EFI – Enhanced Function Interface

Safe SICK device communication

en

SICK
Sensor Intelligence.

Contents

1 About this document

Please read this chapter carefully before working with the technical description.

1.1 Function of this document

This technical information gives you an overview of the possibilities, expanded functionality and the technical implementation of safety-related applications with the Enhanced Function Interface from SICK AG.

1.2 Abbreviations used

CDS	SICK Configuration & Diagnostic Software
EDM	External device monitoring
EFI	Enhanced function interface = safe SICK device communication
ESPE	Electro-sensitive protective equipment (e.g. C4000, S300)
(F)PLC	(Fail-safe) Programmable logic controller
OSSD	Output signal switching device = signal output that drives the safety circuit

1.3 Symbols used

Note   Refer to notes for special features of the device.

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

⚠ WARNING

Warning!

A warning indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents.

Read carefully and follow the warning notices!

Software notes show the location in the CDS (Configuration & Diagnostic Software) where you can make the appropriate settings and adjustments. In the CDS open the menu **View**, **Dialog box** and select the item **File Cards** to go straight to the stated dialog fields. Alternatively, the software wizard will guide you through the appropriate setting.

2   On safety

2.1   General safety notes and protective measures

WARNING

Use the related operating instructions for the devices!

This technical information does not replace the operating instructions for the ESPE, safety controllers or the EFI gateway described in the following.

These operating instructions are to be made available to the operator of the system, machine or vehicle on which an ESPE, a safety controller or an EFI gateway is used. The operator is to be instructed in the use of the device by qualified safety personnel and must be instructed to read and observe the operating instructions.

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3 Basics

This chapter describes the possibilities offered by the Enhanced Function Interface (EFI).

The Enhanced Function Interface (EFI) was developed to implement safe communication between ESPE, Flexi Soft modular safety controller or EFI gateway.

However, EFI is more than an interface for connecting together SICK devices. EFI expands the functionality of the individual protective devices.

Using protective devices connected with EFI, safety-related applications can be implemented that would otherwise only be possible with a large amount of circuitry or extensive installation effort. These applications include, for example, simultaneous protective field monitoring using the S3000 safety laser scanner, operating mode switching on the C4000 or sampling status signals (e.g. for a contaminated front screen).

Status and control information is exchanged between devices via EFI. The applications can be integrated into higher level bus systems using EFI gateways.

In addition the concurrent configuration of the devices in a project is possible.

You will find the advantages of EFI in SICK safety systems only.

3.1 Devices with EFI

The following product families are equipped with EFI:

- M4000 multiple light beam safety device: Advanced, Area
- UE403 switching amplifier
- C4000 safety light curtain: Standard, Advanced, Entry/Exit, Palletizer, Fusion, Standard Guest, Advanced Guest
- M4000 multiple light beam safety device: Standard Curtain, Advanced Curtain
- UE402 switching amplifier
- S3000 safety laser scanner: Standard, Advanced, Professional, Expert, Remote, Cold Store, Anti Collision
- S300 safety laser scanner: Standard, Advanced, Professional, Expert
- S300 Mini safety laser scanner: Remote
- UE4740 EFI gateway
- Flexi Soft FX3-CPU1, -CPU2, -CPU3 modular safety controller

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3.2 Function expansion by connecting ESPE

By connecting together individual ESPE via EFI additional applications become possible.

Example 1: Two S300 in host/guest operation

Fig. 1: Velocity-dependent vehicle monitoring for bi-directional travel
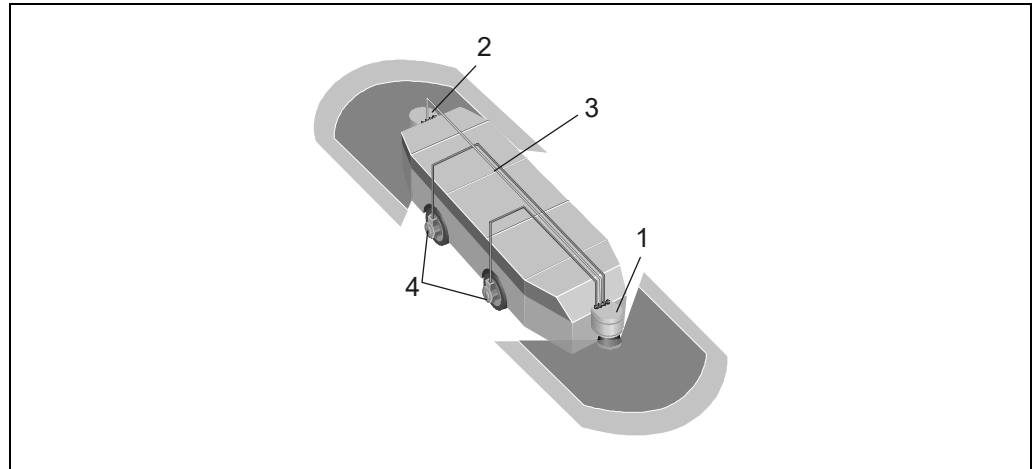
The S300 safety laser scanners are connected to a host/guest system via an EFI connection. It is then possible, for instance, to realize vehicle monitoring in two directions of movement.

