5: Meaning of the LEDs of the left block (A)

Display	Meaning
● **green**	02.0 AND 02.1 = HIGH
● **red**	With all other conditions of outputs 02.0 and 02.1
☼ **yellow**	Reset of the application configured above in the CDS required

Tab. 6: Meaning of the LEDs of the right block (B)

Display	Meaning
● **green**	02.2 AND 02.3 = HIGH
● **red**	With all other conditions of outputs 02.2 and 02.3
☼ **yellow**	Reset of the application configured below in the CDS required

Tab. 7: Meaning of the 7-segment display

Display	Meaning
	System ready for operation
	System initialisation
	Configuration mode
	Inactive signal at the Enable input, for example emergency stop activated (contacts opened)
	Bypass active
Other displays	For all other displays, refer to the meanings in Chapter 10.4 "Displays of the 7-segment display" on Page 92.

4 Configurable functions

ATTENTION

Plan and carry out configuration carefully!

Incorrect configuration can lead to ineffectiveness of the safety function!

- The configuration of safety applications must be carried out with the greatest accuracy and must match the status and the condition of the machine or system to be monitored. Check whether the configured safety application monitors the machine or system as planned and whether the safety of a configured application is ensured at all times. This must be ensured in each operating mode/program and partial application. Document the result of this check.
- Each safety application must be checked at a specific interval. The interval is to be defined to suit the specific case dependant on the application.
- In each case, observe the instructions for commissioning and daily checking in the operating instructions of the protective devices integrated into the safety application!
- Note the warnings and function descriptions of protective devices connected to the compact safety controller! Contact the respective manufacturer of the protective device if in doubt!
- Functions such as the restart interlock, PSDI etc. can be configured in both the UE440/470 and in a device connected via EFI. The UE440/470 does not check whether or not these functions were configured with the connected devices. You must therefore check whether the configured safety application monitors the machine or system as planned.

The configurable functions of the UE440/470 are described in the following sections.

Examples for typical safety applications are found in Chapter 7 "Application and switching examples" from Page 68 and on the Internet at www.sick.com.

4.1 Base settings with the configuration wizard

The functions which you can configure using the configuration wizard are described in this section.

4.1.1 Application name

You can save an application name with max. 22 characters in the device. Use this function as a reminder.

4.1.2 Programs and program selector switch

You can configure up to five programs for your safety application(s) with the UE440/470. In each program, you can configure different links between the connected sensors and actuators and integrate the protective devices connected via EFI into the application(s). This gives you the option of matching the application(s) to the programs of the machine or system to be secured.

You can save a name for each program during configuration in the CDS. Use this function as a reminder, e.g. to describe the program.

ATTENTION

Check the protective device in every program and after every change to a program!

If you configure several programs, you must check the operation of the protective device in each of these programs. Please observe the test notes in the operating instructions of the connected protective device.

Up to two safety applications can be adapted and configured to the requirements of the respective program.

- Input elements are configured once and remain the same in each program. Signals are routed to outputs.
- Logic module, release module and function module can be configured individually for each program.
- Connections between input elements, logic module, enable module and function module can be configured individually for each program.

➢ If you do not wish to use a configured input element in one or more programs, check whether this is permissible with the application!

➢ Ensure that all connected elements are integrated in the safety application. This is especially important when it is an element critical for safety (e.g. an emergency stop or ESPE)!

Notes

- An electrical connection may only be made for programs that are in use.
- If the program is changed with activated bypass (e.g. with a changeover from program 1 to program 3) (see Section 4.2.11 "Bypass" on Page 34), bypass is deactivated and the UE440/470 switches to the new program.
- If the program is switched while teach-in via a teach-in key-activated switch connected to the UE440/470 is active, the UE440/470 first remains in the previous program (see Section 4.7 “Teach-in for C4000" on Page 50). Only after the teach-in is complete does the UE440/470 switch to the selected program and forward the information on the new program, e.g. to the C4000 Standard/Advanced, if such forwarding is configured via EFI in the CDS.
  This applies only if the program change is configured simultaneously at the UE440/470 and at a protective device connected to EFI (for example S3000 or C4000).

ATTENTION

Do not start teaching-in until all the delay times and filter times have expired!

If the operating mode is switched and the teach-in process activated while the time delay at Out2 is running, the teach-in process is carried out in the old operating mode at the C4000.

Observe the filter times in the connected EFI devices and the set filter time for the operating mode switch-over in the UE440/470.

Program change for devices connected via EFI

The status of the program selector switch of the UE440/470 can be transferred to a protective device connected via EFI.

The program selector switch can be configured in such a way that the program change of the EFI device...

- occurs at the same time as the program change of the UE440/470.
- occurs independently of the program change of the UE440/470.

With a simultaneous program change, the status of the program selector switch of the UE440/470 is transferred to an EFI device. In this case, both the UE440/470 and the connected protective device switch to another program when switching occurs.

In the case of an independent program change the status of local inputs is transferred to an EFI device.

The behaviour of the compact safety controller during a program change can be configured according to the "Program change" setting (see Section 4.1.3 "Program change via the program selector switch" on Page 20).

Notes

- When transferring the status of a program selector switch to a device connected via EFI, the same number of programs/operating modes must be configured there. Ensure that when a C4000 is connected, the same number of programs/operating modes are configured in both it and the UE440/470.
- If the status of the program selector switch is transferred via EFI to a safety laser scanner S3000, then there is a switching between the monitoring cases. The OSSD of the S3000 can remain switched on during this switch, depending on the protective field status. The behaviour of the outputs of the compact safety controller is in accordance with the "Program change" setting (see Section 4.1.3 "Program change via the program selector switch" on Page 20).
- Observe the notes on program, operating mode and monitoring switching in the operating instructions of the connected EFI devices (e.g. changeover time with S3000).

Program switching of the UE440/470 with program selector switch

The operator can switch between the programs by means of a program selector switch.

- The behaviour of the outputs of the compact safety controller is in accordance with the "Program change" setting (see Section 4.1.3 "Program change via the program selector switch" on Page 20).
- After switching, the condition of the outputs depends on the configured application and the input signals at their inputs.

As soon as you configure several programs/operating modes in the CDS, the program selector switch automatically appears in the pin assignment of the safety application. It has as many inputs as configured programs/operating modes.

Note The program selector switch must be a (1-of-n) key-operated switch.

You configure whether the program selector switch is actuated with or without testing (see Section 4.8.2 "Testing of the connected input devices and sensors" on Page 52).

The electrical connection of the program selector switch is described in Chapter 6 "Electrical installation" on Page 64.

4.1.3 Program change via the program selector switch

You can configure the type of program change in the configuration wizard.

The following settings are possible:

- Program switching
- Operating mode switching

If you configure the program change as a **switching of the operating mode**, secure deactivation of the outputs assigned to an application occurs during the changeover time.

If you configure the program change as a **switching of the program**, secure deactivation is not in effect. With few exceptions (see below) the status of the outputs is retained during the changeover time.

The setting ...

- can be executed separately for application A and application B
- applies for all configured programs

In the case of the following configurations program switching can cause the controlled output to change its status or switch off:

- Input elements assigned to outputs (outputs are deactivated for 10 – 20 ms at every program change)
- Logic modules routed to ADO (behaviour depends on the application)
- Use of inverted elements (controlled output can change its status during the program change)
- Wiring of the logic module to Input 1 (assigned output is deactivated for approx. 20 ms at every program change)

Note Wiring the logic module to the "Logic" input of the function module does **not** cause deactivation.

Activation of the program change depends on the filter time, changeover time and the delay time of the outputs.

Program switching: Secure deactivation not in effect with program change

During the changeover, the assigned outputs retain the status they had right before the changeover: one active output remains active, one passive output remains passive.

In the new program ...

- the input conditions are checked again
- a configured internal restart interlock is not taken into account if the input conditions are fulfilled after switching of the program (exception: In the new program, an application is implemented with one PSDI function module or one function block with machine cycle contact evaluation.)
- a bypass already activated in an old program or an activated two-handed input device is not active
- the application switches directly to the active state with correct input information if the restart interlock is configured externally in the new program. (exception: In the new program, an application is implemented with one PSDI function module.)

Notes

- If the delay time at Out2 has already expired with the valid detection of a new program, a program change occurs after the delay time has expired (for setting the shutdown delay of the Out2 output, see Section 4.2.12 on Page 36).
- A program change during the activation of external device monitoring (EDM) can impair error recognition. If the EDM contact has not dropped out 300 ms after an OSSD has been switched on, the UE440/470 changes to the lock-out operating mode. If the program change is carried out before the EDM contact has dropped out, a Stuck-at-HIGH at the EDM is not recognized.
- You can assign a normal and an inverted output to an input and use these outputs as information for switching the programs (I1.0 and I1.1). You can change between two programs by switching at the "control input". For this program switching the following relationship has to apply for the minimum input delay (t_{DI}):
  $t_{DI} > t_{PRC} + t_{ST} - 10$ ms
  - t_{PRC}: Input filter program change
  - t_{ST} : Switching time (at program switching 20 ms)

  Example: For a switching time of 50 ms and an input filter for the program change of 10 ms, the input delay of an input has to amount to at least 55 ms.

ATTENTION

Access briefly before or during the changeover is not detected in the normal response time! Take the increased response time into consideration!

- Comply with the applicable standards and guidelines with this setting.
- The response time for the application increases (see also Section 11.1.2 "Response times with program switching" on Page 99). The inputs are not monitored for a brief period during the changeover. Access briefly before or during the changeover is not detected in the normal response time. The changeover has the effect of an additional input filter. This is to be taken into account when calculating the response time during the changeover.
- Combination of UE440/470 with S3000 or S300:
  If switching of the program is transferred from the UE440/470 to the S3000 or the S300 via EFI and if this also reports its status to the UE440/470 via EFI, an additional response time during the switchover is to be taken into account (see also Section 11.1.2 "Response times with program switching" on Page 99).

Operating mode switching: Secure deactivation with program change

During the changeover, the assigned outputs are in standby mode: the outputs are inactive (switching voltage HIGH with inverted signal outputs. See Section 11.2 "Data sheet" on Page 103).

- In the new program, the application functions just like after switching on the voltage supply.

Note If a delay time is configured at Out2 in application A or B, a program change occurs after the delay time has expired (for setting of the delay time of the output Out2, see Section 4.2.12 on Page 36).

Input filter

A new program is detected as valid if it is stably active at the inputs for at least the duration of the set input filter time. During this time, the unit remains in the old program.

The settable input filter time is obtained from the CDS.

Changeover time

With the changeover time, you define the duration for switching operating modes.

The settable changeover time is obtained from the CDS.

Notes

- The changeover time is not in effect with the "program switching" configuration.
- If you require a minimum deactivation time with operating mode switching (e.g. for connected contactors), configure a sufficient amount of time.

Special case

For applications which fulfil both of the following criteria, the internal processing times of the compact safety controller contained in Sections 11.1.1 „Examples“ and 11.1.2 „Response times with program switching“ do not apply:

- Application B is linked to application A.

  and

- Activating application B leads to the deactivation of application A.

This is why the following internal processing times of the compact safety controller must be assumed for calculation of the changeover time for this application:

- In "normal mode": 20 ms
- During program switching: 45 ms

4.1.4 Checking of the device parameters at the EFI interfaces

The UE440/470 checks the devices connected to the EFI interfaces at every voltage reset. The following parameters can be compared with those stored during starting up:

- Type code: A device of the same type is expected
- Serial number: A device with the same serial number is expected
- Configuration date: A device with a configuration that was carried out during starting up is expected.

4.2 Protective operation

To configure the functions described below, you must position a function module for protective operation in the CDS. Two function modules are available for protective operation:

- Standard function module
- Standard function module with machine cycle contact evaluation (UE470)

The function modules for protective operation can have the following inputs:

Tab. 8: Possible inputs of the function modules for protective operation

Input	Effect
Input 1	If an ESPE connected to this input or a switch connected to the input switches off, the outputs Out1 and Out2 are switched off. For information on evaluating the machine cycle contacts please refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on page 42 and Section 6.2.8 "Machine cycle contacts" on page 62.
Logic	If a logic module connected to this input supplies the link result logical 0, the outputs Out1 and Out2 are switched off. For information on evaluating the machine cycle contacts please refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on page 42 and Section 6.2.8 "Machine cycle contacts" on page 62.
Bypass	If a key-operated switch for bypass connected to this input is actuated, the outputs Out1 and Out2 are forced high connected. No activation or a de-activation of the bypass function is carried out in case of de-activation by the Enable input. For information on connecting a key-operated switch for bypass please refer to Section 6.2.6 "Key-operated switch for bypass" on Page 61.
Enable	If, e.g., an emergency stop input device connected to the Enable input is actuated, the outputs Out1 and Out2 are switched off. For information on connecting an emergency stop input device please refer to Section 6.2.4 "Single-channel emergency stop" and Section 6.2.5 "Dual-channel input devices and sensors" from Page 60 on.
Release	If a release module connected to the input releases the application (see Tab. 9), the outputs Out1 and Out2 are activated, depending on the respective status of its other inputs. This is only the case, however, if the device connected to the UE440/470 and integrated at the Enable input is **not** actuated.
Bottom dead centre BDC	If the contact is active, the "Input 1" input is muted. For information on evaluating the machine cycle contacts please refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on page 42 and Section 6.2.8 "Machine cycle contacts" on page 62.

Input	Effect
Overrun monitoring SCC	If the contact is exceeded when the machine is stopped (contact is opened), the UE440/470 switches to the lock-out operating mode. For information on evaluating the machine cycle contacts please refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on page 42 and Section 6.2.8 "Machine cycle contacts" on page 62.
Top dead centre TDC	If the contact is activated, the outputs of the function module are deactivated. For information on evaluating the machine cycle contacts please refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on page 42 and Section 6.2.8 "Machine cycle contacts" on page 62.

If a release module is configured, it checks the release conditions (e.g. actuation of the reset button or external device monitoring) when the application is started or after the assigned outputs are switched off. The output of the release module signals a logical 1 (releases) when the necessary input criteria are met (AND link) at **all the inputs used**.

Tab. 9: Possible inputs of the release module

Input	Input criterion
Reset	A reset button connected to the release module was actuated (signal sequence 0-1-0 present).
Start	An input device connected to the release module, for example a two-handed one, has been actuated (signal sequence 0-1 active). Reset (if present) always has priority over Start. Reset initialises the application; only then is Start accepted.
EDM1 (Out1)	An external device monitoring connected to the release module reports the contactor's dropout (logical 1 present). For information on connecting the external device monitoring refer to Section 6.2.11 "External device monitoring (EDM)" on page 64.
EDM2 (Out2)	An additional external device monitoring connected to the release module reports the contactor's dropout (logical 1 present). For information on connecting the external device monitoring refer to Section 6.2.11 "External device monitoring (EDM)" on page 64.
Application B	An output of application B connected to the release module outputs logical 1 (application B is not deactivated). **Note:** If an output of application B connected to this input supplies the link result logical 0, release for application A is unnecessary. If you have configured a function module, outputs Out1 and Out2 are deactivated.
Logic	A logic module connected to the release module outputs logical 1.

ATTENTION

Take into account the possible Logic levels when using Protection, Release and PSDI function modules!

At least one input of the module has to be assigned. Unused inputs are not evaluated.

4.2.1 Electro-sensitive protective equipment

EFI connections

The UE440/470 has two EFI connections for safe SICK device communication. You can connect protective devices, which also have EFI connections (e.g. S3000 or C4000 Standard/Advanced), to these connections. The UE440/470 can communicate with the connected protective devices via the EFI interface (evaluate/transfer status information).

You configure whether you connect a protective device (e.g. S3000 or C4000) at both EFI inputs and the status information which is accepted from the protective device and the information which is transferred to the protective device. You can, for example ...

- accept the information from the protective device via the protective fields.
- transfer the status of a program selector switch connected to the UE440/470 to the protective device. In this case, a different operating mode/program is switched to when switching occurs, both with the UE440/470 and the connected protective device.
- transfer the status of a Teach-in key-operated switch connected to the UE440/470 to a C4000.

Notes

The status information which can be accepted from the protective device or transferred to it depends on the respective protective device (e.g. S3000 or C4000).

When transferring the status of a program selector switch to a device connected via EFI, the same number of operating modes/programs must be configured there. [2)]

ATTENTION

When determining the safety distance of the protective devices, take the response times of the OSSDs into consideration!

If the OSSD status of a connected protective device is accepted via EFI and used in the compact safety controller to switch off their OSSDs, the response time of the OSSDs of the compact safety controller increases due to the transfer of the OSSD status via EFI. This increases the required safety distance S of the safety device(s) (see also Chapter 11.1 "Response times of OSSDs A and B" on Page 96). [3)]

ATTENTION

Take into account a Lockout condition of the EFI device when integrating the status information!

If the EFI Status Information is processed by the UE440/UE470, please take into account that the OSSDs of the UE440/470 can be active even though the EFI device is in Lockout. Make sure that the BIT information „IO-Error-Status“ is processed as well.

The electrical connection of the EFI connections is described in Chapter 6 "Electrical installation" on Page 65.

Dual-channel inputs for the OSSD of ESPE

You can configure up to seven dual-channel inputs for ESPE (electro-sensitive protective equipment), in addition to the EFI connections, for the UE440/470. You connect the OSSD of ESPE to these.

The electrical connection of the ESPE connections is described in Chapter 6 "Electrical installation" on Page 65.

[2)] A C4000 transmitter connected via the EFI connection to the UE440/470 switches off briefly when connecting to/exiting the CDS software. The activated OSSDs switch off at the C4000 receiver.

[3)] A C4000 transmitter connected via the EFI connection to the UE440/470 switches off briefly when the online monitor is called up and exited.

4.2.2 OSSDs of the UE440/470

You can configure up to two dual-channel OSSDs as outputs for the UE440/470. The OSSDs are short-circuit proof[4] and cross-circuit monitored.

If the compact safety controller switches to the lock-out operational status (see Section 10.1 "In the event of faults or errors" on Page 90), the configured OSSDs are switched off.

4.2.3 Signal output (ADO)

You can configure up to eight signal outputs (ADO) for the UE440/470. With the aid of the respective signal output, the compact safety controller can signal specific states. You can use this output for a relay or a PLC, for example. Two outputs can be operated inverted.

Note If an inverted signal output is configured, it is in standby mode (= HIGH) during the switch between two operating modes.

ATTENTION

You may not use the signal output for safety-relevant functions!

You are only allowed to use the signal output for signalling.

You must never use the signal output for controlling the application or with safety-relevant functions.

With inverted signal outputs, heed that a missing input condition (e.g. emergency stop) leads the signal output to switch to logical 1. With a lock-out (see Page 89) all outputs switch to logical 0.

In calculation of the response time, the input filter time is to be taken into account.

The electrical connection of the signal outputs is described in Chapter 6 "Electrical installation" on Page 66.

4.2.4 Devices and sensors

Single-channel input devices and sensors

You can configure up to 15 connections for single-channel input devices and sensors.

ATTENTION

The single-channel inputs are only approved for safety functions if the following conditions are met!

- The cables are to be installed in accordance with the category to be used, according to EN 954-1; e.g. protected installation, single sheath with shielding etc.
- Single-channel connected protective devices of the controller category 2 according to EN 954-1 are to be configured and connected with testing (see Page 52).

For a single-channel input device or a single-channel sensor, you configure ...

- whether testing is to occur constantly (see Page 52)
- whether an input delay is necessary (see Page 52)

The electrical connection of the single-channel input devices and sensors is described in Chapter 6 "Electrical installation" on Page 59.

[4] Applies for voltages in the range of 0 V to +30 V

Dual-channel input devices and sensors

You can configure up to seven connections for dual-channel input devices and sensors.

For a dual-channel input device or a dual-channel sensor, you configure ...

- whether you evaluate both channels of the input device or sensor complementary or equivalent (see Page 51)
- whether N/C contacts or N/O contacts are to be evaluated in case of equivalent evaluation
- whether testing is to occur constantly (see Page 52)
- whether an input delay is necessary (see Page 53)
- whether a discrepancy time is necessary (see Page 53)

The electrical connection of the dual-channel input devices and sensors is described in Chapter 6 "Electrical installation" on Page 59.

4.2.5 Two-hand control

With the Two-hand control function of the unit, two-handed input devices can be evaluated in accordance with Standard EN 574, Type III/C. Simultaneous switching of two dual-channel complementary inputs is monitored.

The output of the two-handed element is activated as soon as both input pairs are active, i.e. both switches are actuated on the two-handed input device. The output is deactivated as soon as one of the two input pairs becomes inactive.

The time between the actuation of the first and the second switch (activation of the first and second input pair) may not be longer than 0.5 sec. If both input pairs do not switch simultaneously, the 9 fault message appears in the 7-segment display.

In case of a Stuck-at-High error or an activated two-hand input during switching on, the 7-segment display also shows the message 9.

You can configure connections for two-handed switching. Use the four-channel input element to this purpose. The output of the two-handed input element can, for example, be wired to the release module, the function module for protective operation or the logic module of partial application A or B (for connection possibilities see CDS).

The electrical connection of the two-hand control is described in Chapter 6 "Electrical installation“ on Page 60.

4.2.6 Emergency stop

With the Enable input, stop category 0 or 1 can be implemented in accordance with EN 418. You can, for example, connect single- or dual-channel emergency stop reset devices.

You can configure one emergency stop input device at the Enable input for each safety application. The operation of an emergency stop reset device has the following effect:

- If **no** shutdown delay is configured for the Out2 output, the compact safety controller switches off the OSSDs connected to it in accordance with stop category 0.
- If **a** shutdown delay is configured for output Out2 (see Chapter 4.2.12 "Shutdown delay of output Out2" on Page 36), the OSSD connected to it switches off in accordance with stop category 1.
- The 7-segment display shows 11.

Note A de-activation at the Enable input switches off the Out1 and Out2 outputs, also at an activated bypass.

ATTENTION

Pay attention to the way in which the emergency stop function at the Enable input works!

An emergency stop input unit integrated in the safety application switches off all outputs belonging to the safety application.

An emergency stop input device for the safety application implemented with the UE440/470 may only be connected to the UE440/470. Connection to a connected protective device is not permissible.

Take into account the response time of the emergency stop function. The response time of the emergency stop function is increased by an input delay configured for the emergency stop reset devices (see Page 53).

Check the connected emergency stop input devices regularly!

- ➢ Using organisational measures, ensure that the emergency stop input devices are actuated once after a certain interval.

  This is necessary, so that the UE440/470 can identify error conditions of an emergency stop input device which have arisen up until then. The interval is to be defined to suit the specific case dependant on the application.
- ➢ Always check whether the switching outputs on the UE440/470 are deactivated on the operation of the emergency stop input device.

Single-channel emergency stop

For a single-channel emergency stop input device, you configure ...

- whether testing is to occur constantly (see Page 52)
- whether an input delay is necessary (see Page 53)

Note You must use an N/C contact as the single-channel emergency stop input device.

The electrical connection of a single-channel emergency stop is described in Chapter 6 "Electrical installation" on Page 60.

Dual-channel emergency stop

For a dual-channel emergency stop, you configure ...

- whether you evaluate both channels of the emergency stop complementary or equivalent (see Page 51)
- whether testing is to occur constantly (see Page 52)
- whether an input delay is necessary (see Page 53)
- whether a discrepancy time is necessary (see Page 53)

Note With equivalent input evaluation, an emergency stop input device with two N/C contacts must be used.

The electrical connection of a dual-channel emergency stop is described in Chapter 6 "Electrical installation" on Page 60.

4.2.7 External device monitoring (EDM)

The EDM checks whether the contactors connected to an OSSD of the UE440/470 are in the correct state when the protective device responds. If you activate external device monitoring, the UE440/470 checks the contactors cyclically after each switch-off of the assigned OSSD and before the machine is restarted. With this, the EDM can identify if one of the contacts has fused, for instance. In this case ...

- the error message 8 appears in the 7-segment display
- the assigned OSSD of the compact safety controller remains switched off
- the compact safety controller uses the flashing **LED** **yellow** to signal "Reset required" with the internal restart interlock activated

Note If the system is unable to change to a safe operational status (e.g. after contactor failure), the system locks and shuts down completely (see "The lock-out operating status" on Page 90). The 7-segment display will then show the error message 8.

There is no contactor monitoring (EDM) during Bypass.

Connection of the external device monitoring

You can configure up to four connections for external device monitoring.

Notes

- Note the assignment of both connections for external device monitoring for the OSSDs. The release module required for implementation of external device monitoring (see Page 37) has two inputs for external device monitoring (EDM1 (Out1) and EDM2 (Out2)). The following assignment applies: EDM1 ↔ Out1; EDM2 ↔ Out2.

  Example: You switch off a machine via the OSSD connected to output Out1 of the function module. You then connect its external device monitoring to the connection for EDM attached to input EDM1 (Out1) of the release module.

- Wire the EDM and the UE440/470 in the same control cabinet.

The electrical connection of the external device monitoring is described in Chapter 6 "Electrical installation" on Page 64.

4.2.8 Reset interlock

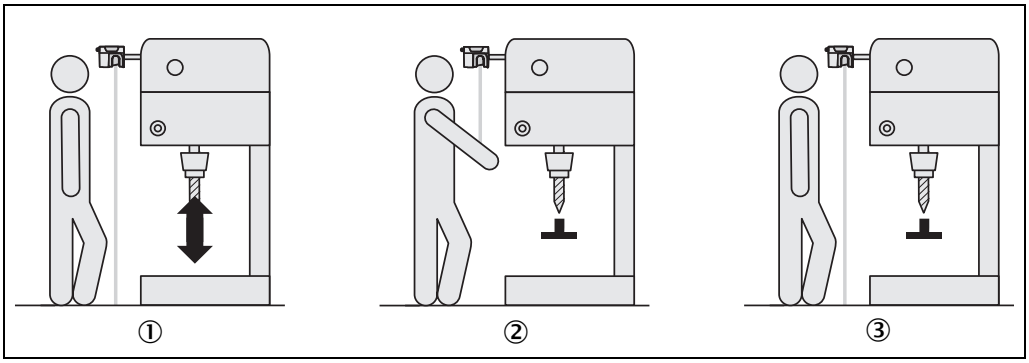


Fig. 4: Schematic presentation of operation with reset interlock

If you have configured a restart interlock, the dangerous condition of a machine ① or system is interrupted ② via switching off one or both OSSDs of the UE440/470 and is not released again ③. The OSSD is not released again until the operator actuates the reset button.