The guest (2) receives the incremental encoder values (4) from the host (1) over the EFI interface (3). It monitors the areas for the second direction of travel as a function of the velocity. As soon as there is an object in the protective field, it switches the OSSDs on the host via the EFI interface to the OFF state (5).

Fig. 2: Principle of the S300 host/guest system
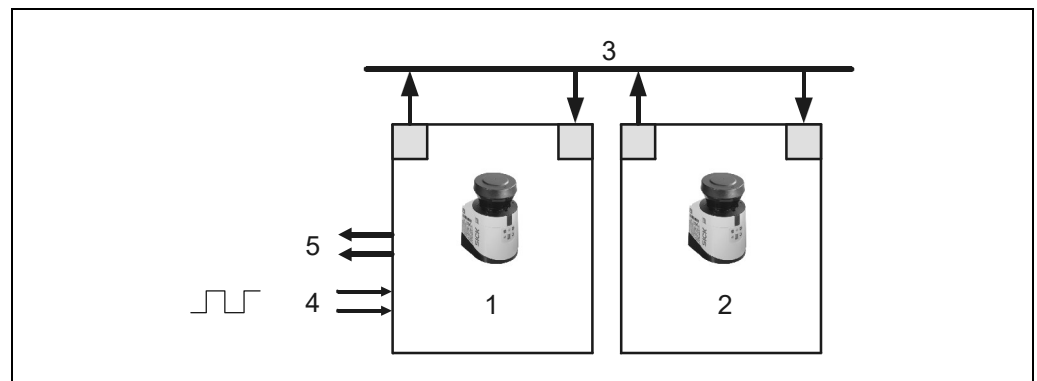
Advantages:

- less configuration effort:
  - central interface for the configuration of the system
  - concurrent monitoring case switching
- less wiring costs:
  - The cables for the input signals only need to be connected to the host.
  - One pair of OSSDs is sufficient for the entire system.
- simplified diagnostics on the host/guest system:
  - combined error messages
  - central interface for system diagnostics

Example 2: Two C4000 in operation as a cascaded system
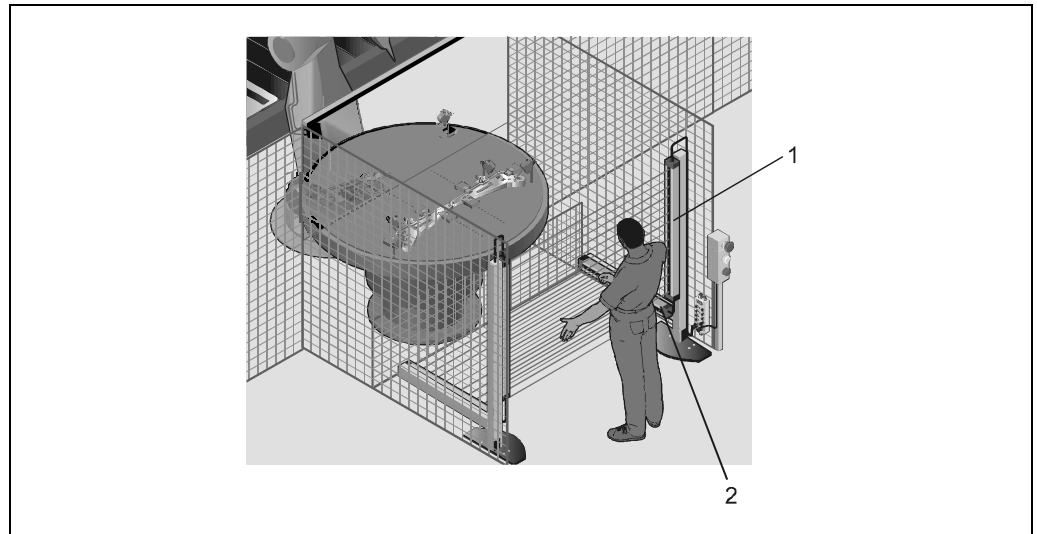
Two C4000 safety light curtains form a cascaded system. The C4000 Host (1) performs the actual hazardous point protection on a press. The C4000 Guest (2) performs the presence detection. The two C4000 are connected together using EFI. The OSSDs on the C4000 Host are integrated into the machine controller (4). If the protective field of the C4000 Guest is interrupted by standing behind or by an attempt at crawling beneath/reaching under, the OSSDs on the C4000 Host are switched via EFI (3) to the OFF state.
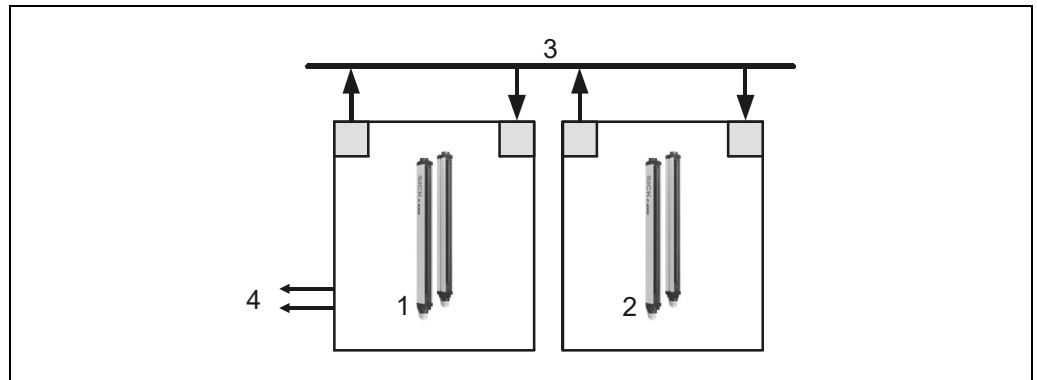
Advantages:

- Up to three safety light curtains can be connected to each other.
- No additional external circuitry required. Quick to connect.
- Resolution and protective field height may differ among the individual systems.

3.3   Function expansion using switching amplifiers

Using the UE402 switching amplifiers for C4000 and UE403 for M4000 the functionality of the C4000 safety light curtains and the M4000 multiple light beam safety devices can be expanded.

Example: Muting with M4000 and UE403

Fig. 5: Access protection with muting
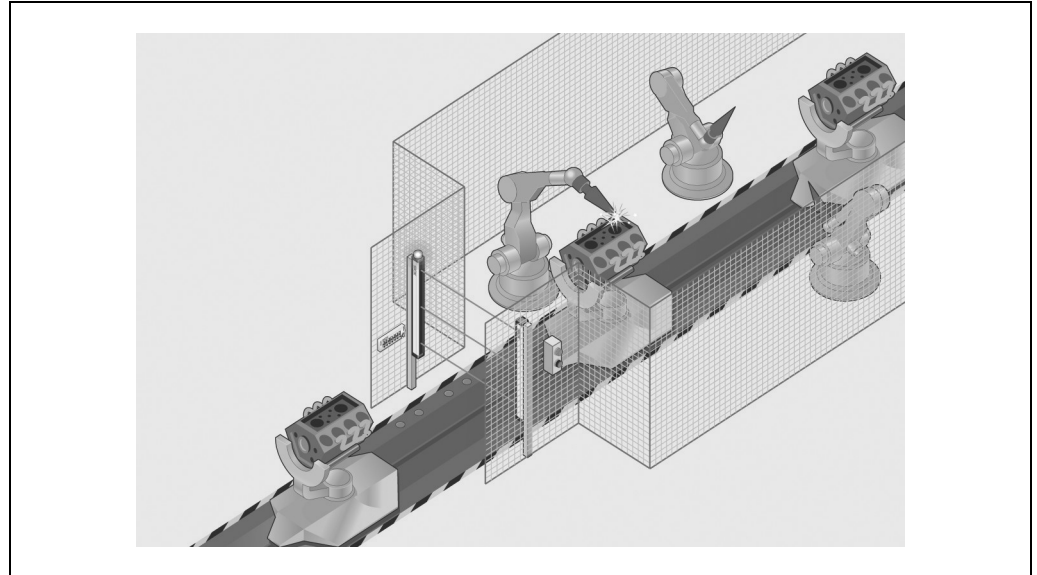
Two pairs of inductive muting sensors (1) connected to the UE403 detect the transport platform. The UE403 switching amplifier (2) transmits signals via EFI (3) to the M4000 multiple light beam safety device (4) and controls the muting function.