Note Do not confuse the restart interlock with the starting interlock on the machine. The starting interlock prevents the machine starting up after being switched on. The restart interlock prevents start-up of the machine, e.g. after an error, a light path interruption (e.g. of a C4000 or S3000) or the actuation of a connected input device.

The restart **interlock** can be implemented in two different ways:

- With the internal restart interlock of the UE440/470:
  The outputs of the UE440/470 are released after the connected reset button is actuated if the remaining initial conditions are also in effect (see Section 4.2.14 "Release of the application with a release module" on Page 37).

With the machine control's **external** restart interlock:
A reset button connected to the UE440/470 does not influence the machine restart. When all input conditions are fulfilled, the outputs of the UE440/470 are reactivated.

Note The start behaviour of the machine is, for example, influenced by the configuration of the Reset **and** Start inputs at the release module (see Section 4.2.10 "Start behaviour" on Page 32).

The possible combinations are shown in the following table:

Tab. 10: Permissible configuration of the restart interlock

Restart interlock of the UE440/470	Restart interlock of the machine	Permissible application
Deactivated	Deactivated	Only if it is not possible to stand behind the protective device (e.g. a light curtain). Observe EN 60204-1!
Deactivated	Activated	Only if an off delay is not configured in the UE440/470 or the supervisory machine control acknowledges the command to switch off.
Activated	Deactivated	Only if it is not possible to stand behind the protective device (e.g. a light curtain). Observe EN 60204-1!
Activated	Activated	All. Restart interlock of the UE440/470 handles the reset function (see "Reset" below).

ATTENTION

Safety notes

- Ensure that the person who actuates the reset button can fully see the hazardous area.
- Attach the Reset button so that it cannot be actuated by a person located in the hazardous area.
- The safety application must be configured with restart interlock if the protective field can be exited via the hazardous area and if it is not possible to see a person at any point in the hazardous area! Check whether exiting of the protective field via the hazardous area can be prevented via a physical structure, if necessary.
- Note the warnings and function descriptions for restart of protective devices connected to the compact safety controller!

Reset

If you want to activate the restart interlock on the UE440/470 (internal) and also a restart interlock on the machine (external), then each restart interlock gets a reset button.

After actuating the reset button for the internal restart interlock (providing the initial conditions are in effect) ...

- the UE440/470 switches the OSSD(s) on

○ red, ● green, ○ yellow

- the neighbouring LED of the respective OSSD illuminates green

The external restart interlock prevents the machine from restarting. The operator must also actuate the restart button of the machine control after resetting the UE440/470.

ATTENTION

Ensure that the proper sequence is followed!

The machine control must be implemented in such a way that the machine only starts up again when the UE440/470 is reset and the restart button of the machine control is then pressed.

Reset button

You can evaluate a maximum of two reset buttons.

Notes

- You must use a single-channel N/O contact as the reset button.
- The operator must *press* and *release* the reset button to trigger the function (LOW-HIGH-LOW sequence evaluation).

The electrical connection of a reset button is described in Chapter 6 "Electrical installation" on Page 61.

"Reset required" signal lamp

You can define up to two "Reset required" signal lamps. The connected signal lamps flash at 1 Hz if all initial conditions for switching on again are in effect after the assigned OSSDs of the UE440/470 were switched off.

The electrical connection of a "Reset required" signal lamp is described in Chapter 6 "Electrical installation" on Page 66.

4.2.9 Machine cycle start condition (Start input)

You can configure the way the Start input is to behave for the release in the element wizard of the release module. The behaviour of the Start input is not dependent on the settings of the restart interlock. Two settings are possible:

- Start with rising edge/Stop with falling edge
- Start with rising edge and lock

4.2.10 Start behaviour

When the input conditions for the release of the outputs of the UE440/470 are fulfilled, the configuration of the Reset and Start inputs at the release module influence the start behaviour of the machine.

The input conditions for the release of the outputs of the UE440/470 or for the start of the machine can be, e.g:

- Enable input not activated/not configured
- Condition at Logic input of function module fulfilled (signal = 1) or not configured
- Input 1 with valid signal, e.g. "1" with an ESPE (see Section 4.3.1 "Function module start behaviour" on page 38).
- Condition at Application B input of release module fulfilled (signal = 1) or not configured
- EDM in correct output position or not configured
- "Reset required" output of release module is activated

The start behaviour depends on the configuration of the Reset and Start inputs. The following combinations are possible:

Tab. 11: Machine start behaviour

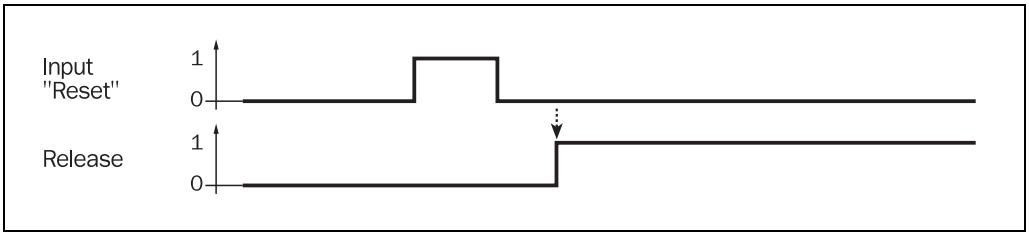
input Reset/configuration restart interlock	**input Start/start behaviour configuration**	**Machine start dependent on input**
With restart interlock (internal)	Input not configured	Reset
With restart interlock (internal)	Start with rising edge/Stop with falling edge	Reset, then Start
	Start with rising edge and lock	
Without restart interlock (external)	Start with rising edge/Stop with falling edge	Start
	Start with rising edge and lock	
Without restart interlock (external)	Input not configured	–
No release module configured		

Notes

- Take the following behaviour into account: If the connected sensors and the UE440/470 have different switch-on times after the supply voltage has been applied, an unintentional positive edge (LOW-HIGH transition) may arise at the input if the output of a sensor becomes active after the UE440/470. An application start can be triggered.
- Observe the "Function module start behaviour" setting ESPE (see Section 4.3.1 "Function module start behaviour" on page 38) regardless of the configuration of the release module. In the "Manual mode" setting, the activation of input 1/Start must occur after the Reset input.

With restart interlock (internal)/reset input

Fig. 5: Reset signal progression



If the Reset input is configured, the following signal sequence at the Reset input is required for the release of the module. LOW-HIGH-LOW.

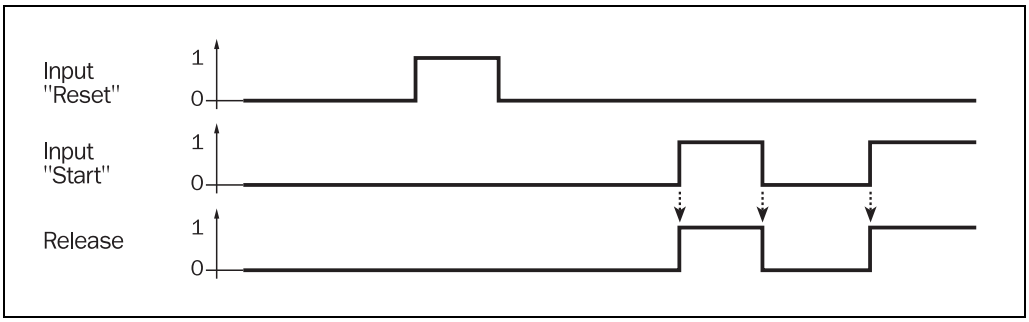
The module is released 100 ms after the negative edge.

With restart interlock (internal)/Reset and Start inputs

If the Reset and Start inputs are both configured, the signal progression for the release of the function module depends on the "Machine cycle start behaviour" setting.

The sequence of the two signals for the release is specified. Reset must occur first, then Start.

Fig. 6: Reset and Start signal progression (1)

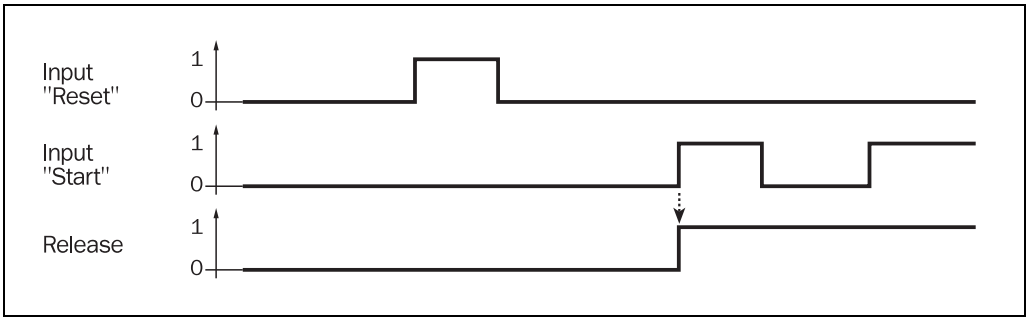


If the **Start with rising edge/Stop with falling edge** setting is configured for the machine cycle start behaviour, the following signal progression at the Reset input is required at the input: LOW-HIGH-LOW.

The Start input can be activated no earlier than 100 ms after the negative edge.

The module is released with the LOW-HIGH edge at the input. A HIGH-LOW edge cancels the release. The release can then be achieved again via a LOW-HIGH edge at the input.

Fig. 7: Reset and Start signal progression (2)



If the **Start with rising edge and lock** setting is configured for the machine cycle start behaviour, the signal progression LOW-HIGH-LOW is required at the input for the release of the function module.

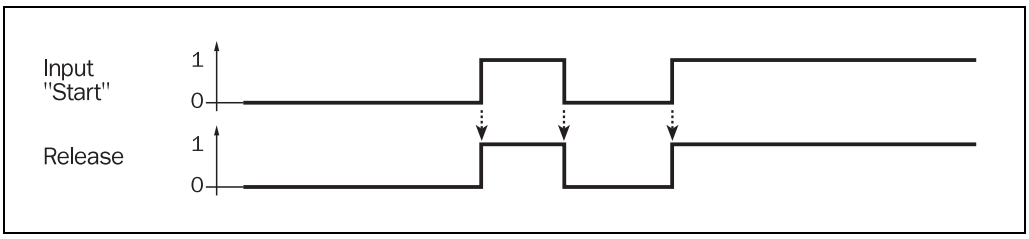
The Start input can be activated no earlier than 100 ms after the negative edge.

The module is released with the LOW-HIGH edge at the input. Additional signal changes at the Start input have **no** effect on the release.

Without restart interlock (external)/Start input

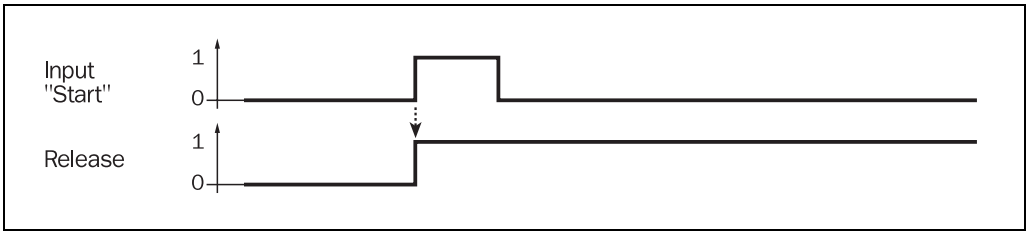
If **only** the Start input is configured, the signal progression depends on the "Machine cycle start behaviour" setting for the release of the function module.

Fig. 8: Start signal progression (1)



If the setting **Start with rising edge/Stop with falling edge** is configured for the machine cycle start behaviour, the module is released with a LOW-HIGH edge at the input. A HIGH-LOW edge cancels the release. The release can then be achieved again via a LOW-HIGH edge at the input.

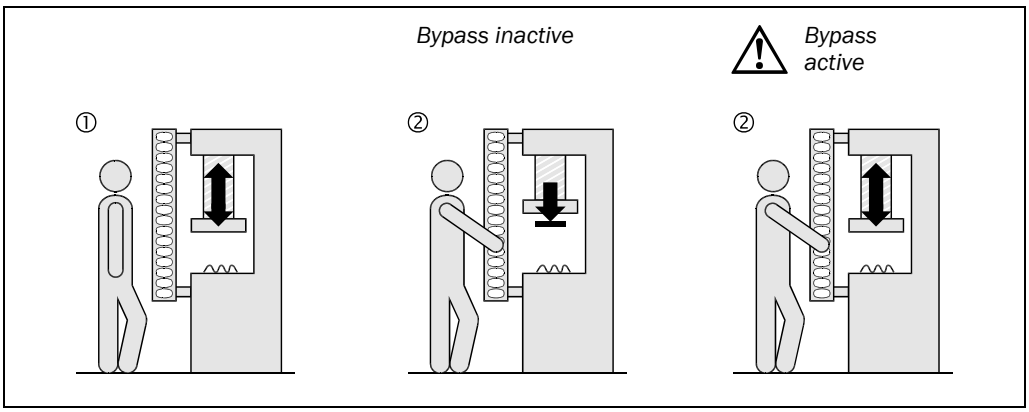
Fig. 9: Start signal progression (2)



If the setting **Start with rising edge and lock** is configured for the machine cycle start behaviour, the module is released with a LOW-HIGH edge at the input. Additional signal changes at the Start input have no effect on the release.

4.2.11 Bypass

Fig. 10: Schematic layout of the bypass function



In some applications it is at times necessary to mute the OSSDs of the compact safety controller. This could be the case, e.g. in a safe machine set-up mode, in which the machine can be operated only in jog mode. When the bypass is active, the compact safety controller displays ● **green** and the 7-segment display shows b.

ATTENTION

Switch on the machine safely when using the bypass function!

As long as the bypass function is active, the OSSDs do **not** switch the compact safety controller off (except when an emergency stop assigned in the application is actuated). You must ensure that other protective measures are activated during the bypass, e.g. the safe setup mode of the machine in order that there is no danger to persons or parts of the machine during the bypass.

The bypass function may only be activated by a key-operated switch with an automatic reset and two levels or by two input signals that are independent of each other, e.g. two position switches.

Notes

- If you implement PSDI mode with a UE470, you may not configure a bypass.
- It must be possible to view the entire hazardous point when pressing the key-operated switch for bypass.
- It may not be possible to actuate the key-operated switch for bypass in the hazardous area.
- The bypass function is not in effect until the test signals for the key-operated switch for bypass have been identified by the UE440/470 (For the test pulse rate for the signal outputs O1.0 and O1.1, see Page 103).
- 200 ms after switching off the bypass, the system is again in a safe status (latency time).
- The EDM input is not evaluated in the bypass state. All other inputs are monitored while the bypass function is in effect. The result is not visible until the bypass is deactivated.
- The compact safety controller ends bypass automatically if ...
  - the operator executes a valid program change
  - an emergency stop input device connected to the UE440/470 and assigned to the application is actuated at the Enable input
  - the lock-out operational status arises
  - a teach-in procedure for a C4000 connected via EFI is started via a Teach-in key-operated switch connected to the UE440/470
  - a teach-in procedure via a Teach-in key-operated switch connected to the C4000 is started at a C4000 connected via EFI
- The compact safety controller does **not** switch to the bypass state if ...
  - a teach-in procedure for a C4000 was already started via a Teach-in key-operated switch connected to the UE440/470
  - a teach-in procedure was already started at a C4000 connected via EFI by way of a Teach-in key-operated switch connected there
  - an assigned emergency stop input device is active at the Enable input

Key-operated switch for bypass

For the key-operated switch for bypass, you configure ...

- whether you evaluate both channels of the switch complementary or equivalent (see Page 51). With equivalent evaluation, you must use an N/O contact as the key-operated switch for bypass.
- whether an input delay is necessary (see Page 53)
- whether a discrepancy time is necessary (see Page 53)

ATTENTION

Check the connected key-operated switch for bypass regularly!

- Using organisational measures, ensure that the key-operated switch for bypass is actuated once after a certain interval.
  This is necessary so that the UE440/470 can identify an error condition of the key-operated switch for bypass or an error condition in its connection cable which occurs up until then. The interval is to be defined to suit the specific case dependant on the application.
- Constantly check in the program in which you have configured the bypass active whether the bypass function can be activated and deactivated.

The electrical connection of a key-operated switch for bypass is described in Chapter 6 "Electrical installation" on Page 55.

Bypass signal lamp

You can configure a Bypass signal lamp within the pin assignment. The connected signal lamp flashes at 2 Hz if bypass was activated.

The electrical connection of the Bypass signal lamp is described in Chapter 6 "Electrical installation" on Page 55.

4.2.12 Shutdown delay of output Out2

You can configure a shutdown delay for the **Out2** output of the function module in its element wizard. For the settable shutdown delay, refer to the Data sheet on Page 101.

If you connect output **Out2** to one of the OSSDs of the UE440/470, you can switch off a machine or system after a delay, for example. With this, you implement stop category 1 according to EN 418 for the assigned emergency stop input device (see Section 4.2.6 "Emergency stop" on Page 27).

ATTENTION

When determining the safety distance of the protective devices, take the response times of the OSSDs into consideration!

The required safety distance of the protective device(s) which switch off the machine or system via output **Out2** is increased due to the shutdown delay (see also Chapter 11.1 "Response times of OSSDs A and B" on Page 96).

Notes

If the criteria for shutting down during the time of the shutdown delay of output **Out2** are no longer relevant (e.g. because the switching off condition is no longer valid, for example in an application with interlock), the behaviour of the output **Out2** depends on the configuration of the restart interlock:

- If you have configured **one** internal restart interlock at the UE440/470, the output **Out2** switches off after the shutdown delay has passed (for example through someone entering the protective field or the switching of the operating mode), and the machine or system stops.
- If you have not configured an enable module at the UE440/470, output **Out2** does not switch off, and the machine or system continues running. An entry into the dangerous area must be avoided through additional safety measures. Additionally, take care that the supervisory machine control acknowledges the command to switch off from **Out2**.
- If you have configured an enable module with an external restart interlock at the UE440/470, output **Out1** remains de-activated until the shutdown delay has expired. Output **Out2** is de-activated for approximately 25 ms after the shutdown delay has expired.

Note The shutdown delay of **Out2** is 5 ms shorter than configured at an operating mode switch-over.

4.2.13 Linking the input elements to logic modules

Using the logic modules, you can link the signals of the input elements (input devices and sensors) with one another logically. In this way, it is possible to, for example, have ESPE and several safety switches influence the OSSDs of the UE440/470.

The following logic modules, for example, are available:

- OR gate
- AND gate
- NAND gate
- NOT gate
- NOR gate
- XOR gate

ATTENTION

Never link safety-relevant input elements in such a way that their effectiveness is compromised!

For example, do not generate OR links between safety switches which are to switch off the OSSDs. Otherwise, both safety switches must have actuated to cause switch-off.

With inverted signal outputs, heed that a missing input condition such as lockout or a wire breakage, leads the signal output to switch HIGH.

ATTENTION

Do not use inverting elements (e.g. logic or input elements) at edge-controlled inputs (e.g. Start, Input 1)!

The use of inverting elements can cause the application to be activated unintentionally or not to switch off during the switching-on process and during a program change.

You can configure two logic modules per program/operating mode (one per safety application).

With a logic module, you configure the number of gate inputs. You can configure two to eight inputs.

4.2.14 Release of the application with a release module

You require a release module in an application, for example, if you would like to implement a restart interlock or external device monitoring. If a release module is configured, it checks the release conditions of the inputs connected to the release module when the application is started or after the OSSDs are switched off.

You can configure the following settings:

- Restart interlock (see Section 4.2.8 on Page 30)
- Machine cycle start behaviour (see Section 4.2.10 on Page 32)

4.2.15 Application name

You can save an application name with max. 16 characters in the device. Use this opportunity to, for example, be able to clearly distinguish between two configured applications. Use the name of the monitored machine or system, for example. The entry is carried out in the function module.

4.3 Function module with machine cycle contact evaluation

Input 1 is muted by an activated machine cycle contact BDC. The muting can be selected and deselected for the Logic input (see Section 4.3.4 "Acceptance/Muting of logic" on Page 41).

Muting ends when the machine cycle contact for top dead centre is reached, but at the latest after 10 minutes.

ATTENTION

If a muted input (1 or Logic) becomes inactive during muting due to the machine cycle contact BDC, this does not lead to the engaging of the restart interlock!

If the machine is stopped by the machine cycle contact TDC, a subsequent input fault affects the inputs Logic and 1 differently:

- If a logic condition is violated, the effect on the restart interlock depends on whether the function block is configured with or without acceptance/muting of logic at an active BDC (refer to Section 4.3.5 "Acceptance/Muting of Logic" on Page 44):
  - **With:** Restart interlock does not latch
  - **Without:** Restart interlock latches
- If there is a signal change at input 1 (e.g. via intervention at the ESPE) and input 1 is configured in automatic mode (see Section 4.3.1 "Function module start behaviour" on Page 38), the restart interlock does **not** engage.

4.3.1 Function module start behaviour

In the element wizard of the function module, you can configure whether a signal change at input 1 is required for the machine cycle start (e.g. ESPE or two-handed input device). Two settings are possible:

- Automatic mode: automatic machine cycle start (protective device)
- Manual mode: start with rising edge (input device)

Thus, for example, a two-handed input device demands re-actuation for the cycle start, whereas no intervention is necessary with an ESPE since control can occur via the release module.

ATTENTION

Unintentional triggering of the machine start!

- The behaviour of the restart interlock is independent of the "Function module start behaviour" setting and is defined in the release module.
- Take the following behaviour into account: If the connected sensors and the UE440/470 have different switch-on times after the supply voltage has been applied and if such signals are connected to the Start input, an unintentional positive edge (LOW-HIGH transition) may arise at the Start input if the output of a sensor becomes active after the UE440/470. An application start can be triggered.
- If no release module is configured or the setting "Without restart interlock (external)" is selected in the release module and no Start input is present, the machine start can be initiated directly depending on the "Function module start behaviour" setting.

4.3.2 Acknowledgement (initialisation) of function module

You can configure how the acknowledgement (initialisation) of the protective module is to occur in the element wizard of the function module. Two settings are possible:

- With each start/machine cycle of the module
- Only with the first start/machine cycle of the module

Thus, for example, switching on, a protection fault, an emergency stop or switching of operating mode requires acknowledgement with the first start.

Acknowledgement occurs via the Reset input at the release module. The settings are only in effect with an internal restart interlock.

Notes

- The restart interlock for the Input 1 and Logic inputs do not engage in case of muting with machine cycle contact BDC.
- The restart interlock for input 1 does not engage with a machine standstill caused by exceeding of the machine cycle contact TDC and subsequent input fault.
- The restart interlock for the Logic input engages with a machine standstill caused by exceeding of the machine cycle contact TDC and subsequent input fault.
- The restart interlock does not affect the "Start" input. The start function can be implemented with this input, i.e. a configured "Start" for the cycle start must be activated, independent of the "Reset" configuration.

Acknowledgement (reset) with each start/machine cycle of the module

With this setting, a reset is required for both the machine start (first start) and for the machine cycle start (without response by the protective function).

Acknowledgement (reset) only with the first start/machine cycle of the module

With this setting, a reset is only required for the machine start (first start).

4.3.3 Machine start

An **application start** must occur under the following conditions:

- during the first start-up of the application (e.g. after operating mode switching, emergency stop, switch-on)
- after the protective function responds

A **cycle start** must be carried out after the end of the machine cycle if the outputs of the UE440/470 have a safe status and no application start is required (see above). The machine cycle is ended when the machine cycle contact TDC is reached. The Out1 and Out2 outputs of the function module are deactivated there.

Tab. 12: Machine stop/Machine start

Reasons for a machine stop (OSSDs off)	Press started by
Top dead centre is reached (contact open)	cycle start
Violation of the input condition for input 1 in the downward movement (BDC open and Out1 = 1)	application start
Violation of the input condition for the Logic input (function module) in the downward movement (BDC open and Out1 = 1)	
Violation of the input condition for the Logic input (function module) in the upward movement (BDC closed and Out1 = 1) if the muting of Logic is not activated.	
Activation of the Enable input	
Operating mode switching or program switching to an application with function module PSDI	
No requirement for the release condition of the release module (e.g. EDM fault, ...)	

Note If the Start input is used at the enable module and the single break PSDI mode, double break PSDI mode press modules are used simultaneously, the Start input is only evaluated for the application start.

4.3.4 Acceptance/Muting of logic

In the element wizard of the function module, you can configure whether the Logic input is made passive with machine cycle contact BDC activated. Two settings are possible:

- **With:** acceptance/muting of logic with BDC active
- **Without:** acceptance/muting of logic with BDC active

If the machine cycle contact BDC is closed, a "0" signal is always muted at input 1. A "0" signal at the Logic input is only muted if the corresponding setting has been configured.

Muting is coupled at the machine cycle contact BDC and ends with the BDC active no later than when the top dead centre (TDC) is reached.

If the machine is started with the BDC active, muting is **not active**. Muting is active no earlier than in the following machine cycle.

Notes

- Violation of the input condition during muting of Logic or input 1 with the machine cycle contact BDC active does not lead to engagement of the restart interlock after deactivation of the BDC.
- If the logic condition is violated by the TDC during a machine standstill, the effect on the restart interlock depends on whether the function block is configured with or without acceptance/muting of logic at an active BDC:
  - **With:** Restart interlock does not latch
  - **Without:** Restart interlock latches

  The setting also acts if the contact for the bottom dead centre is not configured!

4.4 PSDI mode with compact safety controller UE470

Notes

- PSDI mode may only be implemented with protective devices which comply with the category 4 in accordance with EN 954-1.
- PSDI mode may only be implemented with safety light curtains with an effective resolution of ≤ 30 mm during operation.
- A bypass may not be configured for the application with PSDI mode.

When configuring a UE470 in the CDS, the following function modules are available in addition to the function modules for protective operation:

- single break PSDI mode (hydraulic presses)
- double break PSDI mode (hydraulic presses)
- single break PSDI mode (eccentric presses)
- double break PSDI mode (eccentric presses)

Note Using these function modules, you can also implement all functions described in Chapter 4.2 “Protective operation” from Page 23.

The function modules have additional inputs for the machine cycle contacts (see Tab. 21 on Page 63).

4.4.1 Significance of the machine cycle contacts for PSDI mode operation

To form the PSDI mode safely and in accordance with the application, the UE470 evaluates three machine signals:

Tab. 13: Machine signals in press mode and their representation in the following diagrams

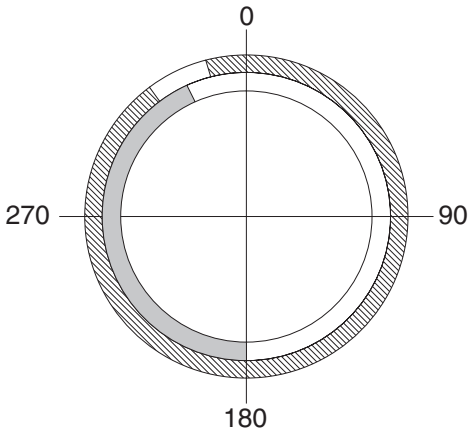
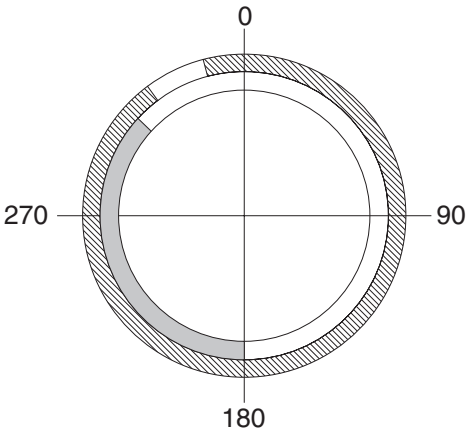
Machine signal	Representation of the HIGH input level in the following diagrams
Overrun monitoring (SCC) The evaluation of overrun monitoring is optional.	
Bottom dead centre (BDC))	
Top dead centre (TDC)	

Within the pin assignment for the UE470, you can configure one connection each for the SCC, BDC and TDC machine cycle contacts.

Without overrun monitoring the following contact arrangements are allowed:

Tab. 14: Schematic layout of the machine cycle at press mode without overrun monitoring

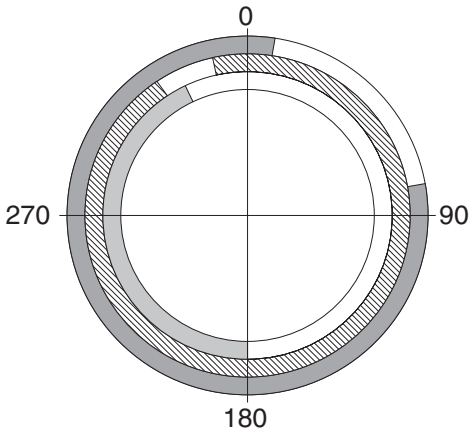
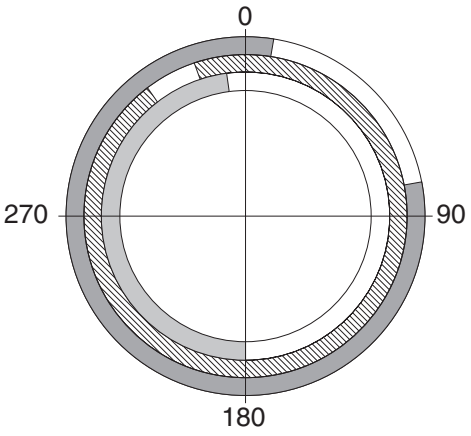
0 °: Top dead centre, 180 °: Bottom dead centre

Taking over of the BDC in the TDC	BDC and TDC not overlapping
	
Muting begins with an active BDC and ends when the TDC is reached.	Muting begins with an active BDC and ends with the inactive BDC.

With a configured overrun monitoring the following contact arrangements are allowed:

Tab. 15: Schematic layout of the machine cycle at press mode with overrun monitoring

0 °: Top dead centre, 180 °: Bottom dead centre

Taking over of the BDC in the TDC	BDC exceeds TDC
	
	Allowed for firmware version V2.24 and higher Prerequisite: • BDC is de-activated *before* the SCC is de-activated

Note The contact arrangement with non-overlapping BDC and TDC (see right-hand column in Tab. 14) is also allowed in case of press mode with overrun monitoring.

On the basis of the three machine signals, the UE470 can identify the machine's current cycle phase:

- Downward movement of the press. This cycle phase involves danger.
- Upward movement of the press. This cycle phase does not involve danger for all machines.
- Stoppage of the press. This cycle phase does not involve danger provided the input level SCC = HIGH.

Note The stopping of a hydraulic press in the downward movement usually results in a reverse movement of the press back into the TDC. This can result in a lock-out at the connected SCC.

➢ Do not connect the SCC if you use a protective module with machine cycle contact evaluation to control/monitor a hydraulic press.

The figure below clarifies the process in time with the aid of an example of the single break PSDI mode:

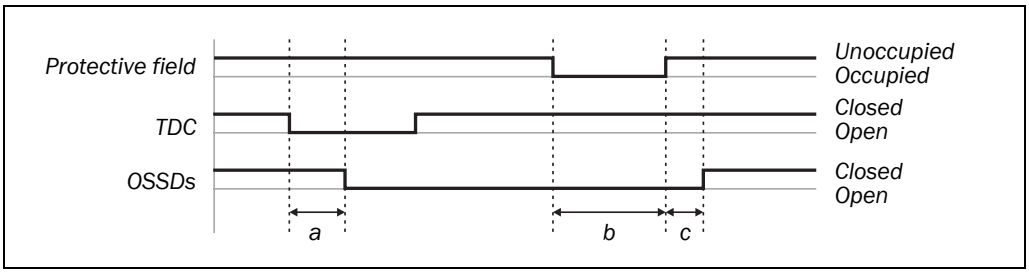


Fig. 11: Time-process diagram for single break PSDI mode

a After reaching the TDC machine cycle contact, the OSSD(s) connected to the function module switch(es) off within the response time.

b The operator reaches into the protective field for at least 100 ms. The safety control therefore recognizes the interruption as PSDI.

c Max. 200 ms after the last PSDI, the OSSD(s) connected to the function module close(s) again.

Notes The UE470 does not offer control and monitoring functions for reverse operations or single-stroke safety. In other words, the compact safety controller cannot detect any reverse movement of the machine.

Constant testing for the SCC machine cycle contact is absolutely necessary (see Page 52).

The electrical connection of the machine cycle contacts and the requirements for the contacts are described in Chapter 6 "Electrical installation" on Page 62.

4.4.2 Principle of PSDI mode

In PSDI mode, protective field interruptions are evaluated at the ESPE for control of the press sequence. The machine first waits at the top dead centre for the number of interruptions by the operator in the protective field of the ESPE which is set in the press mode type (with some presses, interruption is possible after the bottom dead centre). The compact safety controller releases the dangerous movement automatically after the number of interruptions required for the set PSDI mode type.

Single break PSDI mode

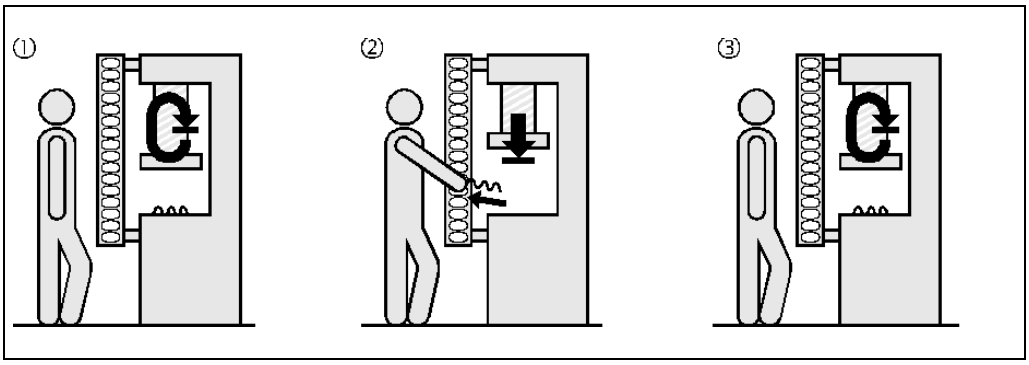


Fig. 12: Schematic layout of the single break PSDI mode

In this context, single break PSDI mode means that the compact safety controller first stops and locks movement at the top dead centre and then waits for a valid PSDI interruption in the ESPE. If the operator now interrupts in the protective field (②) and then retreats, the compact safety controller releases movement (③). If another interruption occurs during the dangerous movement, however, the compact safety controller immediately cuts off the dangerous movement.

Double break PSDI mode

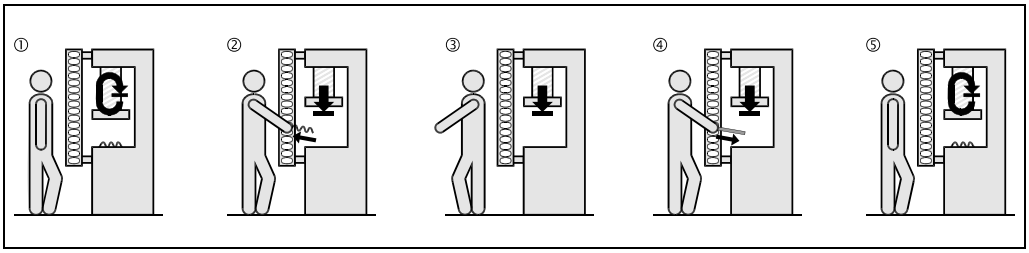


Fig. 13: Schematic layout of the double break PSDI mode

In comparison to single break PSDI mode, double break PSDI mode means that the compact safety controller stops the press after a successful run-through at the top dead centre and then evaluates two interventions within the permissible PSDI time for re-release of the dangerous movement (② and ④).

4.4.3 PSDI time monitoring

With active PSDI time monitoring, the maximum time is limited, and during this time the required number of interventions (in accordance with the set PSDI mode) must be completed. The duration of the PSDI time monitoring can be configured (see "Function data" on Page 101 in Chapter 11.2 "Data sheet").

- The PSDI time monitoring starts by the machine being stopped at the top dead centre.
- If the last PSDI intervention of a complete PSDI is not ended within the PSDI time monitoring, the OSSD(s) of the UE470 connected to the function module remain(s) switched off. The compact safety controller waits for either the actuation of the reset button or for a valid intervention, depending on the set start mode (for Sweden Mode, see also Tab. 10 on Page 30 and Tab. 16 on Page 47).

4.4.4 Start sequence (PSDI mode initiation)

Note In PSDI mode the machine start is carried out with machine cycle contact evaluation, as in protective operation, (see Section 4.3.3 "Machine start" on Page 40). However, if a "Start" enable module input is defined, the cycle start only has to be carried out at the beginning of the first cycle.

The UE470 supports three start sequences in PSDI mode:

Tab. 16: Possible start sequences in PSDI mode

		Standard	Alternative ("Sweden Mode")	Without restart interlock
Start sequence	**Requirements**	The machine cycle contact TDC must be connected.		
		The internal restart interlock of **the PSDI application (UE470)** must be activated.		The internal restart interlock of the **PSDI application (UE470)** is deactivated. An external restart interlock must be available.
	Procedure	You have just switched on the machine or have switched the machine to an operating mode with the PSDI mode.		
		➢ Reach once or twice into the protective field according to the PSDI mode. ➢ Press the reset button.	➢ Press the reset button. ➢ Reach once or twice into the protective field according to the PSDI mode.	➢ Reach once or twice into the protective field according to the PSDI mode.
		The machine runs until it reaches the top dead centre and waits there for the PSDI. A lamp connected to the "PSDI lamp“ of the PSDI module is illuminated constantly.		
PSDI cycle	**Interruption during the downward movement**	The PSDI sensor (e.g. C4000) signals the interruption. The OSSD of the UE470 switches off. The LED ● **red** of the UE470 then illuminates constantly.		
	Interruption during the upward movement	The behaviour of the UE470 depends on the PSDI control (see "Deactivation of the restart interlock during upward movement" and "Eccentric presses" below).		
	Interruption during the stopping phase	First interruption: PSDI start Last interruption: PSDI end. The UE470 switches back to green as soon as the protective field interruption is ended.		

4.4.5 Deactivation of the restart interlock during upward movement

If the upward movement of a press can be classified as not dangerous, reset interlock during this cycle phase is not necessary. In this case, you can deactivate the restart interlock during the upward movement.

If the machine cycle contacts are connected correctly, the UE470 identifies when the press is in upward movement (see Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on Page 42).

The press then stops for intrusion of a protective field during the upward movement, but starts up automatically again once the protective field is unoccupied.

ATTENTION

Prevent it from being possible for people to stand behind the protective field!

The safety application must be configured **with reset interlock** during upward movement if the protective field can be exited toward the hazardous area! Check whether exiting of the protective field via the hazardous area can be prevented via corresponding measures, if necessary.

4.4.6 Eccentric presses

Eccentric presses must not be allowed to stop at the bottom dead centre because their construction does not enable them to stop in this situation. The **1-PDSI (eccentric presses)** or **2-PDSI (eccentric presses)** function modules as well as the protective module with MCC evaluation with BDC configuration mute the protective field function after the bottom dead centre (BDC) has been reached. You must ensure that the machine cycle contact for the bottom dead centre is not made until after the end of the dangerous movement. Muting ends when the machine cycle contact for top dead centre is reached, however at the latest after the total muting time for eccentric presses (see Section 11.2 "Data sheet" on Page 101).

Note If you use the **single break PSDI mode (eccentric presses)** or **double break PSDI mode (eccentric presses)** function modules in your application, you must also connect the machine cycle contact for the bottom dead centre (BDC).

ATTENTION

Protect the machine during the mute state!

If you use the **single break PSDI mode (eccentric presses)** or **double break PSDI mode (eccentric presses)** function modules or the protective module with MCC evaluation with BDC configuration in your application, you must ensure that dangerous states cannot arise by taking suitable measures while muting is active.

Observe during execution of the BDC, e.g. standards EN 692 and EN 693.

4.4.7 Enabling the PSDI control at eccentric presses

You can enable the PSDI control in different ways.

Up to firmware version V2.23:

- **Limited:** The UE470 only evaluates interruptions within the stopping phase as a PSDI, i.e. if the machine cycle contact was made for the top dead centre (TDC) and has also fallen away again.
- **Not limited:** The UE470 also evaluates interruptions within the upward and stopping phases as PSDI if the machine cycle contact is made for the top dead centre (TDC) and has not yet fallen away again. This configuration makes higher PSDI speeds possible.

Firmware version V2.24 and higher:

- **Limited:** The UE470 evaluates interruptions within the stopping phase as PSDI, if the interruption occurs after the machine cycle contact for the top dead centre (TDC) has been reached.
- **Not limited:** In addition to the "Limited" setting, interruptions which are initiated during the upwards movement are evaluated as PSDI in as far as the counter-movement takes place after the machine cycle contact for the top dead centre (TDC) has been reached. In order for this setting to be used, an overlapping of the TDC/BDC machine cycle contacts is required. This configuration makes higher PSDI speeds possible.

ATTENTION

Limit the release of the PSDI control if the machine does not automatically stop at the top dead centre!

- ➢ If you wish to set the release of the PSDI control to "Not limited", then you must make sure at the machine side that the machine stops automatically at the top dead centre.
- ➢ For this you must always observe the standards that apply for your specific application/machine situation.

4.4.8 PSDI signal lamp

You can configure a PSDI signal lamp within the pin assignment for the UE470.

- The connected signal lamp lights up when an interruption in the protective field is expected.
- The signal lamp flashes when the counter-movement out of the protective field is possible.

The electrical connection of the PSDI signal lamp is described in Chapter 6 "Electrical installation" on Page 66.

4.5 Overrun monitoring

The purpose of overrun monitoring is to detect any failure of the machine brake at the top dead centre. The UE470 monitors whether the SCC is still closed before the stroke release, i.e. whether the machine has actually stopped at the top dead centre.

If the press exceeds the SCC before a renewed stroke release, the UE470 switches to the lock-out operating mode (see Page 90).

Note The SCC contact must be connected for overrun monitoring.

4.6 Evaluation of device-specific EFI status bits

The device-specific EFI status bits of the connected EFI devices can be evaluated or stimulated directly in the UE440/470. Thus, for example, monitoring cases in the S3000 can be changed over through the stimulation of the specific input bits of the S3000 via EFI.

The meaning of the individual EFI status bits is described in the document "Status information at the EFI connection".

ATTENTION

Ensure that the machine safety is guaranteed at all times!

If you want to stimulate the input bits of the connected EFI devices or link the output bits, you have to ensure that the machine safety is guaranteed at all times.

➢ Have a check of the protective device carried out by qualified personnel (see Section 8.3.2 "Regular inspection of the protective device by qualified personnel" on page 87).

Note You can configure in the element wizard of the EFI input and output symbols which signals are to be used by the EFI device.

4.7 Teach-in for C4000

Teach-in enables the user to easily define the size of hidden areas. This occurs by guiding objects of corresponding size to the desired position in the protective field and teaching in the object number and size. This is helpful, for example, for a tool change (for additional information, see also the operating instructions "C4000 Standard/Advanced").

To be able to use the teach-in function, the application must meet the following requirements:

- A reset button is connected to the C4000 Advanced and configured properly.
- The number and type of hidden areas and their tolerances are already configured for the C4000 using the CDS.

The teach-in can be initiated at the UE440/470 (Teach-in key-operated switch is connected to the UE440/470) or the C4000 (Teach-in key-operated switch is connected to the C4000).

- If the teach-in is initiated at the UE440/470, its OSSDs switch off during the teach-in.
- If the teach-in is initiated at the C4000, the OSSD of the C4000 switches off during the teach-in. The behaviour of the OSSDs of the UE440/470 depends on how the OSSD of the C4000 or the status information of its OSSD are integrated in the application via EFI.

Notes

- Bypass is not possible during teach-in.
- If the program/operating mode at the UE440/470 is changed during the teach-in, the teach-in procedure is completed first. The program change does not occur until after the teach-in signal is cancelled with the teach-in key-operated switch.

ATTENTION

Receive the configuration of the connected devices via the CDS after teaching has been completed at the C4000!

If you teach in again directly at the C4000 which is connected to the EFI, the C4000 configuration is then different from the C4000 configuration saved in the UE440/470. You must therefore read the modified C4000 configuration into the UE440/470 configuration.

After the teach-in, you must re-receive the configuration from the devices via the CDS for this reason.

4.7.1 Teach-in key-operated switch for C4000

You can configure an input for a teach-in key-operated switch of the C4000 Standard/Advanced. Using the teach-in key-operated switch, teach-in of the connected C4000 is initiated via EFI. Only actuation of the reset button connected to the C4000 causes the new configuration to be received in the C4000.

Notes

- The teach-in key-operated switch connected to the UE440/470 affects all C4000s connected via EFI.
- You must use an N/O contact for the teach-in key-operated switch; the input is active HIGH.

You configure whether an input delay is necessary for a teach-in key-operated switch (see Page 63).

The electrical connection of the teach-in key-operated switch is described in Chapter 6 "Electrical installation" on Page 55.

4.8 Settings for overlapping functions

4.8.1 Complementary or equivalent input evaluation

Complementary evaluation

For proper switching, one channel must always be wired in reverse in comparison to the others. The following table shows the permissible input levels of both channels.

Tab. 17: Complementary evaluation

Channel 1	Channel 2	Logical status	
		If inversion is not activated	If inversion is activated
0	0	Error	Error
0	1	0	1
1	0	1	0
1	1	Error	Error

Equivalent evaluation

For proper switching, one channel must always be wired the same in comparison to the others. The following table shows the permissible input levels of both channels.

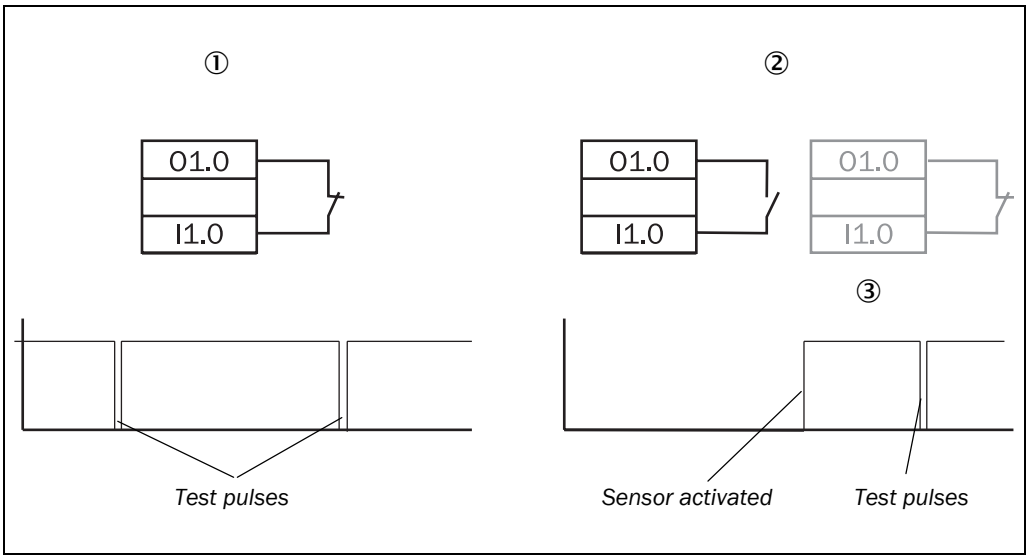
Tab. 18: Equivalent evaluation

Channel 1	Channel 2	Logical status	
		If inversion is not activated	If inversion is activated
0	0	0	1
0	1	Error	Error
1	0	Error	Error
1	1	1	0

4.8.2 Testing of the connected input devices and sensors

To ensure that the connection cables attached to the sensor are in order, a test signal is fed through the contact and evaluated at the accompanying input. The test pulse does not affect the function and evaluation of the sensor.

Fig. 14: Example for the testing of N/C contacts and N/O contacts



Input devices and sensors which are configured as N/C contacts ① are tested cyclically while they are not activated (contact closed).

Input devices and sensors configured as N/O contacts ②, are tested as soon as they are activated (③).

Notes

- Outputs O1.0 and O1.1 are used as test outputs (see Chapter 6 "Electrical installation" on Page 55).
- When connecting input devices and sensors to the UE440/470, ensure that the required category according to EN 954-1 is complied with. Use test signals, for example, or cross-circuit detecting or preventative measures.

4.8.3 Input delay

To mute bounce times of a input device or sensor, you can enter an input delay. For the settable input delay, refer to the Data sheet on Page 101.

ATTENTION

Take the input delay into consideration when switching off the monitored machine or system!

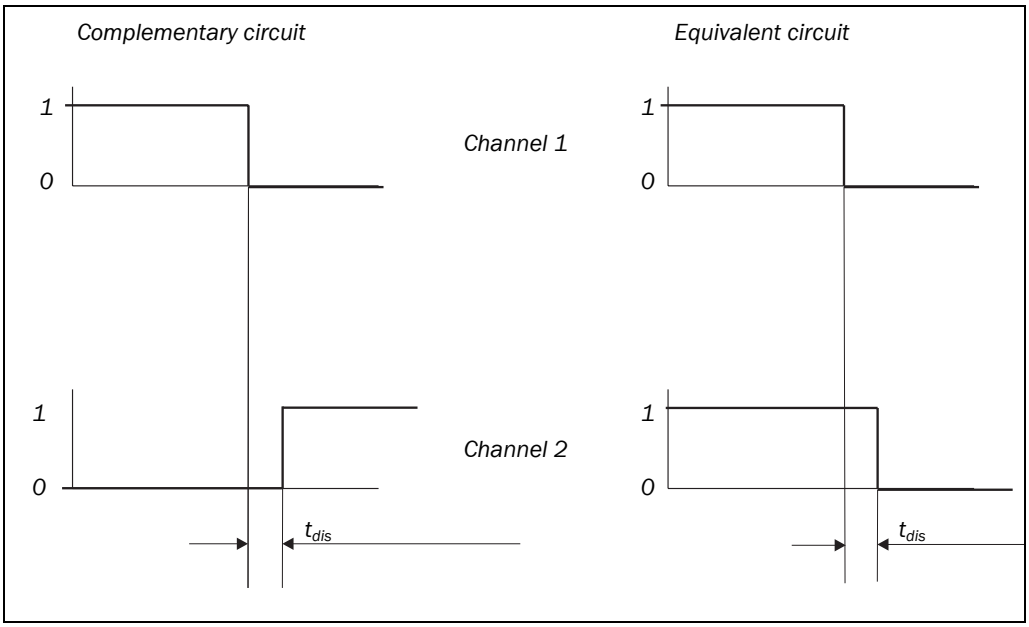
If the configured input elements effect the OSSDs, (e.g. safety switches which switch off the OSSDs of the UE440/470) the response time of the OSSDs increase by the set input delay (see also Chapter 11.1 "Response times of OSSDs A and B" on Page 96).

Note Configure an input delay of at least 5 ms at inputs with the settings "With testing", "Complementary" or "Inversion". This increases the availability of the system.

4.8.4 Discrepancy time

The discrepancy time t_{dis} is the maximum time within which both inputs of a dual-channel connection may be found in impermissible states with dual-channel connection without the compact safety controller evaluating this as an error.

Fig. 15: Discrepancy time



Monitoring of the discrepancy time starts with the first state change of the input. The compact safety controller identifies an error if after the discrepancy time has expired, both inputs of the connection ...

- are not in equivalent (the same) states with equivalent circuit
- are not in complementary (opposite) states with complementary circuit

In this case, the OSSDs of the compact safety controller are switched off and the error message c. ↻ 4. appears in the 7-segment display.

For the settable discrepancy time, refer to the Data sheet on Page 101.

Note The discrepancy time evaluation is not active until any filter time (input delay) that has been set has expired (also refer to Section 11.1 "Response times of OSSDs A and B" on Page 96).

The discrepancy time does not affect the OSSD response time.

5 Installation

The compact safety controller UE440/470 is designed for installation on a 35 mm mounting rail in accordance with EN 50022. The positioning place must at least comply with enclosure rating IP 54.