Fig. 6: Principle of the M4000 muting system
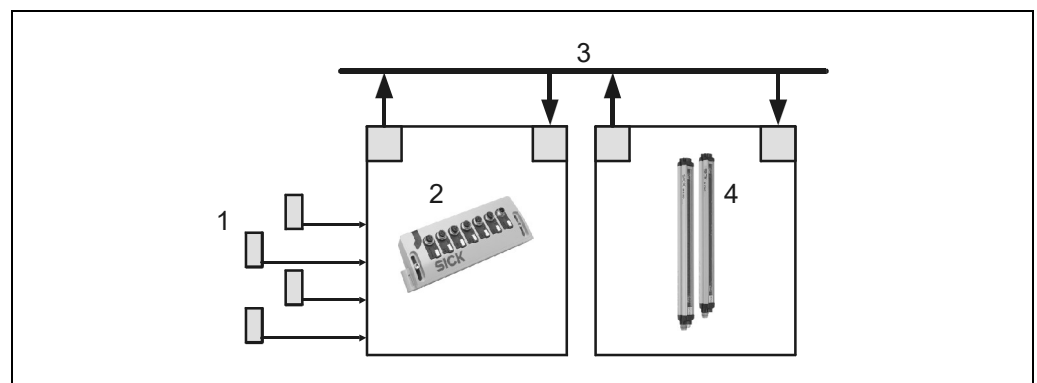
Advantages:

• less wiring due to local connection of all signals

• less wiring between switching amplifier and ESPE due to EFI

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3.4 Applications with safety controllers

Complex safety applications can be solved specifically using safety controllers.

Fig. 7: Safety application with a Flexi Soft safety controller
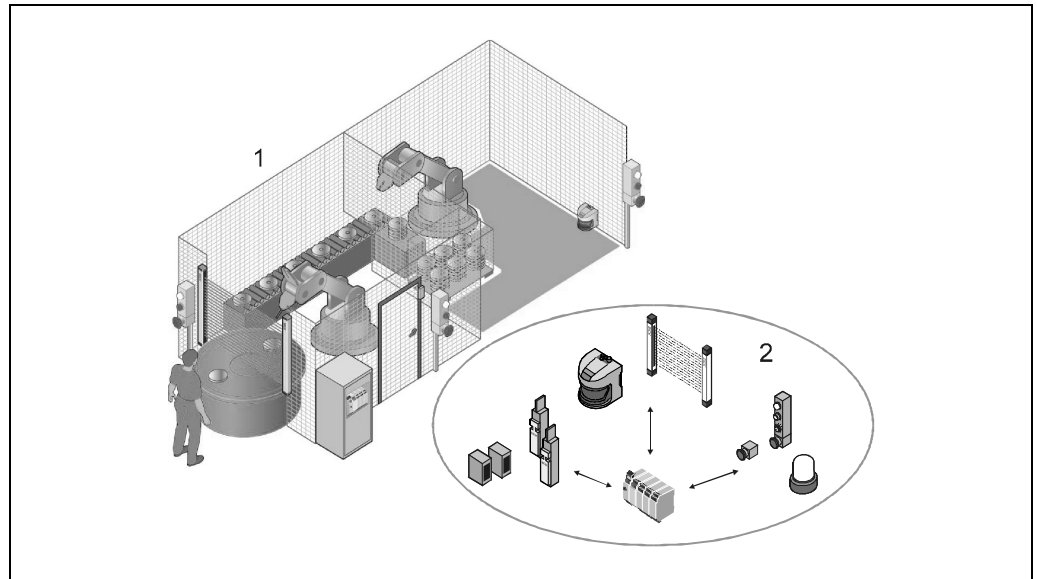
In the insertion station with rotary table shown and the downstream robot station (1) all the safety-related functions (hazardous point protection, hazardous area protection, door contacts, emergency stop, restart) are realized using a Flexi Soft safety controller (2). The ESPE are integrated into the safety application via EFI.