The following steps are necessary after mounting and installation:

- Completing the electrical connections (Chapter 6)
- Commissioning (Chapter 8)
- Configuration (Chapter 9)

6 Electrical installation

ATTENTION

Switch the entire machine/system off line!

The system could start up unexpectedly while you are connecting the devices.

➢ Ensure that the entire system is de-energised during the electrical installation.

Connect OSSDs separately!

➢ To ensure that the signals are safe, 02.0 and 02.1 or 02.2 and 02.3 are to be connected separately to the machine controller and the machine controller must process the two signals separately. 02.0 and 02.1 or 02.2 and 02.3 must not be connected together.

Notes

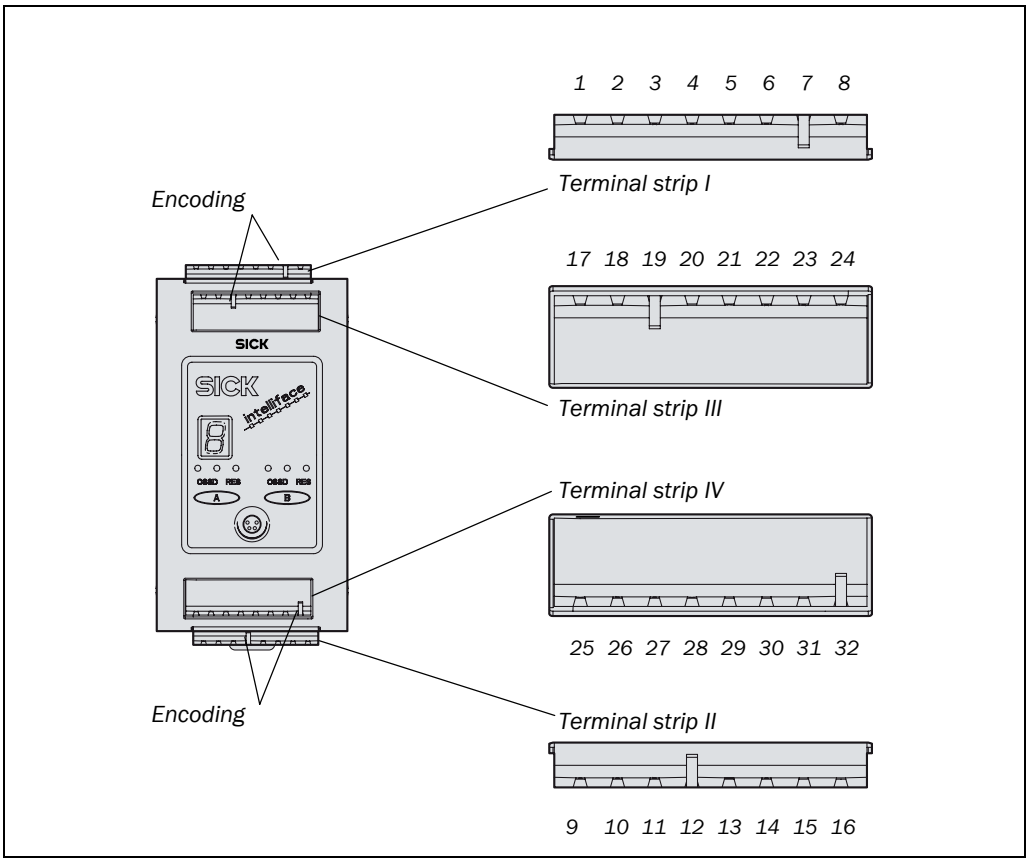
- The compact safety controller UE440/470 fulfils the EMC requirements for industrial use.
- To ensure the necessary electromagnetic compatibility (EMC), functional earthing (FE) must be connected.
- The control cabinet or assembly casing of the UE440/470 must at least comply with enclosure rating IP 54.
- You must connect the UE440/470 to the same voltage supply as the connected protective devices or gateways.
- The voltage supply of the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204-1.
- The cables of a connected reset button must be laid in separate sheathing lines.
- All connected pick-ups and downstream controllers and wiring/installation must correspond to the required category in accordance with EN 954-1 (e.g. protected installation, single sheath line with shielding etc.)
- The OSSDs and the monitoring of the motor contactors (EDM) shall be preformed inside the control cabinet.
- For sensors and input devices not requiring shielding due to their construction (e.g. safety switch, emergency stop, bypass etc.), shielding in the cable may not be connected to the FE of the UE440/470.

6.1 Connections of the UE440/470

6.1.1 System connection

The system connection has four terminal strips with eight pins each. The individual terminal strips are encoded to prevent mix-ups.

Fig. 16: Connections of the UE440/470



ATTENTION

Use only encoded connections and label them!

Dangerous faults could arise if the terminal strips are swapped and this goes undetected.

Tab. 19: Terminal assignment of the system connection

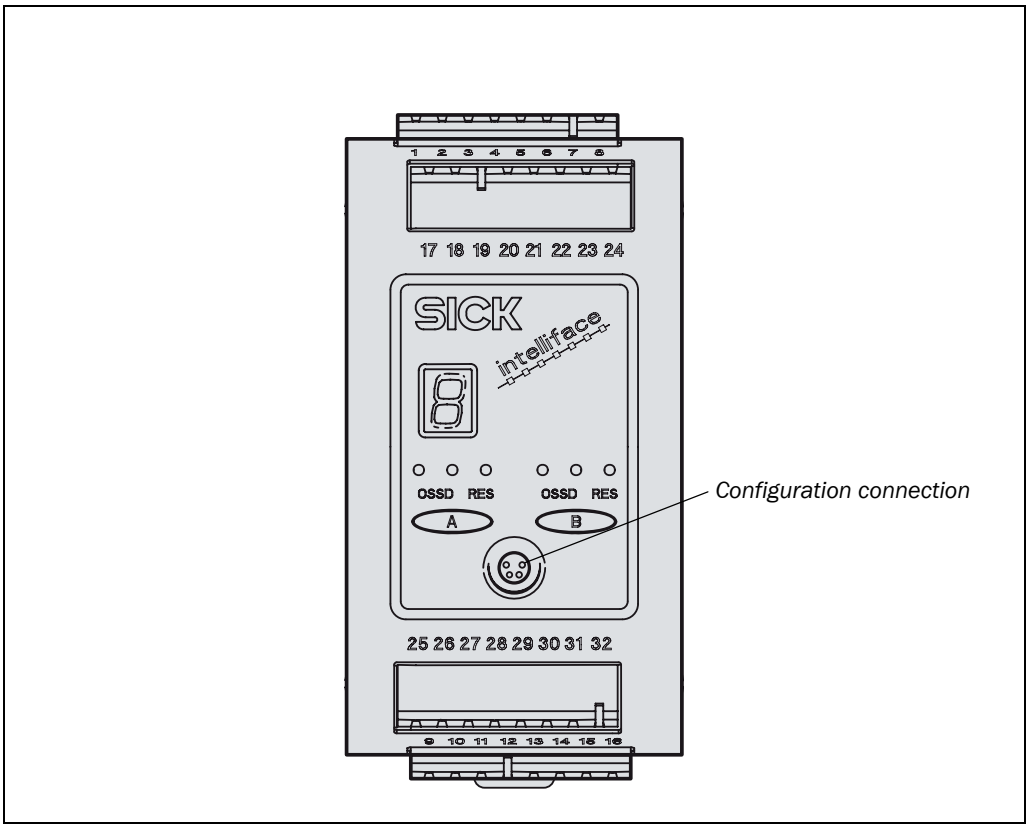
Assignment	Description	Terminal
24 V DC	V DC input (voltage supply)	1
0 V DC	V DC input (voltage supply)	2
FE	Functional earthing	3
I1.0	Input	4
I1.1	Input	5
I1.2	Input	6
I1.3	Input	7
I1.4	Input	8
I1.5	Input	26
I1.6	Input	27
I2.0	Input	30
I2.1	Input	14
I2.2	Input	32
I2.3	Input	16
I3.0	Input	17
I3.1	Input	18
I3.2	Input	19
I3.3	Input	20
O1.0	Signal output (single-channel) or can be used for test signals	21
O1.1		25
O1.2	Signal output (single-channel)	28
O1.3		12
O2.0	Signal output (single-channel) or can be used as switching output (dual-channel switch-off of a machine or system)	13
O2.1		29
O2.2	Signal output (single-channel) or can be used as switching output (dual-channel switch-off of a machine or system)	15
O2.3		31
$EFI1_B$	Device communication for ESPE or gateway via EFI	10
$EFI1_A$		11
FE	Functional earthing, for applying the shielding of devices connected to EFI1 (if shielding is necessary for EMC reasons). The FE connection of other devices is connected centrally in the control cabinet.	9
$EFI2_A$	Device communication for ESPE or gateway via EFI	22
$EFI2_B$		23
FE	Functional earthing, for applying the shielding of devices connected to EFI1 (if shielding is necessary for EMC reasons). The FE connection of other devices is connected centrally in the control cabinet.	24

Note The inputs and outputs of the compact safety controller are freely configurable to a large degree in the CDS. For this reason, use the pin assignment generated in the CDS for electrical installation.

6.1.2 Configuration connection

The configuration connection is found on the front of the compact safety controller.

Fig. 17: Configuration connection M8 × 4



Notes

- Ensure protection from static-electricity discharge before connecting the configuration cable (see Section 12.3.2 "CDS and connection cable" on Page 105).
- Always remove the plug from the configuration connection once you have completed configuration.

6.2 Connection of contact-based safety sensors

6.2.1 Single-channel input devices and sensors

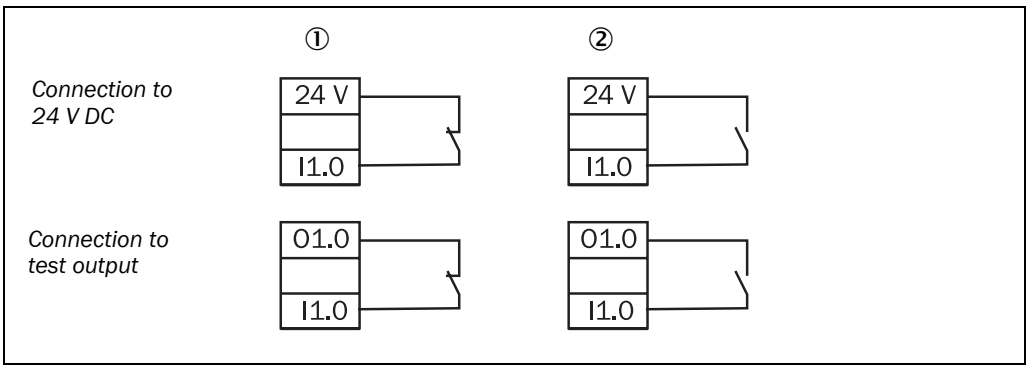
ATTENTION

The single-channel inputs are only approved for safety functions if the following conditions are met!

- The cables are to be installed in accordance with the category to be used, (EN 954-1); e.g. protected installation, single sheath with shielding etc.

You can connect several single-channel input devices and sensors to the UE440/470.

Fig. 18: Examples for the connection of single-channel input devices or sensors



You can use N/C contacts (①) or N/O contacts (②) as the input device or sensor. If you have configured input devices or sensors without testing, connect them to 24 V DC. If you have configured input devices or sensors with testing, connect them to the test outputs of the compact safety controller.

6.2.2 Dual-channel input devices and sensors

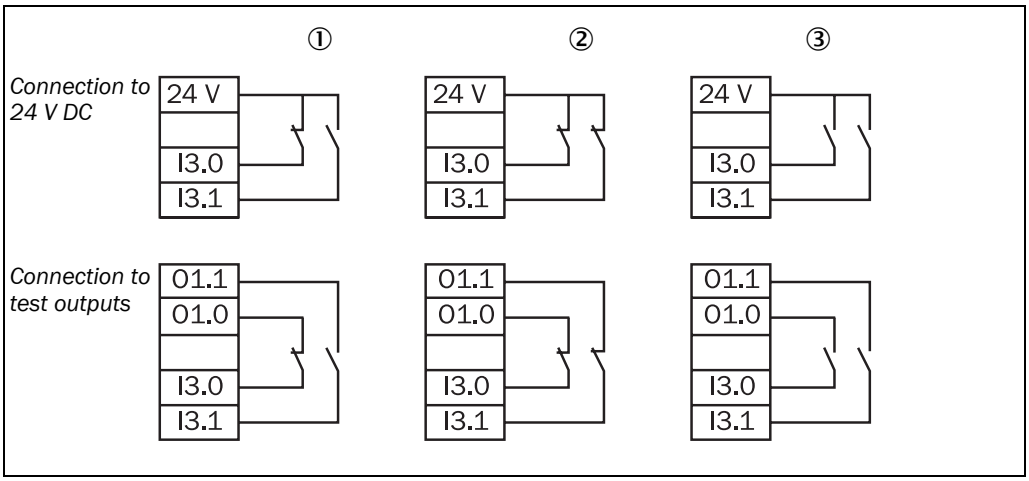
You can connect several dual-channel input devices and sensors to the UE440/470.

ATTENTION

Prevent cross-circuits with non-testable dual-channel input devices!

With non-testable dual-channel input devices and sensors, measures for cross-circuit detection must be taken at the outputs, or they must be protected from short-circuiting and cross-circuiting. These measures depend on the category to be implemented in accordance with EN 954-1.

Fig. 19: Example for the connection of dual-channel input devices or sensors

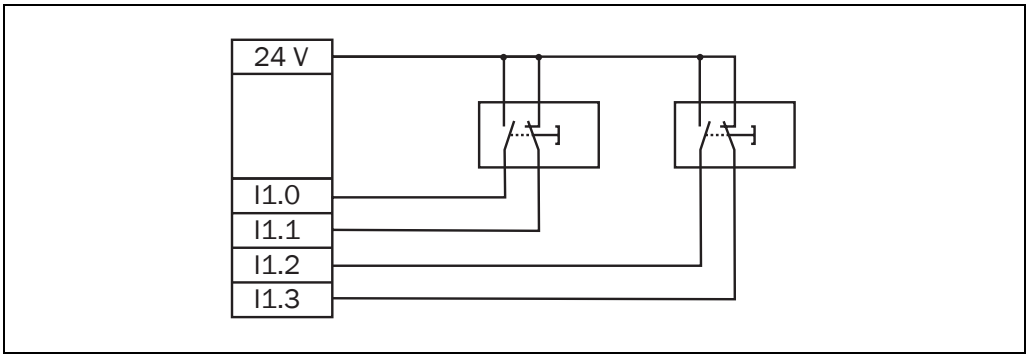


You can use complementary (①) or equivalent input devices and sensors for the input devices and sensors. You can use N/C contacts (②) or N/O contacts (③) if you use equivalent input devices or sensors. If you have configured input devices or sensors without testing, connect them to 24 V. If you have configured input devices or sensors with testing, connect them to the test outputs of the compact safety controller.

You can use N/C contacts or N/O contacts with equivalent input devices. With complementary evaluation, you decide the connection to which the N/C contact or N/O contact is attached during configuration.

6.2.3 Two-hand control

Fig. 20: Example for the connection of a two-hand control input device

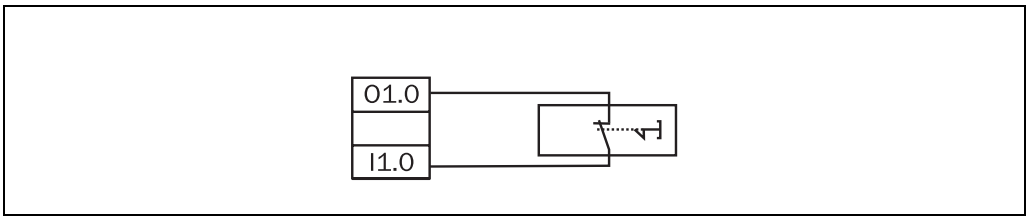


You can connect two two-hand control input devices to the UE440/470.

Use complimentary input devices, also refer to Section 4.2.5 "Two-hand control" from Page 27 on.

6.2.4 Single-channel emergency stop

Fig. 21: Example for connection of a single-channel emergency stop

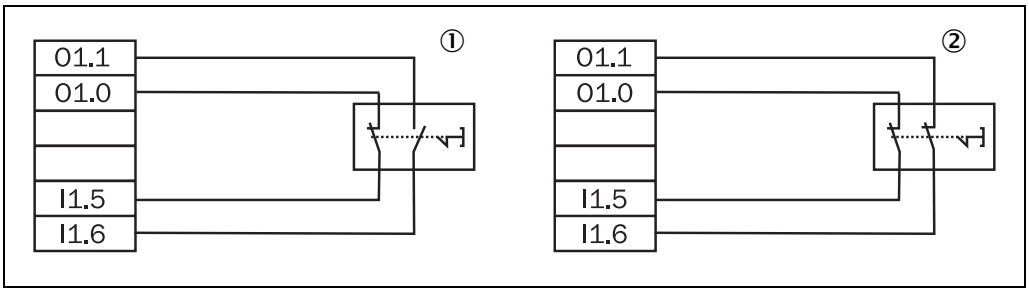


You can connect one emergency stop input device for each safety application. You must use N/C contacts for a single-channel emergency stop input device.

Note Inversion of the input element in the CDS is not permitted.

6.2.5 Dual-channel emergency stop

Fig. 22: Examples for connection of a dual-channel emergency stop



You can use a complementary (①) or equivalent (②) button for a dual-channel emergency stop input device.

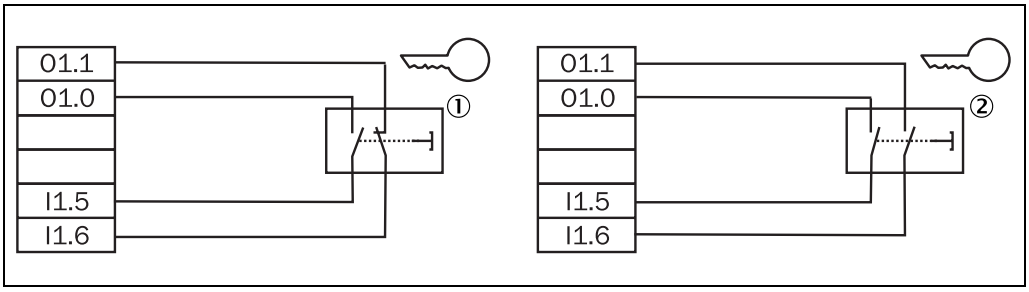
Notes

- With complementary evaluation, the N/C contact must always be connected to the first channel.
- With equivalent input evaluation, an emergency stop input device with two N/C contacts must be used.
- You can connect a dual-channel emergency stop input device for each safety application.
- Inversion of the input element in the CDS is not permitted.

6.2.6 Key-operated switch for bypass

The bypass function may only be activated by a key-operated switch with an automatic reset and two levels or by two input signals that are independent of each other, e.g. two position switches.

Fig. 23: Examples for the connection of a key-operated switch for bypass



You can use a complementary ① or equivalent ② switching key-operated switch.

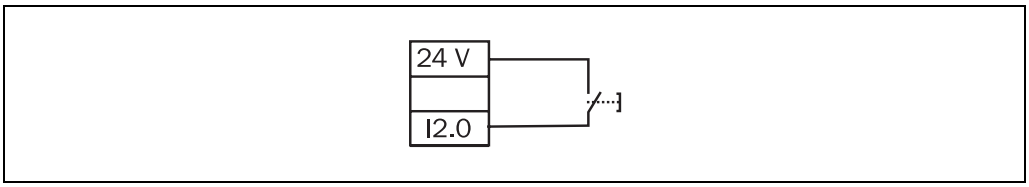
Notes

- Mount the key-operated switch for bypass in such a way that the hazardous point is completely visible when the key-operated switch is used.
- With equivalent evaluation, the contacts of the key-operated switch for bypass must be dual-channel N/O contacts.
- With complementary evaluation, the N/O contact must always be connected to the first channel.
- Inversion of the input element in the CDS is not permitted.
- The key-operated switch for bypass must have volt-free contacts.

6.2.7 Reset button

You can connect separate reset buttons for each of the two safety applications which you can implement with the compact safety controller.

Fig. 24: Example for connection of a reset button



Use single-channel N/O contacts for reset buttons.

Inversion of the input element in the CDS is not permitted.

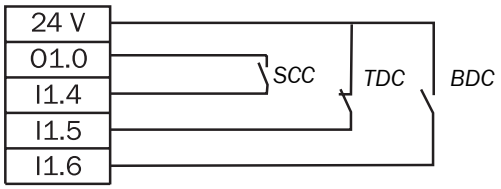
6.2.8 Machine cycle contacts

For PSDI mode, the machine cycle contact of the machine must be connected to the UE470. Depending on the PSDI mode, the UE470 can evaluate various contacts, some of which are mandatory (Tab. 20). The signals of the machine cycle contacts BDC and TDC should briefly overlap one another. For further information please refer to the diagram in Tab. 14.

Tab. 20: Necessary machine cycle contacts

Configured function	Top dead centre contact (TDC)	Bottom dead centre contact (BDC)	Overrun monitoring contact (SCC)
PSDI mode with restart interlock	■	■ (optional)	■ (optional)
PSDI mode without restart interlock	■	■ (optional)	■ (optional)
PSDI mode Alternative ("Sweden Mode")	■	■ (optional)	■ (optional)
Eccentric press mode	■	■	■ (optional)
Overrun monitoring	■	■ (optional)	■
Protective operation with MCC evaluation	■	■ (optional)	■ (optional)

Fig. 25: Connection of the machine cycle contacts



You must ensure that the machine cycle contacts meet the following criteria:

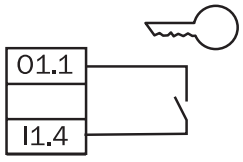
Tab. 21: Criteria for connecting the machine cycle contacts

Machine cycle contact	Criteria
Top dead centre (TDC)	• The contact is normally closed. • Inversion of the input element in the CDS is imperative. • Testing of the input elements is not permitted. • The contact must be open for at least 20 ms before reaching the top dead centre. Also refer to Section 4.4.1 "Significance of the machine cycle contacts for PSDI mode operation" on Page 42.
Bottom dead centre (BDC)	• Contact is implemented with one or two single-channel N/O contacts. • Inversion of the input element in the CDS is not permitted. • Testing of the input elements is not permitted. • The contact must be opened again at the top dead centre. • After the TDC has opened, the contact can be opened again. • In case of configuration without SCC: The contact must be opened again before the TDC is closed. • In case of configuration with SCC: The contact must be opened again before the SCC is opened (firmware version V2.24 and higher).
Overrun monitoring (SCC)	• The contact is normally open. • Inversion of the input element in the CDS is not permitted. • Testing of the input elements is imperative. • The contact must be closed when the machine is restarted. • If the TDC opens, the contact must already be closed. • The contact may be opened shortly after the machine is restarted.

Recommendation In accordance with Standard EN 692, we recommend implementing the machine cycle contact BDC with two single-channel N/O contacts. Configure a dual-channel input element in the CDS.

6.2.9 Teach-in key-operated switch for C4000

Fig. 26: Example for connection of a teach-in key-operated switch for C4000



You must use an N/O contact for the teach-in key-operated switch and connect it to a test output.

Notes
- Inversion of the input element in the CDS is not permitted.
- Testing of the input elements is imperative.
- You can also connect the teach-in key-operated switch to the C4000. More detailed information is contained in the operating instructions of the C4000 Standard/Advanced.

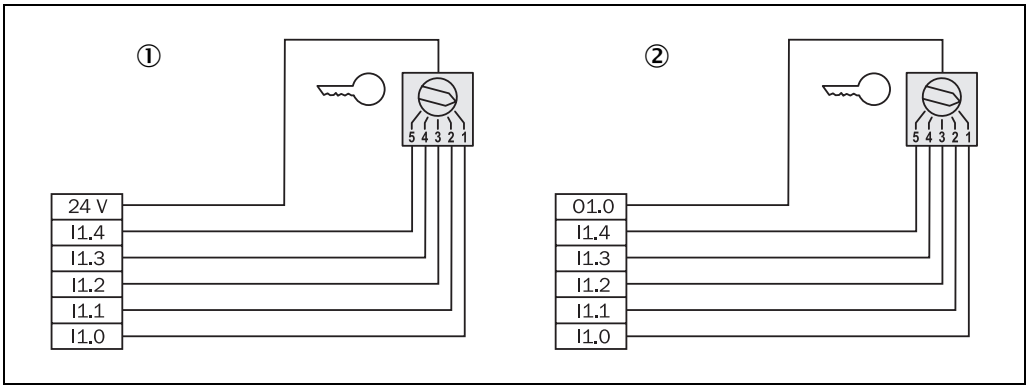
6.2.10 Program selector switch

You can connect a program selector switch for up to five programs to the compact safety controller. Using the program selector switch, you can switch between the programs/operating modes of the compact safety controller and also switch the programs, operating modes and monitoring cases of the connected protective device (e.g. the blanked areas with a safety light curtain C4000).

Note The program selector switch *must* be a key-operated switch.

Recommendation Use a program selector switch that has only the same number of switch settings that you actually need. This will help you to reduce the likelihood of operating errors.

Fig. 27: Example for connection of a program selector switch



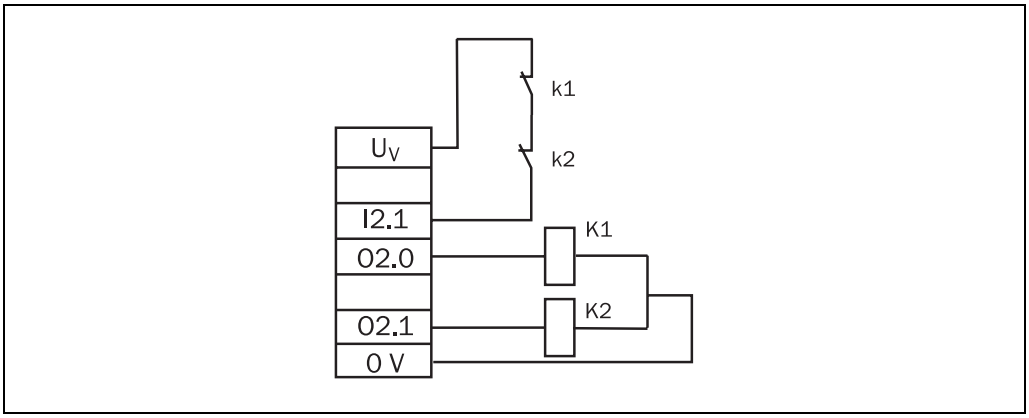
The program mode selector switch is to be connected to 24 V (①) without configured testing and to O1.0 (②) with configured testing.

6.2.11 External device monitoring (EDM)

ATTENTION

Wire the external device monitoring within the control cabinet!

Fig. 28: Example for connection of the external device monitoring



You must implement the external device monitoring electrically by the positive closing action of both N/C contacts (k1, k2) when the contact elements (K1, K2) reach their de-energised position after the protective device has responded. 24 V is then applied at the input of the EDM. If all criteria for switching on the OSSD are fulfilled and the 24 V are not connected, one of the contact elements is defective and the external device monitoring prevents switch-on of the OSSD.

Notes

- Spark-suppressing elements must be circuited in parallel to the inductivity. Circuiting parallel to the output contact is not permitted. Spark-suppressing elements extend the response time of the OSSDs depending on the type of the protective circuiting.
- If a filter time is used, the EDM time is reduced by the corresponding time. Inversion of the input element in the CDS is not permitted.

6.3 Connection of active sensors

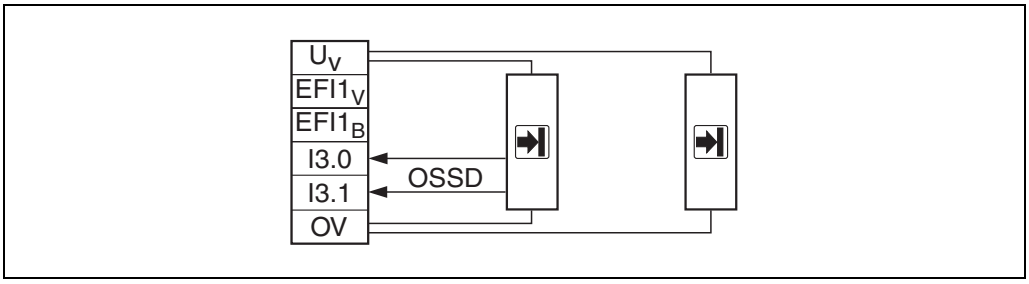
6.3.1 Electro-sensitive protective equipment

Note The UE440/470 and the connected device are supplied with power from a common source. The UE440/470 does not form the voltage supply for the connected protective devices.

You have three options for connecting ESPE to the UE440/470:

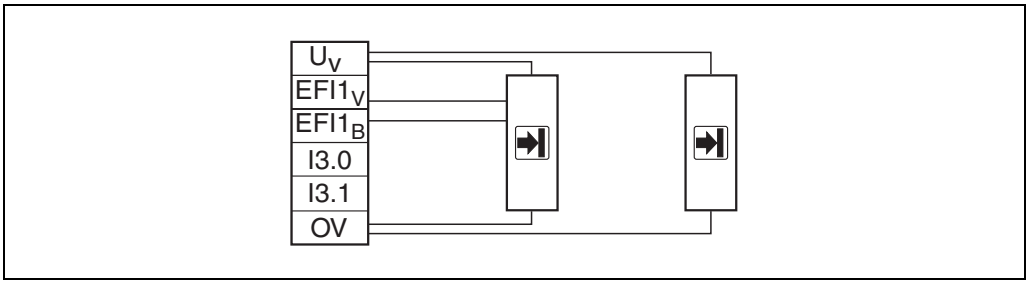
- You can connect the OSSD of the ESPE to the dual-channel inputs (see Fig. 29).
- You can connect the ESPE via EFI, and the OSSD status is passed on to the compact safety controller via device communication depending on the configuration in the CDS (see Fig. 30).
- You can connect the ESPE to the dual-channel inputs of the compact safety controller and via EFI (corresponds to SDL) (see Fig. 31). The OSSD status is passed on to the compact safety controller via the OSSD inputs, and the other status information is passed on to it (depending on the configuration in the CDS) via EFI.

Fig. 29: Example for connecting the OSSD via ESPE



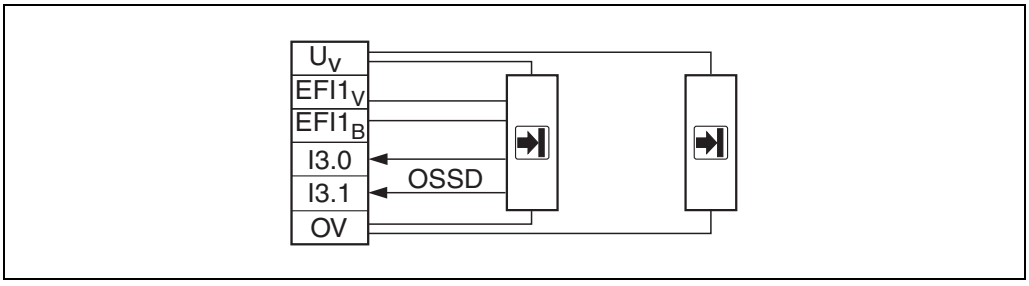
If the OSSD is included as an input element in the CDS, it is imperative that you use N/O contacts without testing and filter times. Inversion of the input element in the CDS is not permitted.

Fig. 30: Example for connection of ESPE via EFI



Note If the OSSD status is passed on to the UE440/470 via EFI, the response time of the OSSDs of the compact safety controller increases due to the transfer time. Take this into account when planning the safety distance/protective field size of the connected ESPE (see Chapter 11.1 "Response times of OSSDs A and B" on Page 96).

Fig. 31: Example for connection of ESPE via SDL

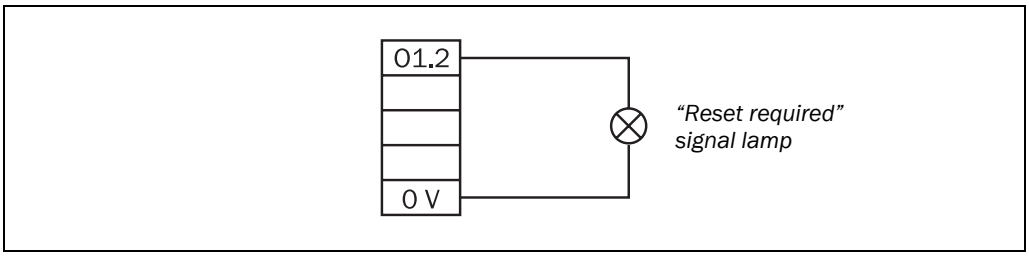


6.4 Connection to the outputs

Note Ensure that output 01.3 is monitored for wire break and current when connecting signal lamps to the outputs and when configuring signal or test outputs.
Observe the minimum current described in Section 11.2 "Data sheet" on Page 103.

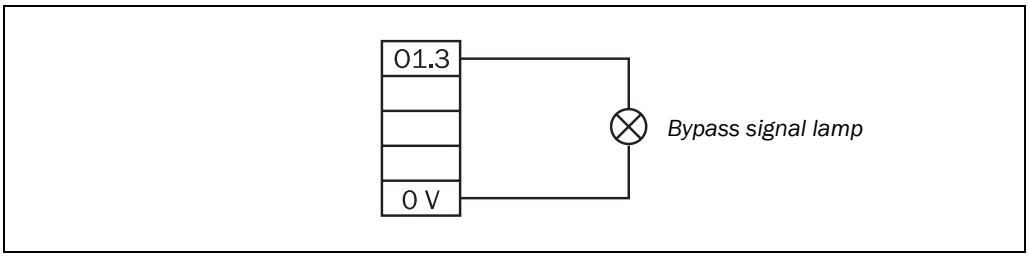
6.4.1 "Reset required" signal lamp

Fig. 32: Example for connection of a "Reset required" signal lamp



6.4.2 Bypass signal lamp

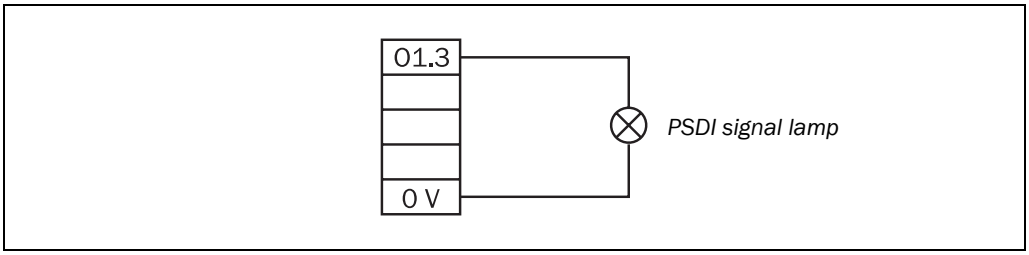
Fig. 33: Example for connection of a Bypass signal lamp



6.4.3 PSDI signal lamp

Note You can only connect a PSDI signal lamp to the compact safety controller UE470.

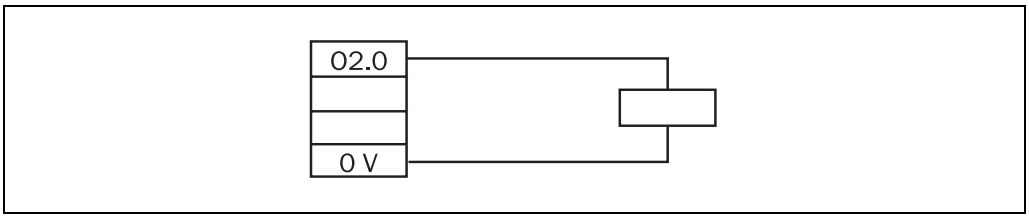
Fig. 34: Example for connection of a PSDI signal lamp



6.4.4 Signal output (ADO)

You can make various signals of the UE440/470 available at the outputs, e.g. for a relay or an EPLC.

Fig. 35: Example for connection of signal output (ADO)



6.4.5 Test outputs

The outputs 01.0 and 01.1 are used as test outputs. The example shows the connection of a single-channel and two dual-channel sensors.

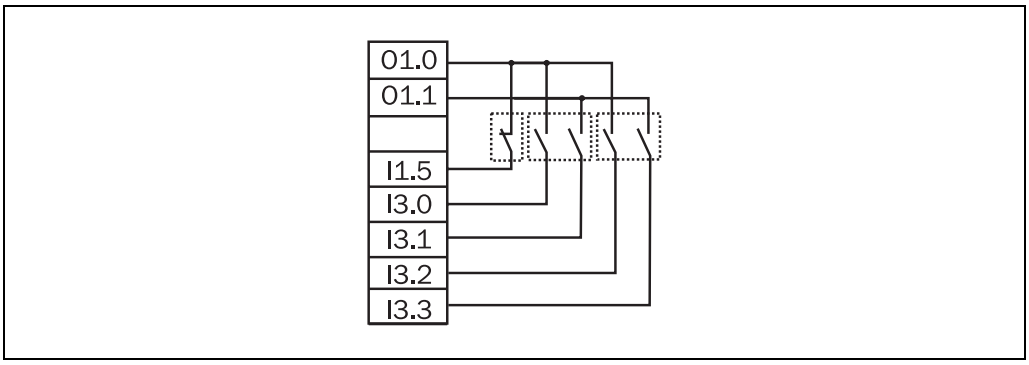


Fig. 36: Example for the connection of several sensors with testing

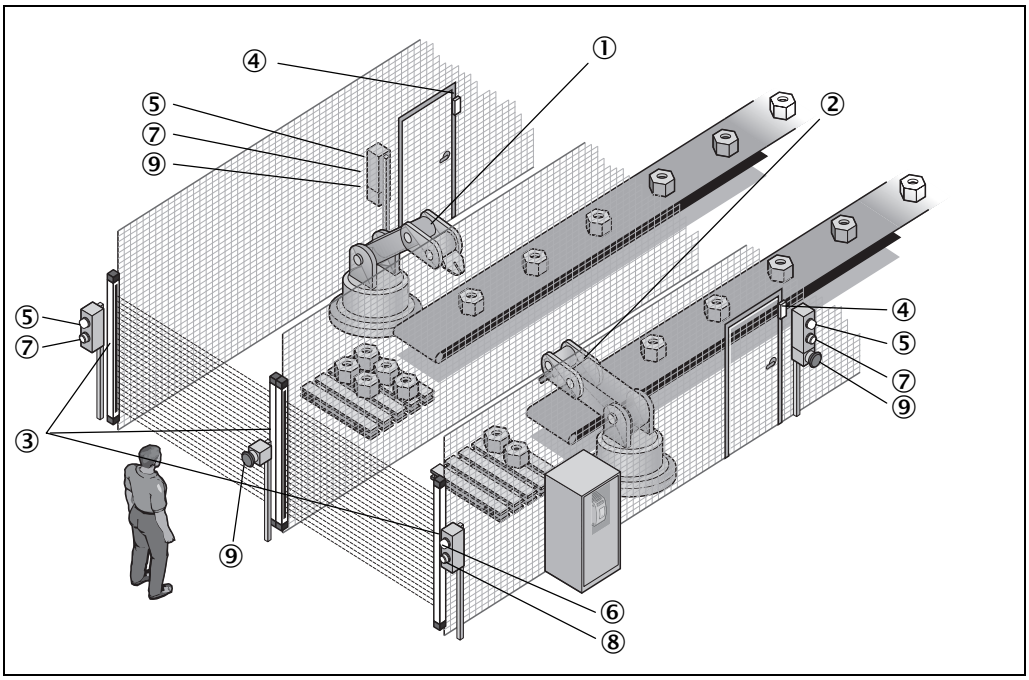
7 Application and switching examples

Note All SIL values specified for the application and switching examples are based on a temperature of +40 °C. The values in accordance with IEC 61508 refer only to the UE440/470. Please also take the PFH values of their sensors and actuators according to IEC 61508 into account for the entire application.

7.1 Access protection

7.1.1 Access protection for two robot cells

Fig. 37: Access protection for two robot cells

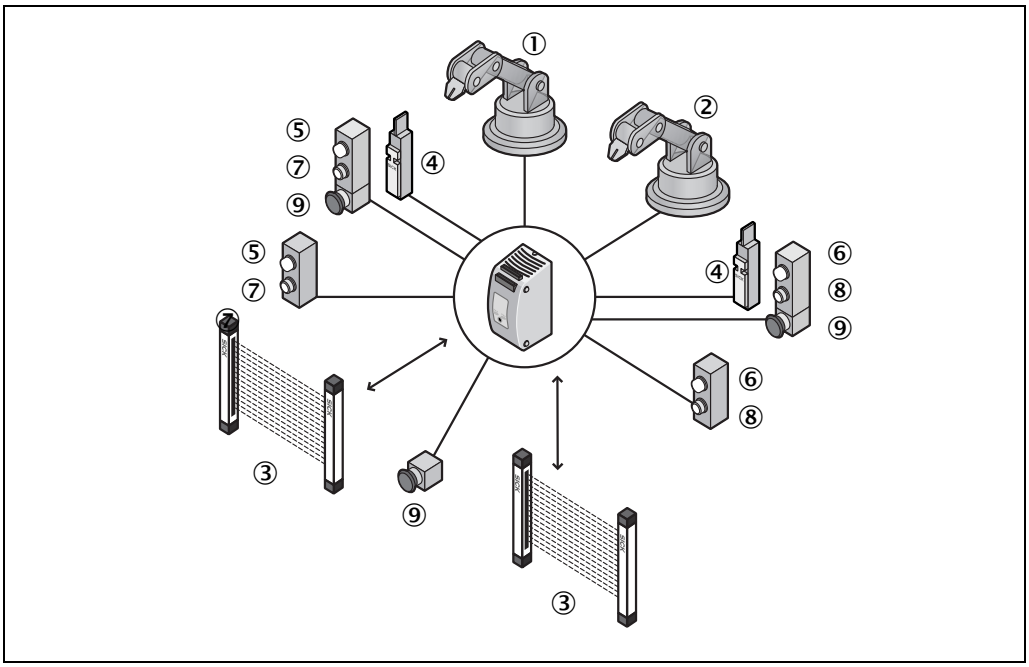


Access to two robot cells (① and ②) is secured via a UE440 with safety light curtains C4000 (③). Both C4000s are connected via EFI. Two safety applications (application A and B) were configured in the UE440. The OSSD of the respective safety application is switched off due to the interruption of a protective field. The side access doors to the robot cells are monitored by safety switches (④). If the doors are opened, the safety switches also switch off the OSSD of the respective safety application.

A restart interlock is configured for both safety applications. Two independent signal lamps (⑤ and ⑥) indicate that a reset is required after one of the robots is switched off (for ① = ⑤, for ② = ⑥). The respective OSSD of the UE440 is reactivated by actuating the connected reset button (for ① = ⑦, for ② = ⑧).

Three emergency stop input devices are connected (⑨) and switch off both safety applications (robot cells). Each emergency stop also affects both OSSDs of the compact safety controller.

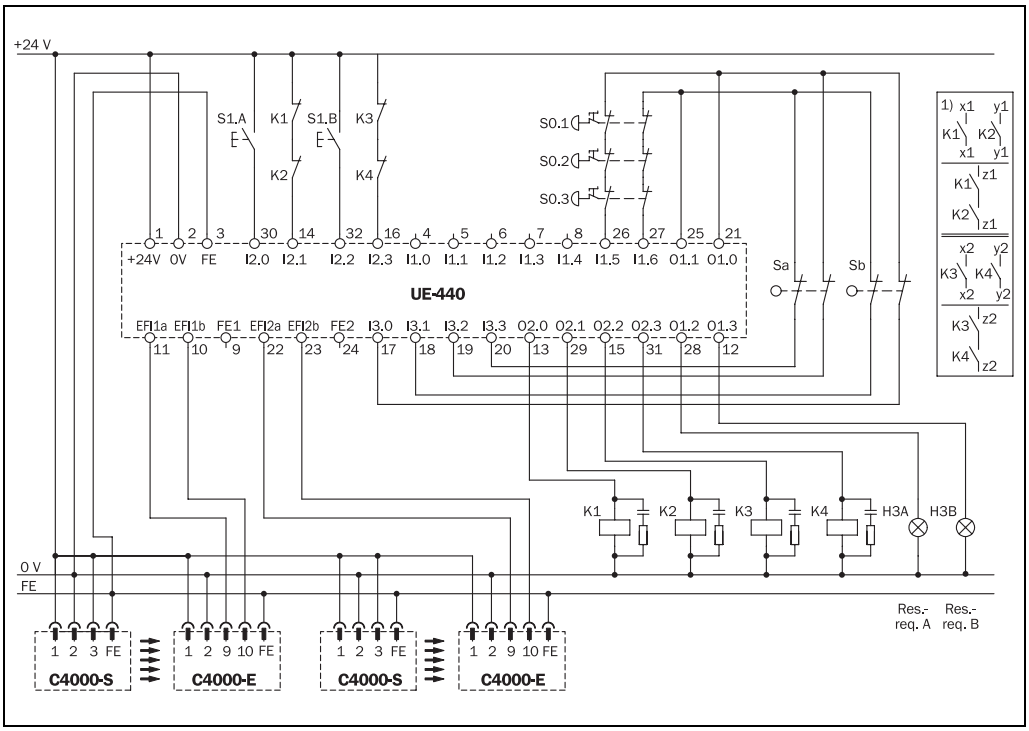
Flg. 38: Components of the access protection for two robot cells



Tab. 22: Failure probability according to IEC 61508 for the example access protection for two robot cells

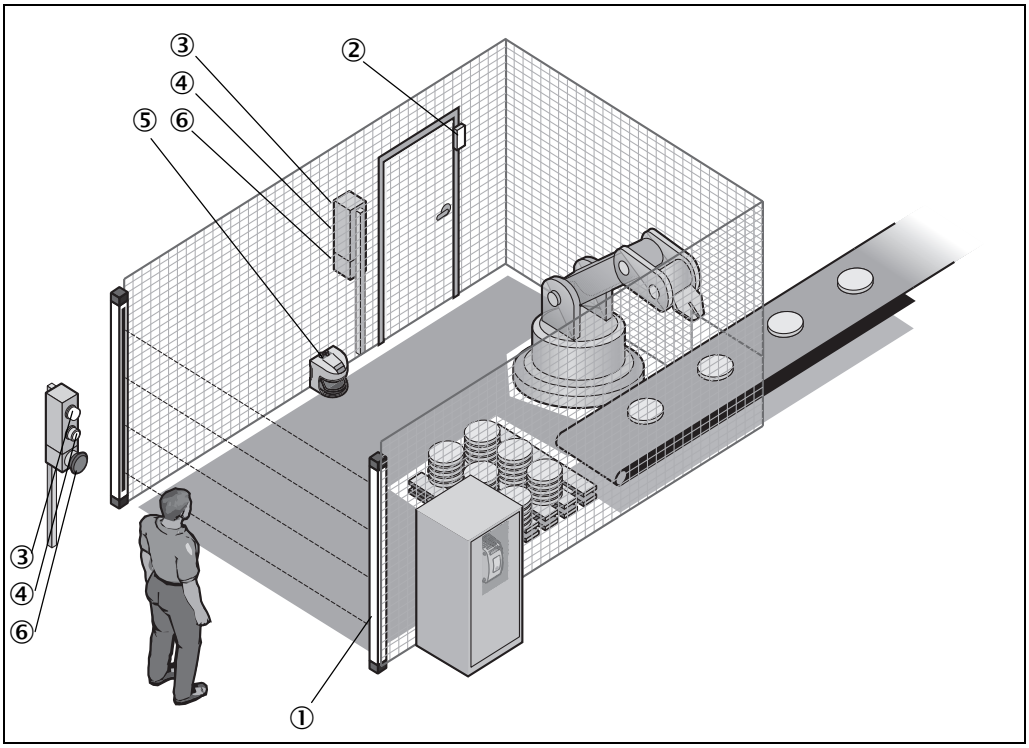
	Application A	Application B
Single-channel inputs	• Reset • EDM	• Reset • EDM
Dual-channel inputs	• Safety switch tested	• Safety switch tested
	• Emergency stop input device tested (switches both applications)	
EFI inputs	• C4000 receiver	• C4000 receiver
Single-channel outputs	• "Reset required" signal lamp	• "Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross circuits)	
Dual-channel outputs	• OSSD A	• OSSD B
Marginal conditions	• Both OSSDs are monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • EDM and contactors are wired within the control cabinet. • The connection cables of both reset buttons are installed in separate sheathing lines or protected.	
Result	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.20*10^{-9}$	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.43*10^{-9}$

Fig. 39: Connection of the access protection for two robot cells



7.1.2 Access protection with point-of-operation protection

Fig. 40: Access protection with point-of-operation protection



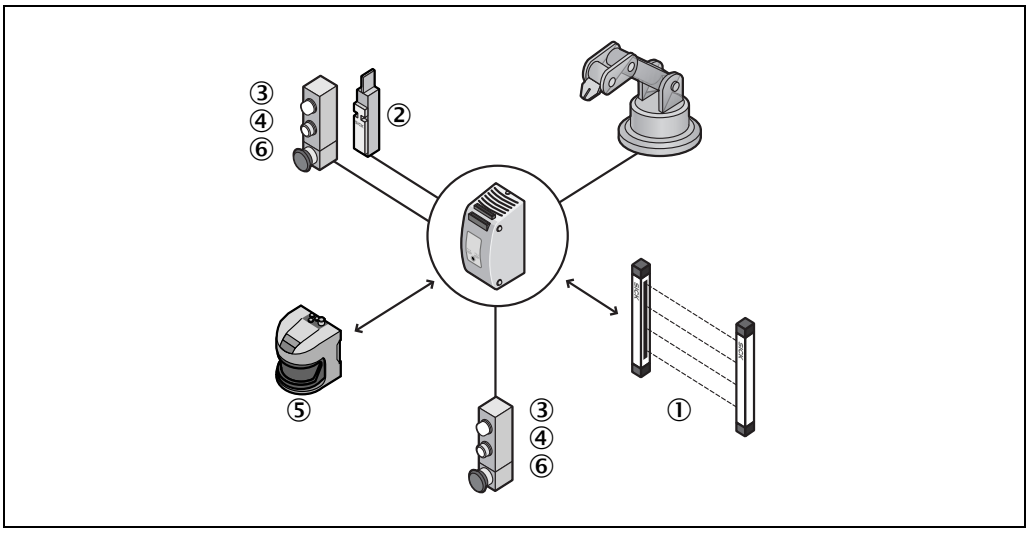
Access to a robot cell is protected via a UE440 with a multiple light beam safety device M2000 (①). The OSSD of the safety application is switched off due to the interruption of a protective field. The side access door to the robot cell is monitored by a safety switch (②). If the door is opened, the safety switch also switches off the OSSD of the safety application.

An internal restart interlock is configured for the safety application. A signal lamp (③) indicates that a reset is required after switch-off of the OSSD. The OSSD of the UE440 is reactivated by actuating the connected reset button (④).

The S3000 serves as point-of-operation protection (⑤). It prevents the interior of the robot cell from being accessed via the multiple light beam safety device and prevents the reset button from being actuated.

Two emergency stop input devices are connected (⑥) and switch off the safety application (robot cell).

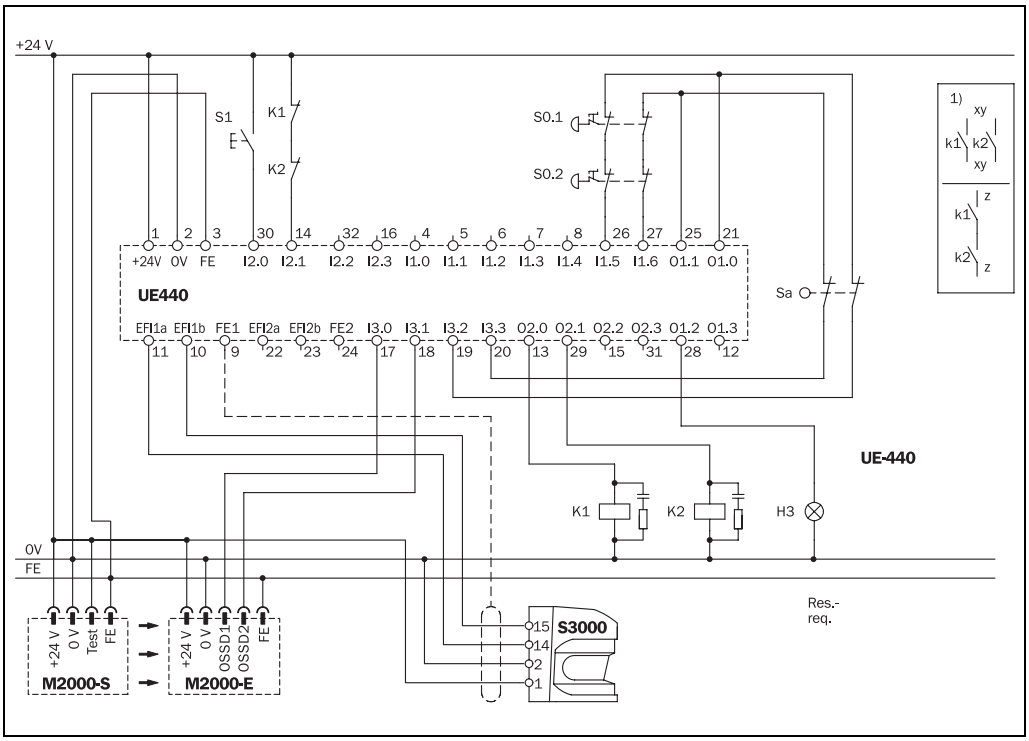
Fig. 41: Components of access protection with point-of-operation protection



Tab. 23: Failure probability according to IEC 61508 for the example access protection with point-of-operation protection

	Application A
Single-channel inputs	• Reset • EDM
Dual-channel inputs	• M2000 receiver • Emergency stop input device tested • Safety switch tested
EFI inputs	• S3000
Single-channel outputs	• "Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross-circuits)
Dual-channel outputs	• OSSD A
Marginal conditions	• The OSSD is monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • EDM and contactors are wired within the control cabinet. • The connection cables of the reset button are installed in separate sheathing lines or protected.
Result	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.20*10^{-9}$

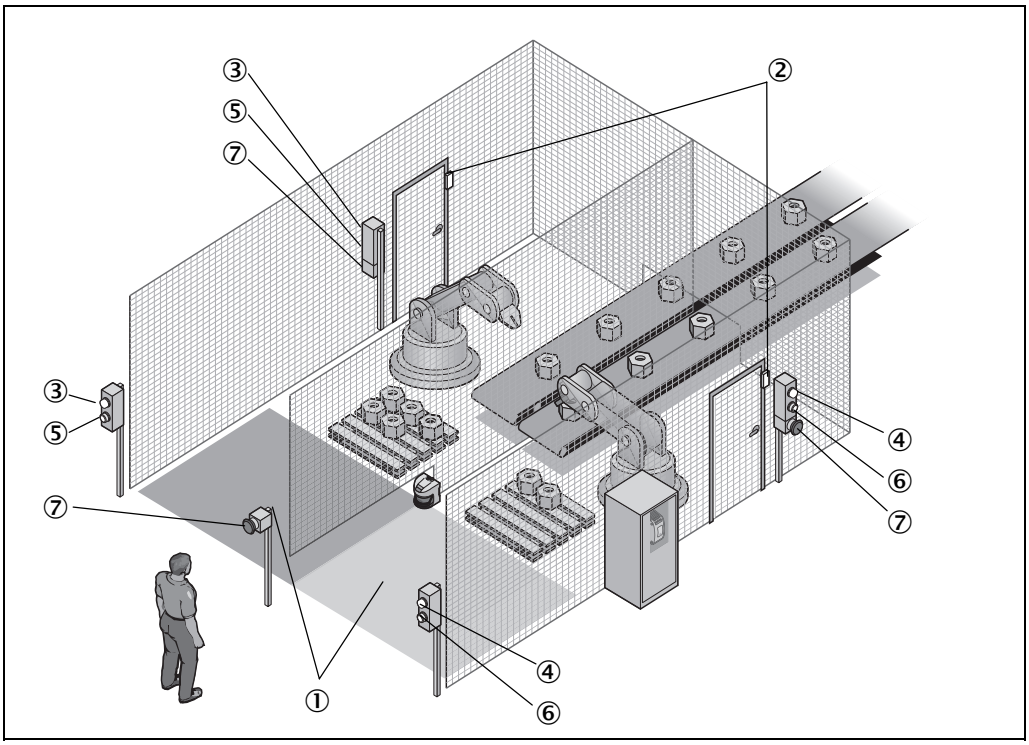
Fig. 42: Connection of the access protection with point-of-operation protection



7.2 Hazardous area protection

7.2.1 Simultaneous hazardous area protection

Fig. 43: Simultaneous hazardous area protection



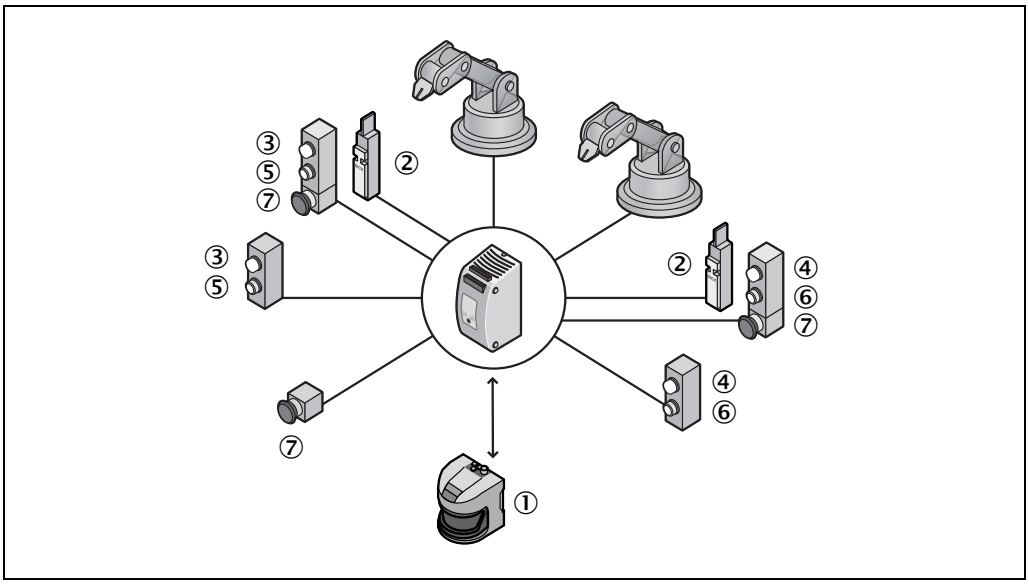
The dangerous areas of two robot cells are protected via a UE440 with a safety laser scanner S3000 (①). Two safety applications are configured in the UE440 for this. The S3000 monitors both hazardous areas with two simultaneous protective fields. The OSSD of the respective safety application is switched off due to an object in one of the protective fields.

The side access doors to the robot cells are monitored by safety switches (②). If the doors are opened, the safety switches also switch off the OSSD of the respective safety application.

A restart interlock is configured for both safety applications. Two independent signal lamps (③ and ④) indicate that a reset is required after one of the OSSDs is switched off. The respective OSSD of the UE440 is reactivated by actuating the connected reset button (⑤ and ⑥).

Three emergency stop input devices are connected (⑦) and switch off both safety applications (robot cells) simultaneously. Each emergency stop also affects both OSSDs of the compact safety controller.

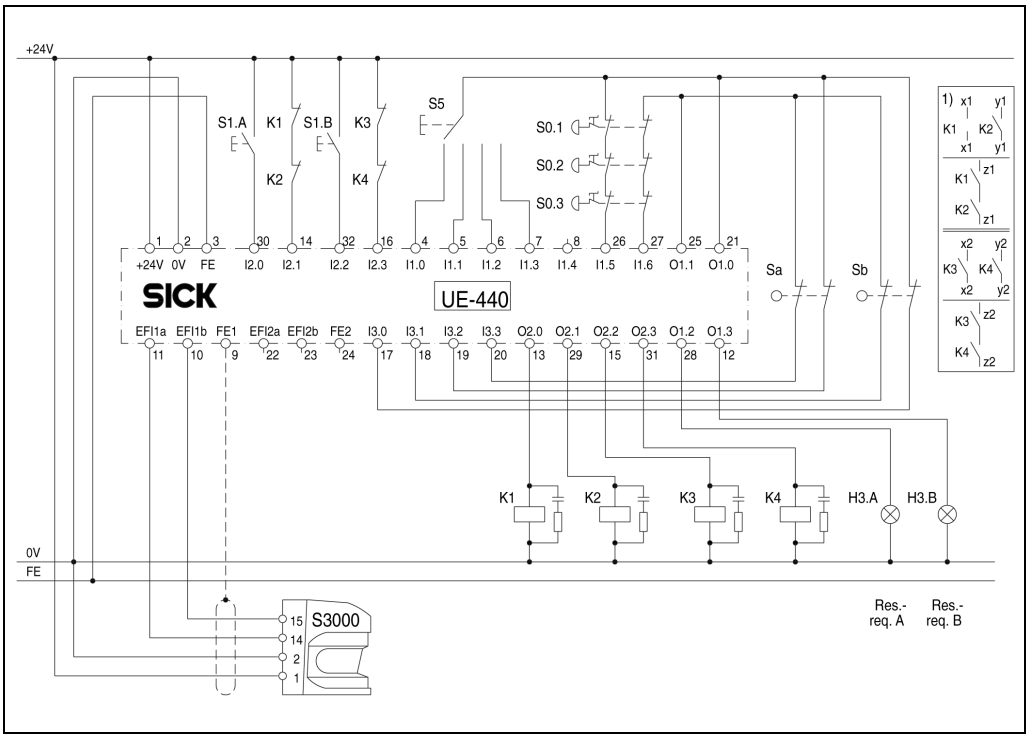
Fig. 44: Components of the simultaneous hazardous area protection



Tab. 24: Failure probability according to IEC 61508 for the example simultaneous hazardous area protection

	Application A	**Application B**
Single-channel inputs	• Reset • EDM	• Reset • EDM
Dual-channel inputs	• Safety switch tested	
	• Emergency stop input device tested (switches both applications)	
EFI inputs	• S3000 (for both applications)	
Single-channel outputs	• "Reset required" signal lamp	"Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross-circuits)	
Dual-channel outputs	• OSSD A	• OSSD B
Marginal conditions	• Both OSSDs are monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • EDM and contactors are wired within the control cabinet. • The connection cables of both reset buttons are installed in separate sheathing lines or protected.	
Result	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.20*10^{-9}$	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.43*10^{-9}$

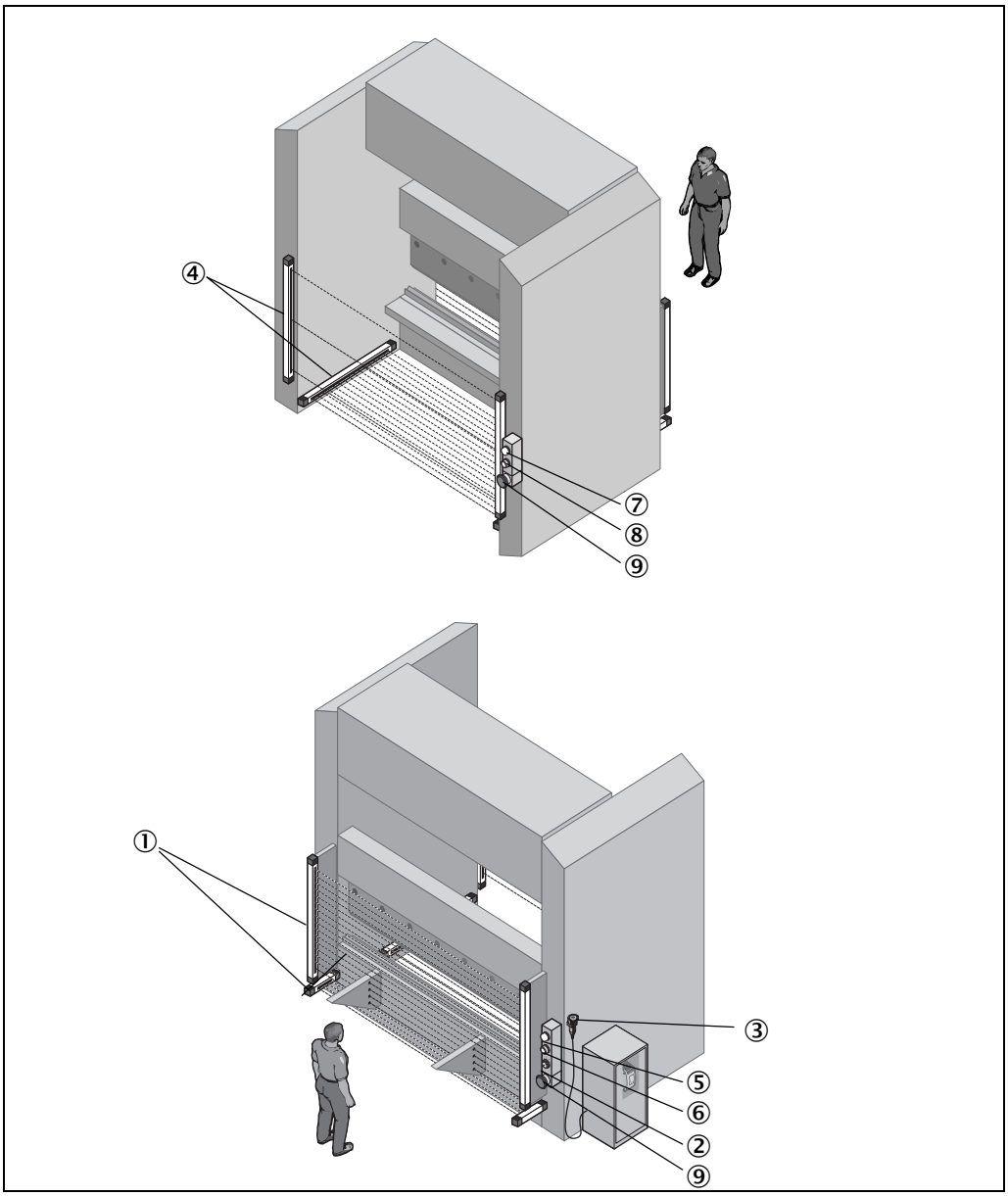
Fig. 45: Connection of the simultaneous hazardous area protection



7.3 Hazardous point protection

7.3.1 Hazardous point protection with PSDI mode

Fig. 46: Hazardous point protection with PSDI mode



The hazardous point at a press is protected via a UE470 with a cascaded C4000 system consisting of a vertically mounted safety light curtain and a horizontally mounted safety light curtain (①). PSDI mode is configured for the C4000. Using the operating mode selector switch (②), you can switch between the various operating modes (e.g. single break PSDI mode, double break PSDI mode, Set-up).

An enabling switch is active in the "Set-up" operating mode (③) and switches the OSSD off as soon as the operator leaves the enabling position of the switch.

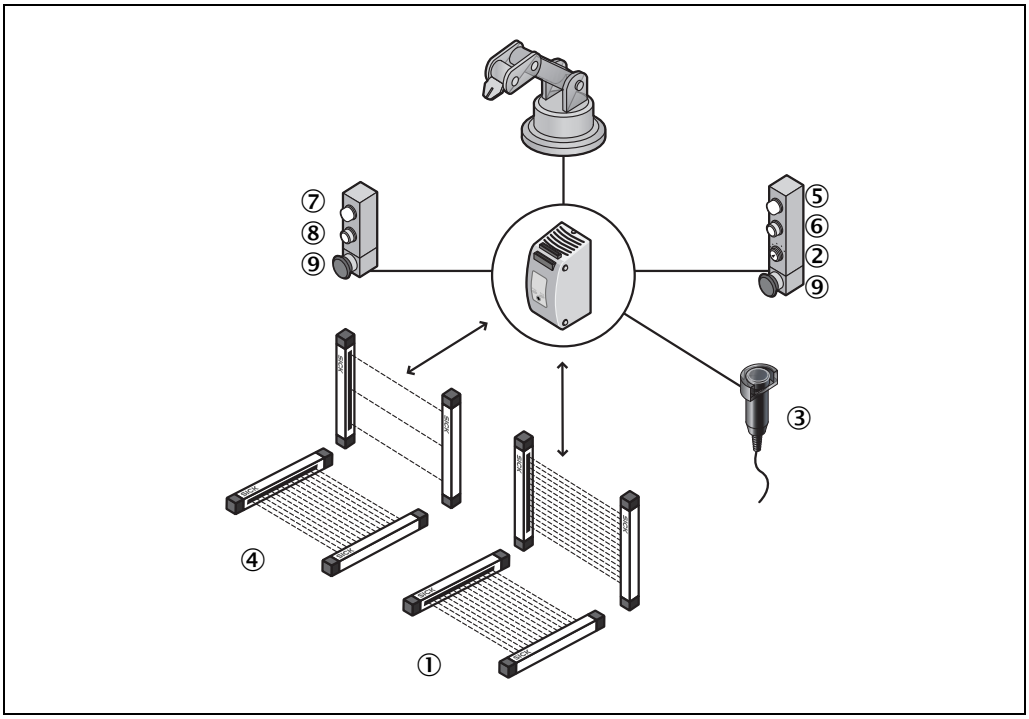
A restart interlock is configured for the safety application. A signal lamp (⑤) indicates that a reset is required after switch-off of the OSSD. The OSSD of the UE470 is reactivated by actuating the connected reset button (⑥).

In a second application (implemented with the same UE470), access from behind the press is prevented with a cascading C/M2000 system (④), and the horizontally mounted C2000 Guest serves as point-of-operation protection.

A restart interlock is configured for the safety application. A signal lamp (⑦) indicates that a reset is required after switch-off of the OSSD. The OSSD of the UE470 is reactivated by actuating the connected reset button (⑧).

Two emergency stop input devices are connected (⑨) and switch off the press. The emergency stop input devices are installed at the front and rear of the press and switch both applications off.

Fig. 47: Components of the hazardous point protection with PSDI mode

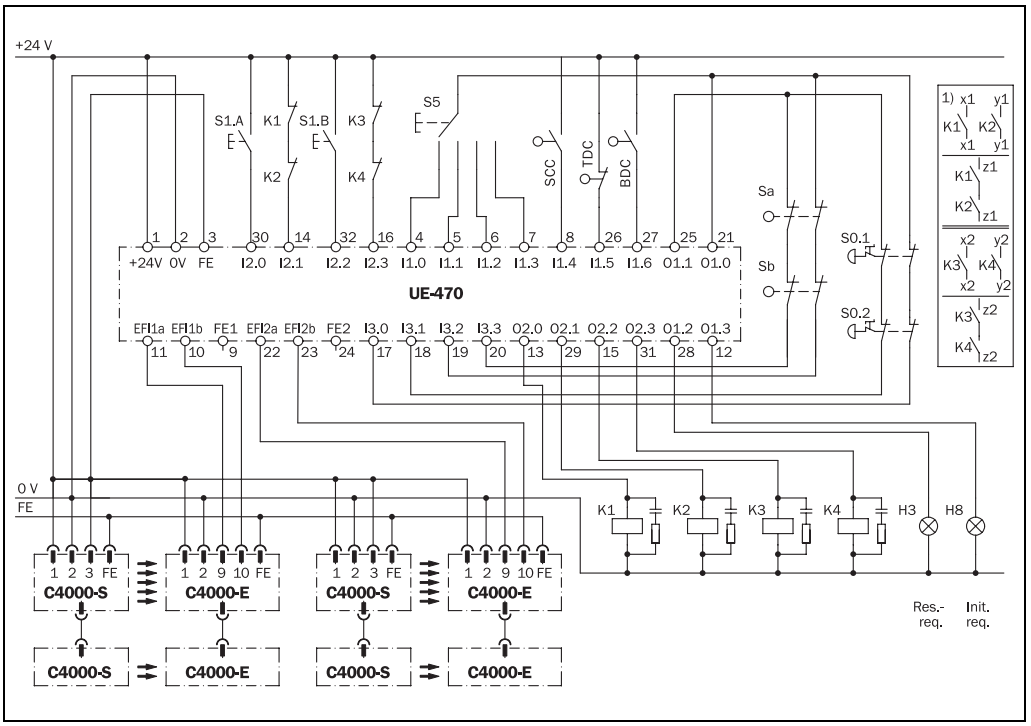


Tab. 25: Failure probability according to IEC 61508 for the example hazardous point protection with PSDI mode

	Application A	Application B
Single-channel inputs	• EDM • TDC • BDC • SCC	• EDM
	• Reset for both applications	
	• Operating mode selector switch for both applications	
Dual-channel inputs	• M/C200	
	• Enabling switch tested	
	• Emergency stop input device tested (switches both applications)	
EFI inputs	• C4000	
Single-channel outputs	• "Reset required" signal lamp	• "Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross-circuits)	
Dual-channel outputs	• OSSD A	• OSSD B

	Application A	**Application B**
Marginal conditions	• Both OSSDs are monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • The operating mode selector switch has a 1-of-4 evaluation (i.e. expectations of the availability of the signals). • EDM and contactors are wired within the control cabinet. • The connection cables of both reset buttons are installed in separate sheathing lines or protected.	
Result	Under the specified marginal conditions the following values apply for the UE470: • SIL3 • PFH = $4.11*10^{-9}$	Under the specified marginal conditions the following values apply for the UE470: • SIL3 • PFH = $3.20*10^{-9}$

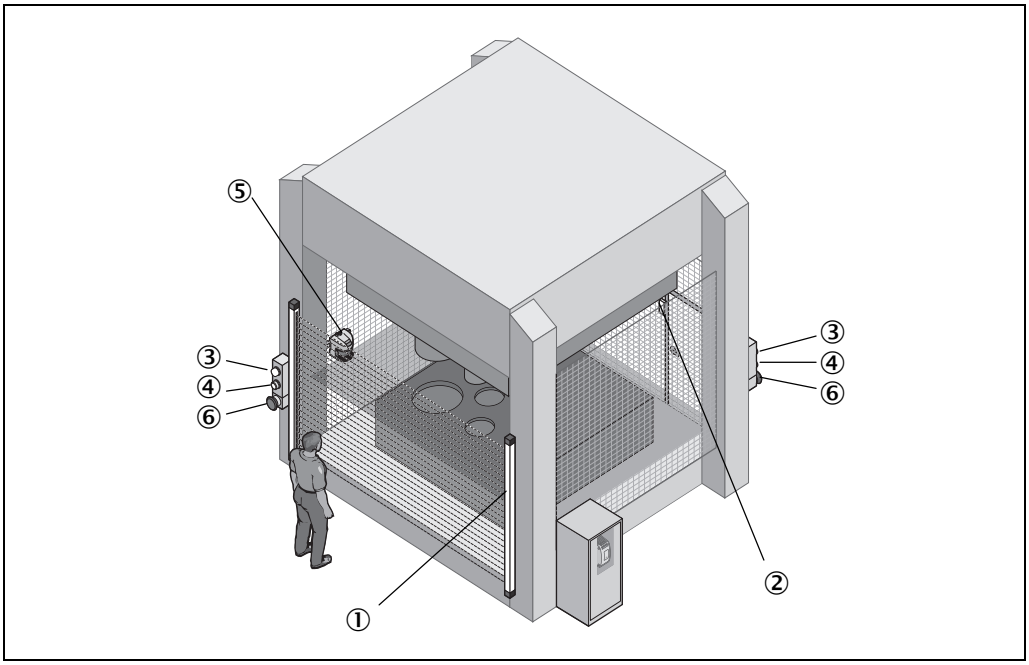
Fig. 48: Connection of the hazardous point protection with PSDI mode



Note In accordance with Standard EN 692, the machine cycle contact BDC must be implemented with two independent signals (e.g. two single-channel N/O contacts).

7.3.2 Hazardous point protection with interior area protection

Fig. 49: Hazardous point protection with interior area protection



The hazardous points at a press are protected via a UE440 with a safety light curtain C4000 (①). The OSSD of the safety application is switched off due to the interruption of a protective field.

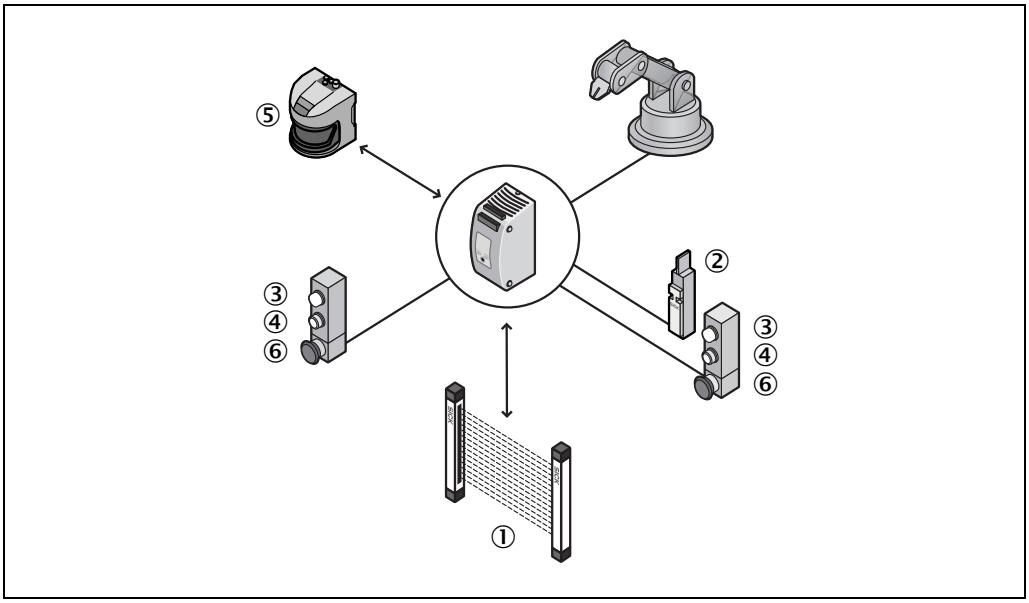
The rear access door to the press is monitored by a safety switch (②). If the door is opened, the safety switch also switches off the OSSD.

A restart interlock is configured for the safety applications. A signal lamp (③) indicates that a reset is required after switch-off of the OSSD. The OSSD of the UE440 is reactivated by actuating the connected reset button (④).

The interior area of the press is monitored via an S3000 (⑤) once the OSSD has switched off. If a person is found in the interior area of the press, the press is prevented from starting up, even if the reset button is pressed inadvertently.

Two emergency stop input devices are connected (⑥) and switch off the press.

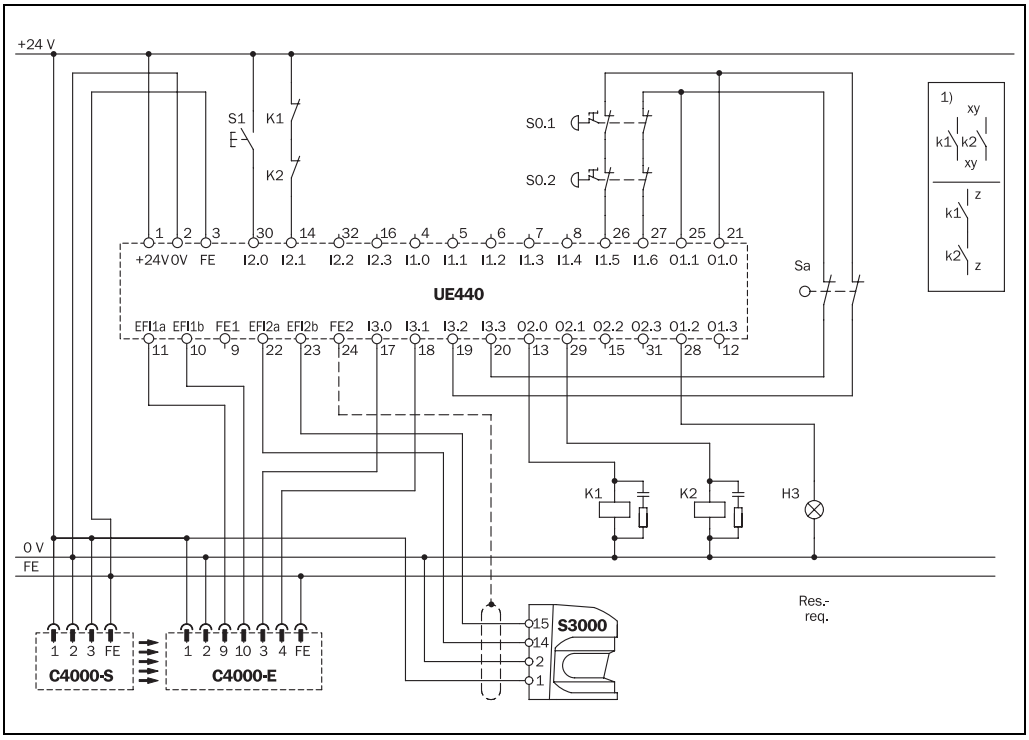
Fig. 50: Components of the hazardous point protection with interior area protection



Tab. 26: Failure probability according to IEC 61508 for the example hazardous point protection with interior area protection

	Application A
Single-channel inputs	• Reset • EDM
Dual-channel inputs	• C4000 receiver • Emergency stop input device tested • Safety switch tested
EFI inputs	• C4000 receiver • S3000
Single-channel outputs	• "Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross-circuits)
Dual-channel outputs	• OSSD A
Marginal conditions	• The OSSD is monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • EDM and contactors are wired within the control cabinet. • The connection cables of the reset button are installed in separate sheathing lines or protected.
Result	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.89*10^{-9}$

Fig. 51: Connection of the hazardous point protection with interior area protection



7.3.3 Hazardous point protection with hazardous area protection

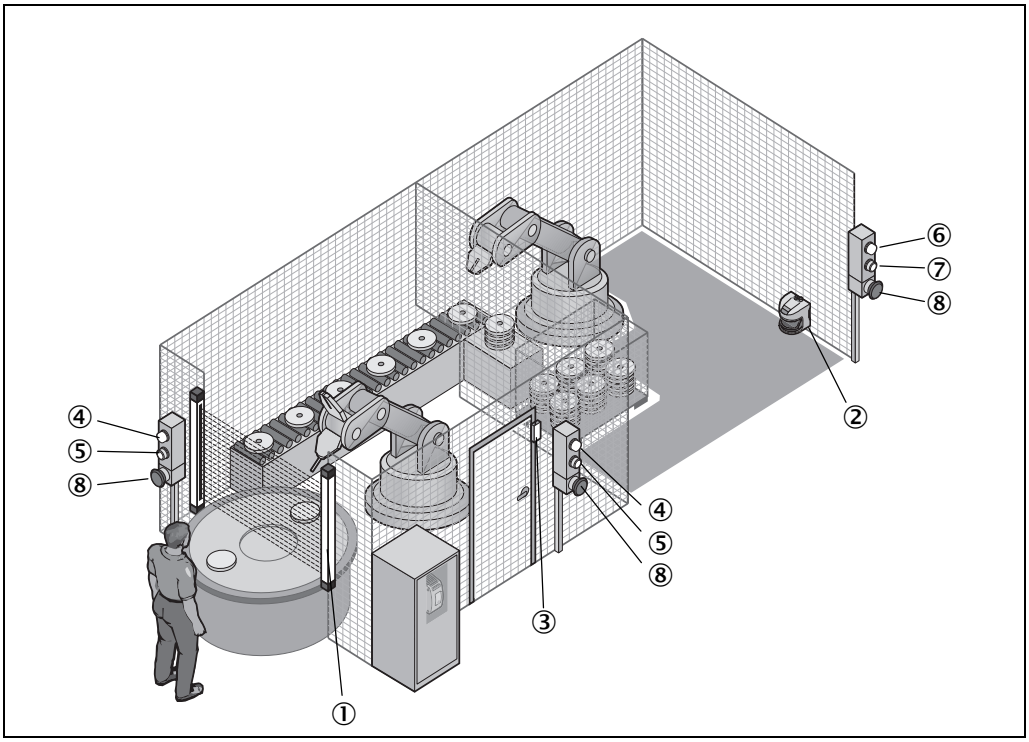


Fig. 52: Hazardous point protection with hazardous area protection

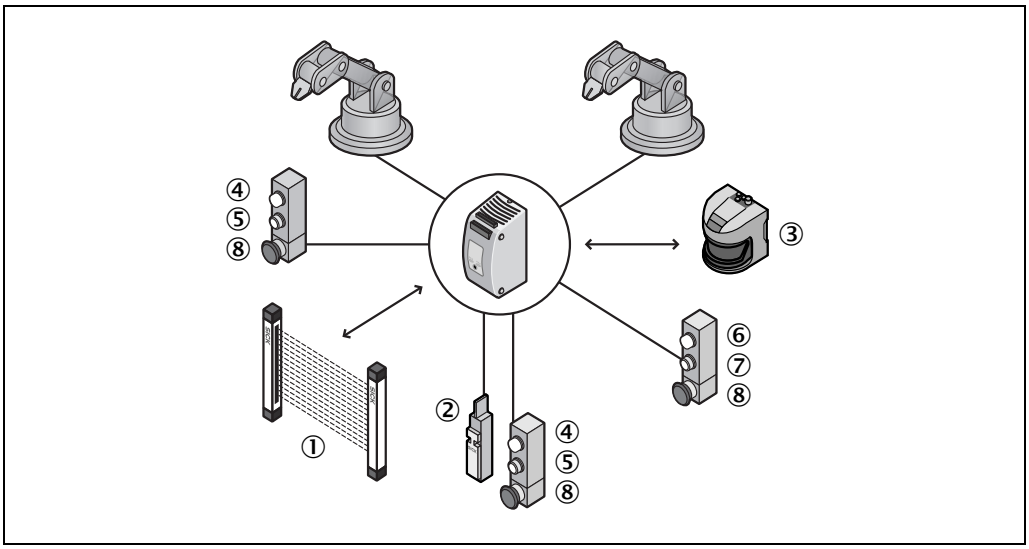
In the example, two separate protected applications are implemented with only one UE440. The hazardous point at the turntable of a robot cell is protected via a safety light curtain C4000 (①). The hazardous area at the following robot cell is protected via a safety laser scanner S3000 (②). Two safety applications were implemented in the UE440 for this. The OSSD of the respective safety application is switched off due to the interruption of a protective field.

The side access door to the front robot cell is monitored by a safety switch (③). If the door is opened, the safety switch also switches off the OSSD of the front safety application in the example.

A restart interlock is configured for both safety applications. Two independent signal lamps (④ and ⑥) indicate that a reset is required after one of the OSSDs is switched off. The respective OSSD of the UE440 is reactivated by actuating the connected reset button (⑤ and ⑦).

Three emergency stop input devices are connected (⑧) and switch off both safety applications (robot cells). Each emergency stop also affects both OSSDs of the compact safety controller.

Fig. 53: Components of the hazardous point protection with hazardous area protection

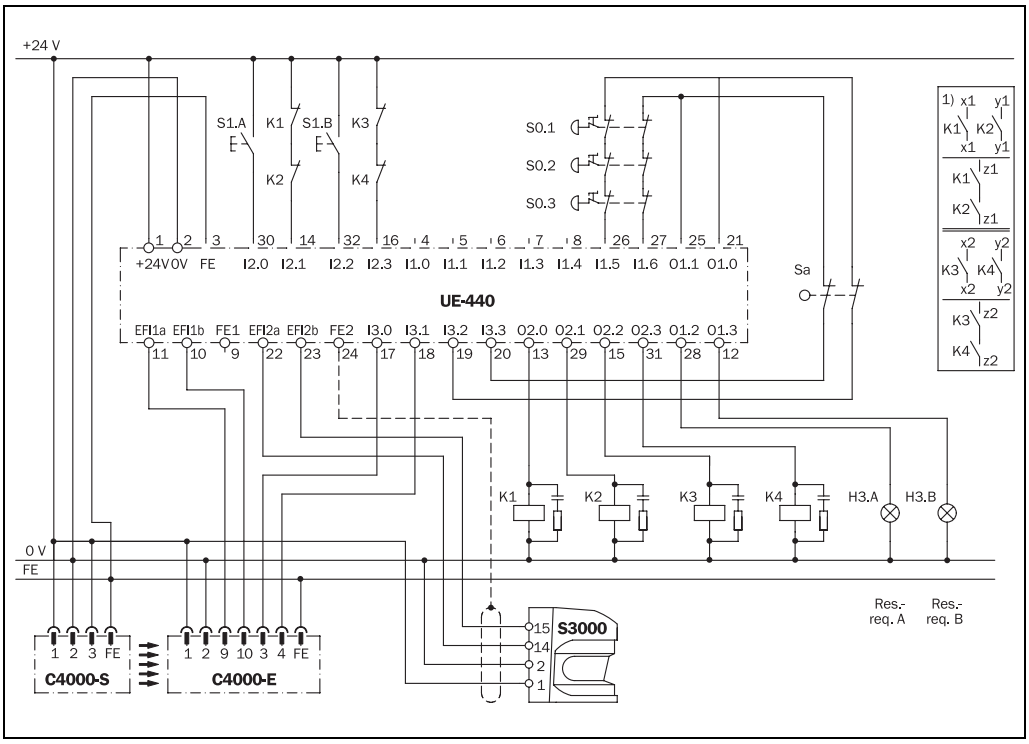


Tab. 27: Failure probability according to IEC 61508 for the example hazardous point protection with hazardous area protection

	Application A	**Application B**
Single-channel inputs	• Reset • EDM	• Reset • EDM
Dual-channel inputs	• Safety switch tested • C4000 receiver (EFI connection as well)	
	• Emergency stop input device tested (switches both applications)	
EFI inputs	• C4000 receiver (dual-channel connection as well)	• S3000
Single-channel outputs	• "Reset required" signal lamp	• "Reset required" signal lamp
	• Two test outputs for testing of single- or dual-channel inputs (tests are offset by time for detection of cross-circuits)	
Dual-channel outputs	• OSSD A	• OSSD B
Marginal conditions	• Both OSSDs are monitored for cross circuits. • The connection cables of the dual-channel safety switches are installed in separate sheathing lines or protected. • EDM and contactors are wired within the control cabinet. • The connection cables of both reset buttons are installed in separate sheathing lines or protected.	
Result	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.43*10^{-9}$	Under the specified marginal conditions the following values apply for the UE440: • SIL3 • PFH = $3.89*10^{-9}$

UE440/470

Fig. 54: Connection of the hazardous point protection with hazardous area protection



8 Commissioning

ATTENTION

Do not commission without a check by specialist personnel!

Before the initial commissioning of the system in which you are using a compact safety controller UE440/470, it must be checked and released by specialist personnel. Observe the notes from Chapter 2 "On safety" from Page 9 here.

ATTENTION

Check the hazardous area!

You must ensure that no one is located in the hazardous area before commissioning.

- Check the hazardous area and secure it against being entered by people (e.g. set up warning signs, attach blocking ropes or similar). Observe the relevant laws and local regulations.

8.1 Sequence for commissioning

When commissioning the entire system, you must prevent faults in the sub-systems by following a specialised sequence for commissioning.

- First commission the devices at the EFI connections and test their system behaviour. Please read the corresponding operating instructions of the ESPE for this.

Note You will find the "Commissioning" chapter for this in the operating instructions of the ESPE from SICK AG.

- Check all other actuators and sensors connected to the compact safety controller for proper functioning.
- Do not commission the UE440/470 until the behaviour of the sub-systems is safe and as predicted.

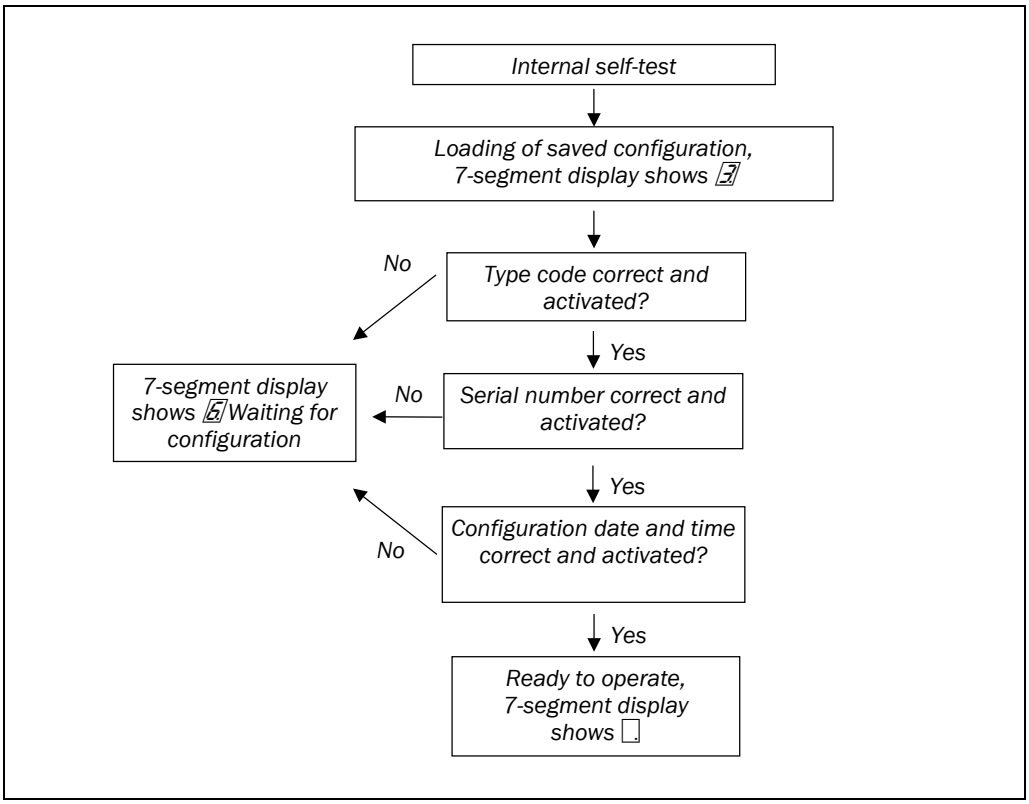
8.1.1 System self-check after switching on

The compact safety controller UE440/470 carries out the following steps automatically immediately after the voltage supply is switched on:

- Internal self-test
- Loading of the saved configuration
- Check whether the loaded configuration fits one of the devices connected via EFI

The following figure shows the course of the system self-check after switching on with an activated parameter.

Fig. 55: System self-test after switching on and checking of the type code, serial number, configuration date and time of a device connected via EFI



8.1.2 Switch-on sequence

After switch-on, the UE440/470 runs through the switch-on cycle. During the switch-on cycle, the 7-segment display indicates the device status.

When commissioning a UE440/470, the following display values are possible:

Tab. 28: 7-segment display during and after the switch-on sequence of initial commissioning

Step	Display	Meaning
1	', ¯, ', ,, _, ', -, .	Testing the 7-segment display. All segments are activated sequentially.
2	6.	Device is in configuration mode
or		
2	3.	Any configuration of one or more ESPE saved in the compact safety controller is transferred to them.
or		
2 or 3	.	System ready for operation
	Other display	Safety lock activated. Malfunction in device or in connected actuators or sensors or their wiring. See Chapter 10.4 "Displays of the 7-segment display" on Page 92.

Tab. 29: Displays of the LEDs after the switch-on sequence during commissioning

Display			Meaning
Red	**Green**	**Yellow**	
●	○	☀	OSSD deactivated Reset required
○	●	○	OSSD activated
●	○	○	OSSD deactivated
Other display			Malfunction in device or in connected actuators or sensors or their wiring. See Chapter 10.3 "LED displays" on Page 91.

The LEDs are grouped in two blocks. The left block indicates the statuses of OSSD A (outputs O2.0 and O2.1), and the right block indicates that of OSSD B (outputs O2.2 and O2.3). See Chapter 3.3.1 "LEDs and 7-segment display" on Page 15.

8.2 Full approval of the application

You may only commission the system if full approval was successful. Full approval may only be performed by professionals trained accordingly.

The full approval includes the following items to be checked:

- Check whether the attachment of components to the connections corresponds to the required category in accordance with EN 954-1.
- Check the devices connected to the compact safety controller in accordance with the test notes from the accompanying operating instructions.

Note For this purpose, the operating instructions of the ESPE from SICK AG contain the chapter "Tests before the first commissioning", and a "Manufacturer's checklist" is found in the "Annex" chapter.

- Clearly mark all connection cables and plugs at the compact safety controller.
- Perform a complete verification of the safety functions of the system in each operating mode/program. Observe the response times of the individual operating modes/programs of the application in particular. Observe the response times during the switching of programs (see Chapter 11.1 "Response times of OSSDs A and B" on Page 96).
- Completely document the configuration of the system, the individual devices and the result of the safety check.

8.3 Test notes

8.3.1 Tests before the first commissioning

The purpose of the initial-commissioning tests is to confirm the safety requirements specified in the national/international rules and regulations, especially in the Machine and Work Equipment Directive (EC Conformity).

- Check the effectiveness of the protective device mounted to the machine, using all selectable operating modes/programs as specified in the checklist in the Annex (see Checklist for the manufacturer on Page 107).
- Ensure that the operating personnel of the machine fitted with the compact safety controller is instructed by the specialist personnel of the machine owner before beginning work. Arranging the instruction is the responsibility of the machine owner.
- Annex 13.2 of this document shows a checklist for review by the manufacturer and OEM. Use this checklist as a reference before commissioning the system for the first time.

8.3.2 Regular inspection of the protective device by qualified personnel

- Check the system, following the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes on the machine or manipulations of the protective device are detected before use/re-use.
- If any modifications have been made to the machine or the protective device, or if the compact safety controller has been changed or repaired, the system must be checked again as specified in the checklist in the Annex.

8.3.3 Daily functional checks of the protective device

The effectiveness of the protective device must be checked daily by authorised commissioned persons.

9 Configuration

ATTENTION

Check the configuration for the protective device in every operating mode/program and after every change!

If you configure several operating modes/programs, you must especially check the operation of the protective device in each of these operating modes/programs. This also applies when you change individual settings for operating modes/programs or the entire configuration. Please observe the test notes in the operating instructions of the connected protective device.

For configuration of the UE440/470 and the devices connected to it (ESPE, emergency stop input devices etc.), you require:

- CDS (Configuration & Diagnostic Software) on CD
- User manual for CDS on CD
- PC/notebook with Windows 9x/NT 4/2000 Professional/XP and a serial interface (RS-232). PC/Notebook not included with delivery
- Connection instructions for connecting the PC to the UE440/470 (not included with the delivery)
- Release code for the CDS (not included with the delivery)

➢ To configure the device, please read the user manual for the CDS (Configuration & Diagnostic Software) and use the online help function of the program.

Configuration requires the following steps:

➢ Offline configuration of the UE440/470 to determine the electrical connections of the compact safety controller

➢ Electrical installation of the UE440/470 and the ESPE, sensors and actuators used

➢ Possible offline configuration of the connected ESPE from SICK AG

➢ Transfer of the configuration to the UE440/470 and the connected ESPE from SICK AG

Notes

- If protective devices (such as C4000 or S3000) are connected via EFI, you transfer their configuration draft together with the UE440/470 to the connected protective devices. Do not transfer a configuration draft to protective devices connected to the UE440/470 via EFI by directly connecting the PC or notebook to these protective devices. In this case the configuration of the connected EFI device would be recognised as being incorrect and the message 6 would be displayed in the 7-segment display.
- The initial configuration of the UE440/470 must first be performed offline to set the type of connections of the compact safety controller. Only then can you perform the electrical installation and transfer the configuration to the compact safety controller.
- Changes to an existing configuration can be made online. If these changes affect the electrical installation, however, you must decommission the system, change the electrical installation and then recommission the system (for this purpose, read Chapter 8 "Commissioning" on Page 84).

9.1 Default delivery status

When delivered, the compact safety controller UE440/470 is in secure condition.

- It is in the **Waiting for configuration** device mode.

●○○ ●○○

- The OSSDs are deactivated by this (the LEDs of the OSSD A and OSSD B illuminate red).
- The 7-segment display shows 6.

9.2 Offline configuration

➢ Plan all the necessary settings (operating modes/programs, restart, PSDI mode, etc.).

➢ Determine the pin assignment for the compact safety controller in the CDS and configure your safety application(s) (for this purpose, read Chapter 4 "Configurable functions" from Page 17). Please also read the user manual for the CDS and use the online help of the program.

➢ If desired, configure the connected ESPE from SICK AG in the CDS as well. Please read the corresponding operating instructions of the ESPE and the user manual for the CDS and use the online help of the program for this purpose.

➢ Save the created project on the PC or notebook.

9.3 Online configuration

How to prepare the configuration:

➢ Ensure that the UE440/470 and the used ESPE, sensors and actuators are installed properly and connected electrically.

➢ Connect the PC or notebook to the configuration connection of the UE440/470 using the connection cable.

➢ Open the project configured offline in the CDS, connect the project in the CDS to the devices and transfer the configuration. Please read the user manual for the CDS and use the online help of the program for this purpose.

10 Fault diagnosis

10.1 In the event of faults or errors

ATTENTION

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

Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely remedy the malfunction.

ATTENTION

Complete functional test after malfunction remedying!

Carry out a full functional test after a malfunction has been remedied. See Chapter 8.3 "Test notes" on Page 87.

The lock-out operating status

With certain malfunctions or a faulty configuration, the UE440/470 enters the safe lock-out status. The 7-segment display of the compact safety controller shows the corresponding error. To place the device back in operation:

- Rectify the cause of the malfunction as per Tab. 31.
- Switch the voltage supply of the UE440/470 off and back on again.

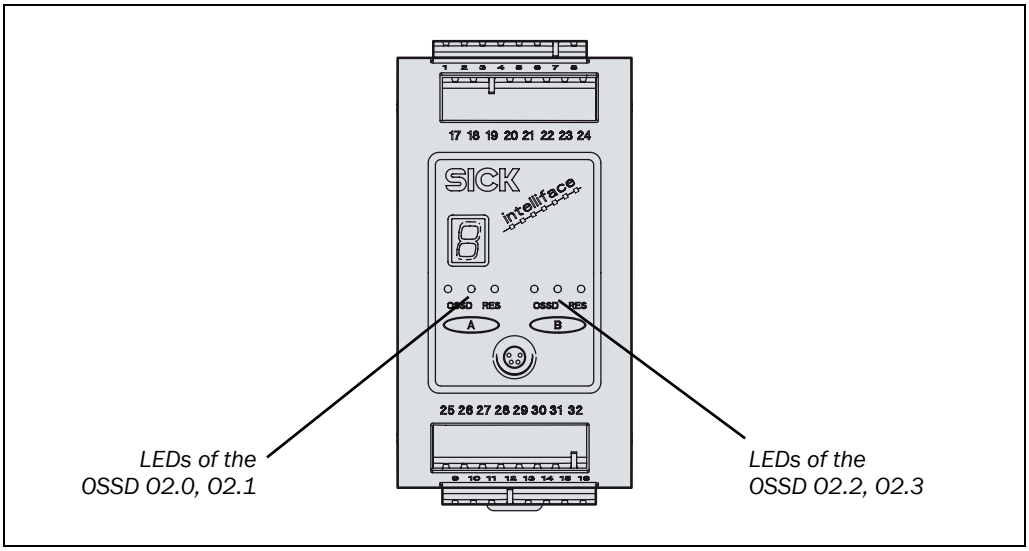
10.2 SICK support

If you cannot remedy a malfunction using the information in this chapter, please contact your local SICK branch.

Note If you send in a device for repair, you will receive it back in the delivery state, i.e. not configured. For this reason, save the configuration(s) of your devices and back up this data.

10.3 LED displays

Fig. 56: LEDs of the UE440/470



Tab. 30: Error displays of the LEDs

Display						Possible cause	How to remedy the fault/error or change the status
02.0, 02.1			02.2, 02.3				
Red	Green	Yellow	Red	Green	Yellow		
○	○	○	○	○	○	No operating voltage, or voltage too low	➢ Check the voltage supply and activate, if necessary.
○	●	○	○	●	○	02.0, 02.1 / 02.2, 02.3 switched on	
●	○	○	●	○	○	02.0, 02.1 switched off	➢ Ensure that, for example, the protective field of the connected ESPE is unoccupied.
●	○	☼	●	○	☼	02.0, 02.1 / 02.2, 02.3 switched off Reset required	➢ Press the reset button.

10.4 Displays of the 7-segment display

This section explains the meaning of the 7-segment display. A description of the positions and symbols used at the UE440/470 is found in Section 3.3 "Display elements" on Page 15.

Tab. 31: Error displays of the 7-segment display

Display	Possible cause	How to remedy the error
0.	System ready for operation	No error
1., 2., 3., 4., 5., 6., 7., 8.	Switch-on cycle – All segments are activated sequentially.	No error
3.	System initialisation	No error
6.	Waiting for configuration or configuration incomplete	No error: The display goes off automatically once the configuration has been successfully transferred. If display 6. does not go off: ➢ Check the configuration of the system using the CDS (Configuration & Diagnostic Software). Re-transfer the corrected configuration to the UE440/470.
8. or :8:	EDM error	➢ Check whether the contactors are stuck or wired incorrectly and remedy the fault if necessary. ➢ For :8:: Switch the device off and back on again.
9.	Error of the reset button or two-handed input device	➢ Check the reset button/two-handed input device for correct function. The button/input device may be defective or stuck. ➢ Check the wiring of the reset button/two-handed input device for any short-circuit to 24 V.
b.	The key-operated switch for bypass was actuated.	No error: The UE440/470 waits until bypass is switched off again.
c. ↻ 3.	No test pulse seen on one or more inputs circuits.	➢ Check the wiring of the input devices.
c. ↻ 4.	Discrepancy time of a dual-channel input element exceeded	➢ Check the wiring of the dual-channel input elements. ➢ Check whether a longer discrepancy time for one or more dual-channel input elements is necessary.

Display	Possible cause	How to remedy the error
C. ↻ 5.	At least two input signals at the connections of the program selector switch are identical.	➢ Check the wiring for short-circuit. ➢ Check the program selector switch.
C. ↻ 6.	Two input signals at the connections of the program selector switch are identical.	➢ Check the wiring for short-circuit. ➢ Check the program selector switch.
C. ↻ 7.	A signal combination active at the inputs of the program selector switch is not configured.	➢ Use a program selector switch at which only the configured programs can be selected. ➢ Check the UE440/470 configuration with the aid of the CDS.
C. ↻ 8.	Key-operated switch for bypass or its wiring is defective.	➢ Check the key-operated switch for bypass and its wiring. ➢ Check whether the configuration of the key-operated switch for bypass (e.g. complementary or equivalent circuit) matches the construction. ➢ Ensure that both contacts on the key-operated switch for bypass are switched within the configured discrepancy time.
C. ↻ 9.	Short-circuit after 24 V at program selector switch	➢ Check the wiring of the program selector switch. ➢ Check the program selector switch.
E.	UE440/470 defective	➢ Send the compact safety controller to the manufacturer for repair.
F.	Overcurrent at a single-channel output or undercurrent at O1.3	➢ Check for possible overload/underload at the output element. ➢ Check the wiring of the connected switching element.
F. ↻ 1.	Overvoltage at OSSD A, connection 1	➢ Check the wiring for short-circuit to 0 V. ➢ Check the connected switching element. Replace, if necessary.
F. ↻ 2.	Short-circuit at OSSD A, connection 1 after 24 V	➢ Check the wiring for short-circuit to 24 V.
F. ↻ 3.	Short-circuit at OSSD A, connection 1 after 0 V	➢ Check the wiring for short-circuit to 0 V.
F. ↻ 4.	Overvoltage at OSSD A, connection 2	➢ Check the connected switching element. Replace, if necessary. ➢ Check the wiring for short-circuit to 0 V.

Display	Possible cause	How to remedy the error
F 5	Short-circuit at OSSD A, connection 2 after 24 V	➢ Check the wiring for short-circuit to 24 V.
F 6	Short-circuit at OSSD A, connection 2 after 0 V	➢ Check the wiring for short-circuit to 0 V.
F 7	Short-circuit at OSSD A between connections 1 and 2	➢ Check the wiring and rectify the error.
3 0	Short-circuit between OSSD pairs (cross circuit).	➢ Check the connected switching element. Replace, if necessary. ➢ Check the wiring for a short circuit
3 1	Overvoltage at OSSD B, connection 1	➢ Check the connected switching element. Replace, if necessary. ➢ Check the wiring for short-circuit to 0 V.
3 2	Short-circuit at OSSD B, connection 1 after 24 V	➢ Check the wiring for short-circuit to 24 V.
3 3	Short-circuit at OSSD B, connection 1 after 0 V	➢ Check the wiring for short-circuit to 0 V.
3 4	Overvoltage at OSSD B, connection 2	➢ Check the connected switching element. Replace, if necessary. ➢ Check the wiring for short-circuit to 0 V.
3 5	Short-circuit at OSSD B, connection 2 after 24 V	➢ Check the wiring for short-circuit to 24 V.
3 6	Short-circuit at OSSD B, connection 2 after 0 V	➢ Check the wiring for short-circuit to 0 V.
3 7	Short-circuit at OSSD B between connections 1 and 2	➢ Check the wiring and rectify the error.
L 0	Emergency stop input device defective	➢ Check the emergency stop input device and its wiring. ➢ Check whether the configuration of the emergency stop input device (e.g. complementary or equivalent circuit) matches the construction.
L 2	Invalid configuration of the external device monitoring	➢ Verify that the machine-side EDM is connected correctly.

Display	Possible cause	How to remedy the error
L ↻ 4	A device connected via EFI or the connection to the device is defective or impaired.	➢ Check the connected device and the connection to this device. ➢ Check whether a device with an EFI connection is connected.
L ↻ 5	A connection cannot be established with a device connected via EFI.	➢ Check the connected device.
L ↻ 9	A short-circuit exists between the input for the reset button and another input or output.	➢ Check the wiring for cross-circuit.
L ↻ P	Fault in PSDI mode	➢ Verify the configuration of the system using the CDS (Configuration & Diagnostic Software). Re-transfer the corrected configuration to the system. ➢ Check the switch for the machine cycle contacts. Ensure that these are correctly connected and configured. Replace, if necessary.
II	Inactive signal at Enable input	No error: The UE440/470 is waiting for a 1-signal at the Enable input.
P	All outputs are inactive	➢ Switch the voltage supply of the UE440/470 off and back on again.

Note If you experience difficulties while remedying errors/faults, contact SICK support. Also have a printout of the diagnostic results on hand (see the following Chapter 10.5 "Extended diagnostics").

10.5 Extended diagnostics

The CDS software supplied with the device (Configuration & Diagnostic Software) includes extended diagnostic options. It allows you to diagnose the system status in case vague malfunctions occur. Detailed information is to be found ...

- in the online help for the CDS
- in the user manual for the CDS

11 Technical data

11.1 Response times of OSSDs A and B

The response time of the UE440/470 is not to be set the same as the overall response time of the safety application. When considering the response time, you must calculate the response times for the individual signal paths (e.g. from input of an input device or sensor or from an EFI connection to the OSSDs).

ATTENTION

Take the response times into account when planning the safety distance!

The OSSDs of the UE440/470 are subject to a response time due to the initial conditions and the internal logic. Increase the safety distance/protective field size of the connected ESPE accordingly.

The listed response times do not take into consideration a case where a fault occurs during response. (This can lead to an increase of the response time.)

To set the total response time of the protective device, you must also take into consideration the response time of the sensors, the dropout time of following contactors and their spark supression and the stop time of the machine.

The response time of your application depends on ...

- the processing time of the compact safety controller
- the response times of the devices connected to the compact safety controller
- a configured input delay for the inputs of the UE440/470 if the connected input devices and sensors affect the OSSDs
  Example: A safety switch secures the entry to a robot cell, and opening of the door switches one of the OSSDs off. A configured input delay increases the response time of the OSSD.
- the transfer time of OSSD status information via EFI if it is only transferred via the EFI connection to the compact safety controller and affects one of the OSSDs (see Chapter 6.3.1 "Electro-sensitive protective equipment" on Page 6)
- a configured shutdown delay for output **Out2** of a function module if it affects one of the OSSDs (see Section 4.2.12 "Shutdown delay of output Out2" on Page 6)

Stated simply:

Response time = 10 ms + t_{DI} + t_{DO}

Where ...

t_{DI} = delay time at the inputs

t_{DO} = shutdown delay at the outputs

Using the following calculation scheme, you determine the response time on a signal path up to the OSSDs of the compact safety controller.

Notes

- Calculate the response times of the OSSDs for each switch-off condition within your safety application. Then use the calculated response times to define the safety distance.
- Calculate the response time with the "Program switching" setting during the program change (see Section 11.1.2 "Response times with program switching" on Page 99).
- If you have configured several programs/operating modes, it is imperative that you calculate the response times of the OSSDs for each program/operating mode in your safety application. Then use the greatest calculated response time to define the safety distance.

How to determine the response time of an OSSD for the response of a single- or dual-channel input device or sensor:

➢ Determine the response time of the connected input device or sensor using the respective operating instructions.

➢ Fill out the following table to determine the response time of this signal path:

Tab. 32: Determining the response time of a single-channel input device or sensor

Line	Required detail	Time
1	Response time of the connected input device or sensor	+ _____ ms
2	Set input delay	+ _____ ms
3	Internal processing time of the compact safety controller	+ 10 ms
4	Set shutdown delay	+ _____ ms
5	**Response time of the OSSDs**	**= _____ ms**

How to determine the response time of an OSSD for the response of a protective device connected via EFI:

➢ Determine the response time of the connected input device or sensor using the respective operating instructions.

➢ Fill out the following table to determine the response time of this signal path:

Tab. 33: Determining the response time of ESPE

Line	Required detail	Time
1	Response time of the connected input device or sensor	+ _____ ms
2	Additional value for the transfer time of OSSD status information via EFI: • C4000: 4 ms3000: 21 ms • M4000: 4 ms • S300: 21 ms	+ _____ ms
3	Internal processing time of the compact safety controller	+ 10 ms
4	Set shutdown delay	+ _____ ms
5	**Response time of the OSSDs**	**= _____ ms**

Special case

Notes

For applications which fulfil both of the following criteria, the internal processing times of the compact safety controller contained in Sections 11.1.1 „Examples“ and 11.1.2 „Response times with program switching“ do not apply:

- Application B is linked to application A.

  and

- Activating application B leads to the deactivation of application A.

This is why the following internal processing times of the compact safety controller must be assumed for calculation of the response time for this application.

- In "normal mode": 20 ms
- During program switching: 45 ms

11.1.1 Examples

ESPE with input delay and discrepancy time

The ESPE used has a response time of 64 ms. You have configured a 20 ms input delay and 50 ms discrepancy time for its "ESPE" input element.

Tab. 34: Example for the calculation of the response time of ESPE

Line	Required detail	Time	
1	Response time of ESPE	+	64 ms
2	Set input delay	+	20 ms
3	Internal processing time of the compact safety controller	+	10 ms
4	Set shutdown delay	+	0 ms
5	**Response time of the OSSDs**	**=**	**94 ms**

Transfer of the OSSD status via EFI

You accept the OSSD status of an S3000 via EFI

Tab. 35: Example for the calculation of the response time of ESPE connected via EFI

Line	Required detail	Time	
1	Response time of ESPE	+	120 ms
2	Additional value for the transfer time of OSSD status information via EFI: • S3000: 21 ms	+	21 ms
3	Internal processing time of the compact safety controller	+	10 ms
4	Set shutdown delay	+	0 ms
5	**Response time of the OSSDs**	**=**	**151 ms**

Different operating modes

You have defined the program change as a switching of the operating mode and configured an application with two operating modes. The ESPE used has a response time of 64 ms.

- In both operating modes, a 10 ms input delay and a 50 ms discrepancy time are configured for the "ESPE" input element.
- In operating mode 1, you have configured a shutdown delay of the OSSDs of 30 ms.
- In operating mode 2, you have not configured a shutdown delay.

Tab. 36: Example for the calculation of the response time for operating mode 1

Line	Required detail	Time	
1	Response time of ESPE	+	64 ms
2	Set input delay	+	10 ms
3	Internal processing time of the compact safety controller	+	10 ms
4	Set shutdown delay	+	30 ms
5	**Response time of the OSSDs**	**=**	**114 ms**

Tab. 37: Example for the calculation of the response time for operating mode 2

Line	Required detail	Time	
1	Response time of ESPE	+	64 ms
2	Set input delay	+	10 ms
3	Internal processing time of the compact safety controller	+	10 ms
4	Set shutdown delay	+	0 ms
5	**Response time of the OSSDs**	**=**	**84 ms**

➢ Use the response time of operating mode 1 (= 114 ms) to calculate the safety distance.

11.1.2 Response times with program switching

If the program switching is configured as a program change (see 4.1.3 "Program change via the program selector switch" on Page 20), special response times apply for the duration of the changeover.

For signal changes at the inputs to affect the outputs in the old program, they must occur at least $t \geq 5$ ms + t_{DI} before the changeover (t_{DI} = input filter time at the inputs).

If a signal change occurs at the inputs between $t < 5$ ms + t_{DI} and the activation of the new program, this can only have an effect in the new program. The inputs are analysed again in the new program.

➢ Observe the following examples for calculation of the response time.

Note When calculating the response time with program switching,

- t_{DI} = delay time at the inputs
- t_{DO} = shutdown delay at the outputs (new program)
- $t_{S300(0)}$ = Response time of the S3000 or S300

Response time at program switching

The period in which changes at the inputs remain unrecognised or do not act on the outputs, is greater during program switching than during the execution of a program/operating mode. This results in the following response time during program switching:

Tab. 38: Response time at program switching

Response time at program switching
20 ms + t_{DI} + t_{DO}

The calculation shows that a signal change has to exist for at least 20 ms in order for it to be recognised securely and act on the outputs.

Special case: Combination UE440/470 with S3000 or S300

An additional response time has to be taken into account during the changeover of ...

- the program switching is transferred from the UE440/470 via EFI to an S3000 or S300
- the S3000 or S300 supplies the status again via EFI to the UE440/470
- and this OSSD information is wired to an output of the UE440/470.

Tab. 39: Response time with transfer to S3000 or S300 via EFI

Response time program switching with S3000 or S300
1.5 x $t_{S300(0)}$ + 21 ms + 20 ms t_{DI} + t_{DO}

Example

The S3000 used has a response time of 60 ms. You have not configured an input delay or a shutdown delay.

Tab. 40: Example for the calculation of the response time of an S3000

Line	Required detail	Time
1	1.5 x response time of the connected sensor: S3000: 60 ms	+ 90 ms
2	Additional value for the transfer time of OSSD status information via EFI S3000: 21 ms	+ 21 ms
3	Internal processing time of the compact safety controller	+ 20 ms
4	Set input delay	+ 0 ms
5	Set shutdown delay	+ 0 ms
6	**Response time of the OSSDs**	**= 131 ms**

Special case: Combination of UE440/470 with C4000

If the operating mode switch-over is transferred from the UE440/470 via EFI to a C4000, the input filter time of the C4000 is to be observed (see operating instructions "C4000 Standard/Advanced").

The C4000 does not switch to the new operating mode until after this filter time has expired.

11.2 Data sheet

All data based on a temperature of 40 °C.

Tab. 41: Technical data UE440/470

	Minimum	Typical	Maximum
General system data			
Protection class	III according to EN 50178		
Enclosure rating	IP 20 according to EN/IEC 60529		
Category	Type 4 (EN 954-1), SIL3[5] (IEC 61508)		
Casing dimensions	See Chapter 11.3 "Dimensional drawing" on Page 104		
Weight	590 g		
Operating data			
Voltage supply (SELV) U_V at device[6]	19.2 V	24 V	28.8 V
Residual ripple[7]			±10 %
Current consumption			4.5 A
Operating temperature	0 °C		+50 °C
Storage temperature	–25 °C		+80 °C
Air humidity (non-condensing)	35 %		85 %
Power-up delay after connecting the voltage supply		3 s	
Function data			
Active PSDI time limit for hydraulic presses (configurable)	5 s		500 s
Muting for eccentric press modules and protective module with machine cycle contact evaluation			30 s (< V2.21) 10 min (V2.21 and higher)
EFI connections (secure SICK device communication)			
Cable length for 500 kbps and 0.5 mm² cables			50 m
Cable type to be connected	Twisted pair (if shielding is required for EMC reasons, copper shield netting)		
Wave resistance of the cable to be connected	108 Ω	120 Ω	132 Ω

[5] Depending on sensor connection.
[6] The external voltage supply must be capable of buffering brief mains failures of 20 ms as specified in EN 204-1.
[7] Within the limits of U_V.

	Minimum	Typical	Maximum
Inputs (I1.0 to I1.6, I2.0 to I2.3, I3.0 to I3.3)			
Input voltage HIGH	11 V	24 V	30 V
Input current HIGH	6 mA	12 mA	20 mA
Input voltage LOW	–30 V	0 V	5 V
Input current LOW	–2.5 mA	0 mA	5 mA
Test pulse data for connected input devices and sensors			
Test pulse width[8)]			600 µs
Input delay (configurable)	This information is to be obtained from the CDS.		
Discrepancy time for dual-channel inputs used (configurable)	This information is to be obtained from the CDS.		
Input frequency			100 Hz
Switching Outputs O2.0 to O2.3			
Switching outputs	2 PNP semiconductor, short-circuit protected[9)], cross-circuit monitored		
Response time	See Section 11.1 "Response times of OSSDs A and B" on Page 96		
Shutdown delay (configurable)	This information is to be obtained from the CDS.		
Switch off time	5 ms		
Switch on time (once the necessary signals are present at the inputs)			10 ms
Switching voltage[10)] HIGH (active, U_{eff})	Uv –2.7 V		Uv
Switching voltage[10)] LOW (inactive)	0 V	0 V	3.5 V
Switching voltage	0 mA		500 mA
Leakage current[11)]			0.25 mA
Load capacity			2.2 µF

[8)] Pulses ≤ the test pulse width are filtered at the inputs. They do not influence the input result.
[9)] Applies for voltages in the range of 0 V and +30 V.
[10)] In accordance with IEC 61131-2.
[11)] In case of a fault (interruption of the 0V line), the leakage current flows to the OSSD line. The downstream control element must identify this condition as LOW. An EPLC (error-proof programmable logic controller) must identify this condition.

	Minimum	Typical	Maximum
Switching sequence	Depending on load inductance		
Load inductance[12)]			2.2 H
Test pulse data[13)]			
Test pulse width	120 µs	150 µs	300 µs
Test pulse rate	3 ^{1}/s	4 ^{1}/s	10 ^{1}/s

Signal outputs O1.0 to O1.2

Output voltage HIGH	Uv –3.5V		Uv
Output current HIGH			100 mA
Internal resistance to 0 V (switched off)		3.7 kΩ	
Current limit	300 mA		500 mA
Output voltage LOW	0 V	0 V	3 V
Test pulse rate (O1.0 and O1.1)		1 ^{1}/s	

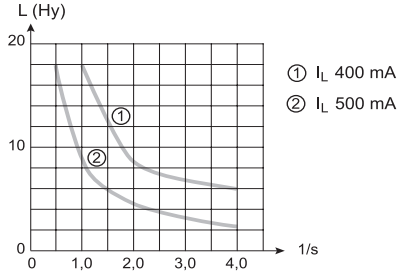
Signal output O1.3

Output voltage HIGH	U_V –3.5 V		U_V
Output current HIGH			275 mA
Current limit	300 mA		500 mA
Internal resistance to 0 V (switched off)		3.7 kΩ	
Minimum current (undervoltage detection)		20 mA	
Output voltage LOW	0 V	0 V	3 V

Configuration and diagnostics interface

Communication protocol	RS-232 (proprietary)		
Transfer speed	9600 baud 19200 baud 38400 baud 57600 baud		
Cable length for 9000 kbps and 0.25 mm² cables			15 m
Galvanized decoupling	No		

[12)] The maximum rated load inductance is higher with lower switching sequence.



[13)] When active, the outputs are tested cyclically (brief LOW). When selecting the downstream controllers, make sure that the test pulses do not result in deactivation when using the above parameters.

	Minimum	Typical	Maximum
Terminal screws			
Screw torque	0.5 Nm		0.6 Nm
Stripped length of wire		7 mm	
Connection capacity (1 conductor)			
Diameter of fixed wires	0.2 mm²		2.5 mm²
Diameter of flexible wires	0.2 mm²		2.5 mm²
American Wire Gauge (AWG)	24		12
Diameter of flexible wires with wire end ferrules	0.25 mm²		2.5 mm²
Connection capacity (2 conductors of the same diameter)			
Diameter of fixed wires	0.2 mm²		1 mm²
Diameter of flexible wires	0.2 mm²		1.5 mm²
Diameter of flexible wires with wire end ferrules (no plastic sheath)	0.25 mm²		1 mm²
Diameter of flexible wires with TWIN wire end ferrules (with plastic sheath)	0.5 mm²		1.5 mm²
Permissible cable resistance between supply cables			1 Ω
Permissible cable resistance between cables and load[14)]			2.5 Ω

11.3 Dimensional drawing

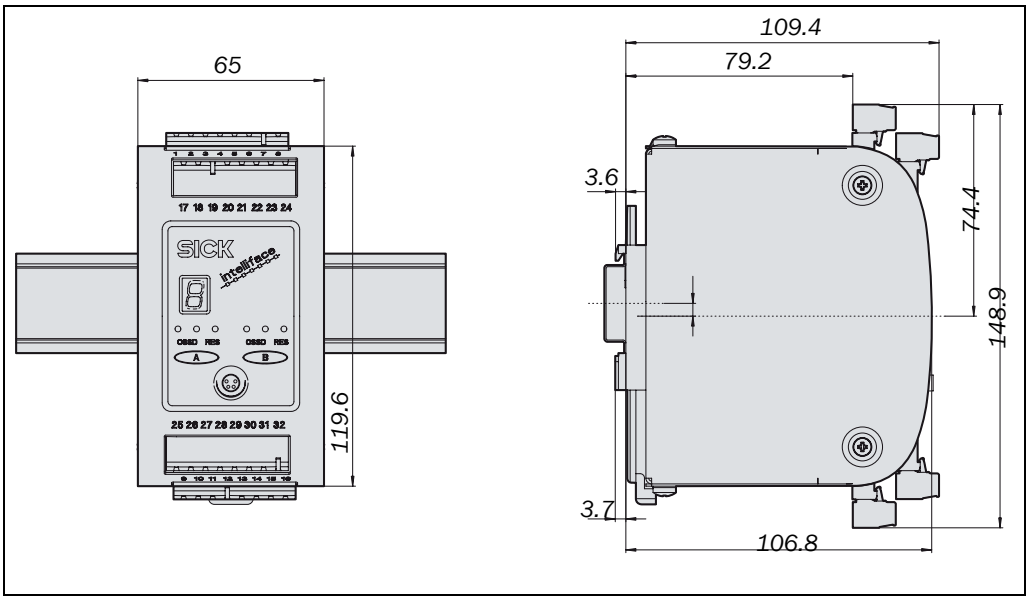


Fig. 57: Dimensional drawing of UE440/470 (dimensions in mm)

[14)] Limit the cable resistance of the individual wires to the downstream control element to this value so that a cross-circuit between the outputs is definitely identified. (In addition, note EN 60204 Electrical Machine Equipment, Part 1: General Requirements.)

12 Ordering information

12.1 Scope of delivery

- Compact safety controller UE440/470
- System plug
- Operating instructions and CDS (Configuration & Diagnostic Software) on CD

Note You will require the release code for the UE440/470 for CDS (see Section 12.3.2 "CDS and connection cable" on Page 105), which is not included with the delivery.

12.2 Available systems

Tab. 42: System article numbers

Device type	Part	Part number
UE440-A0410	Compact safety controller for multifunction applications	1023859
UE470-A0410	Compact safety controller for UE470 PSDI applications	1023862

12.3 Accessories/Spare parts

12.3.1 System plug

Tab. 43: System plug article numbers

Part	Description	Part number
System plug	Four pre-encoded screw-connection terminal strips, including blank fields in bag	2029991

12.3.2 CDS and connection cable

Tab. 44: Part numbers of CDS and connection cable

Part	Description	Part number
CDS	Configuration & Diagnostic Software on CD including online documentation and operating instructions in all available languages	2032314
Release code of CDS software	Release code of CDS software Enables configuration and online diagnostics of the UE440/470 and the connected EFI devices	2031323
2 m connection cable	For connection of the configuration connection to the serial interface of the PC M8×4-pin/D-Sub 9-pin (DIN 41642) approx. 2 m	6021195
8 m connection cable	For connection of the configuration connection to the serial interface of the PC M8×4-pin/D-Sub 9-pin (DIN 41642) approx. 8 m	2027649

12.3.3 Connection cable for self-made cables

Tab. 45: Connection line part numbers

Part	Part number
EFI line sold by the metre 1 × 2 × 0.22 mm^2	6029448
EFI line sold by the metre 3 × 2 × 0.75 mm^2	6020500

13 Annex

13.1 Declaration of conformity

SICK

EC Declaration of conformity

en

Ident-No. : 9092088

The undersigned, representing the following manufacturer

SICK AG
Industrial Safety Systems
Sebastian-Kneipp-Straße 1
79183 Waldkirch
Deutschland

herewith declares that the product

UE440/UE470

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Waldkirch, 12.9.09

ppa. Dr. Plasberg
(Manager Research and Development)
(Industrial Safety Systems)

i.V. Knobloch
(Manager Production)
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13.2 Checklist for the manufacturer

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Checklist for the manufacturer/installer for installation of the compact safety controller UE440/470

The specifications for the following items listed must be available at least for the initial commissioning. They are dependent on the application, whose requirement must be checked by the manufacturer/installer.

This checklist should be retained/stored with the machine documentation so that you can use it as a reference for periodical tests.

1. Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	Yes ☐	No ☐
2. Are the applied directives and standards listed in the declaration of conformity?	Yes ☐	No ☐
3. Does the protective device comply with the required category?	Yes ☐	No ☐
4. Are the required protective measures against electric shock in effect (protection class)?	Yes ☐	No ☐
5. Has the protective function been checked in compliance with the test notes of this documentation? Especially: • Functional check of the input devices, sensors and actuators connected to the compact safety controller • Test of all switch-off paths	Yes ☐	No ☐
6. Are you sure that the compact safety controller was tested fully for safety functionality after each configuration change?	Yes ☐	No ☐

This checklist does not replace initial commissioning and regular tests by specialist personnel.

13.3 List of tables

13.4 List of illustrations

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