Fig. 8: Simultaneous protective field monitoring with S3000 and a safety controller
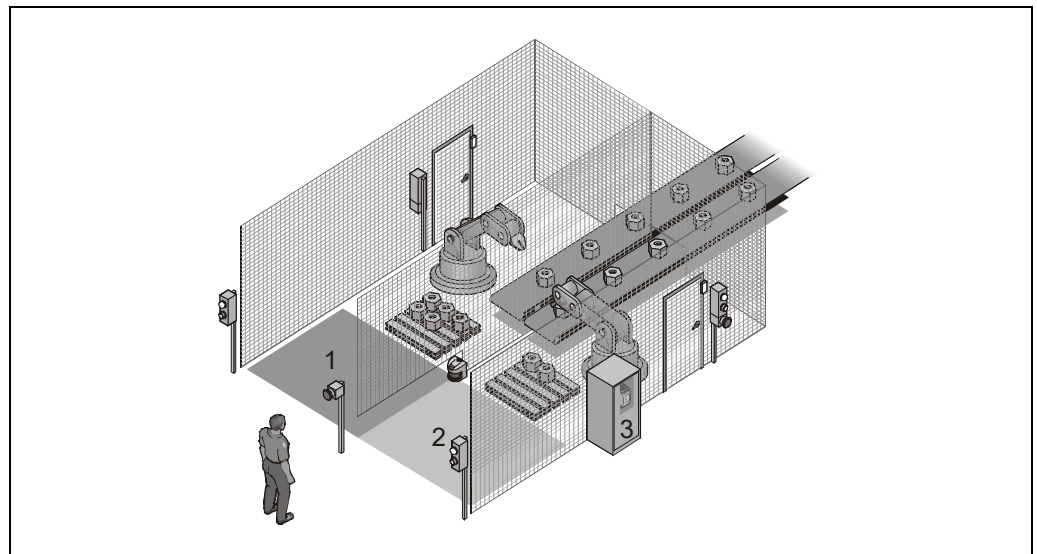
One S3000 simultaneously monitors two protective fields (1 and 2). Via EFI it signals the states of the protective fields to the Flexi Soft safety controller (3). The safety controller has two OSSDs for separate safe shut down. The related industrial robot is shut down by an object in one of the protective fields. The second station continues to operate.

Advantages:

- all safety-relevant functions in one application

- one ESPE saved due to simultaneous protective field monitoring

- increased availability of the system, as only the robots related to the hazardous situation are stopped and not the complete system

3.5   Network solutions

By integrating ESPE with the aid of the EFI gateway it is possible to bidirectionally transmit configuration, status and diagnostics functions from the ESPE to the bus system PROFINET IO PROFIsafe.

Using the EFI gateway, one or more ESPE or even entire applications realized with safety controllers can be integrated into, for example, an (F)PLC.

Fig. 9: Integration of two S300 in host/guest operation into a bus system

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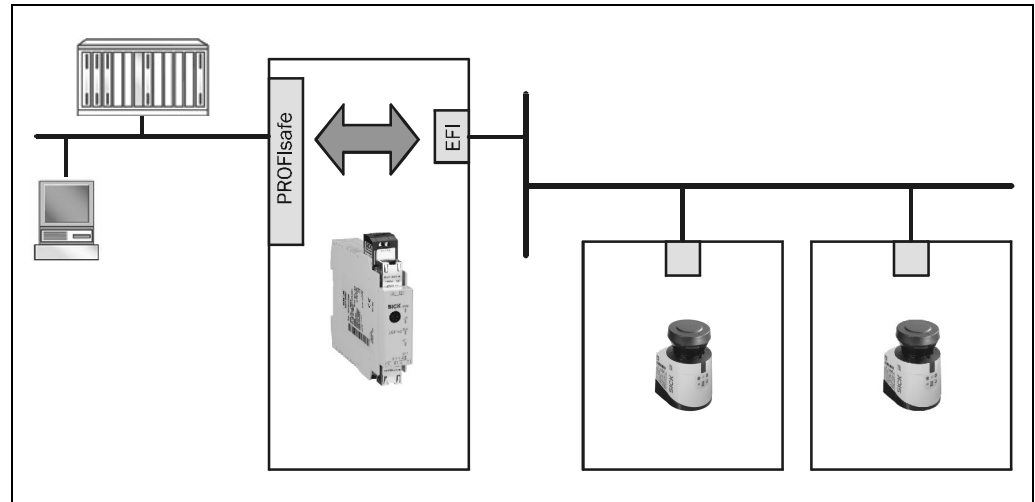
4   Technical realization

EFI is a linear bus system. Up to four devices can be connected to this bus system. The actual number of devices depends on the related application or product family.

Fig. 10: Safety controller with ESPE connected via two EFI strings
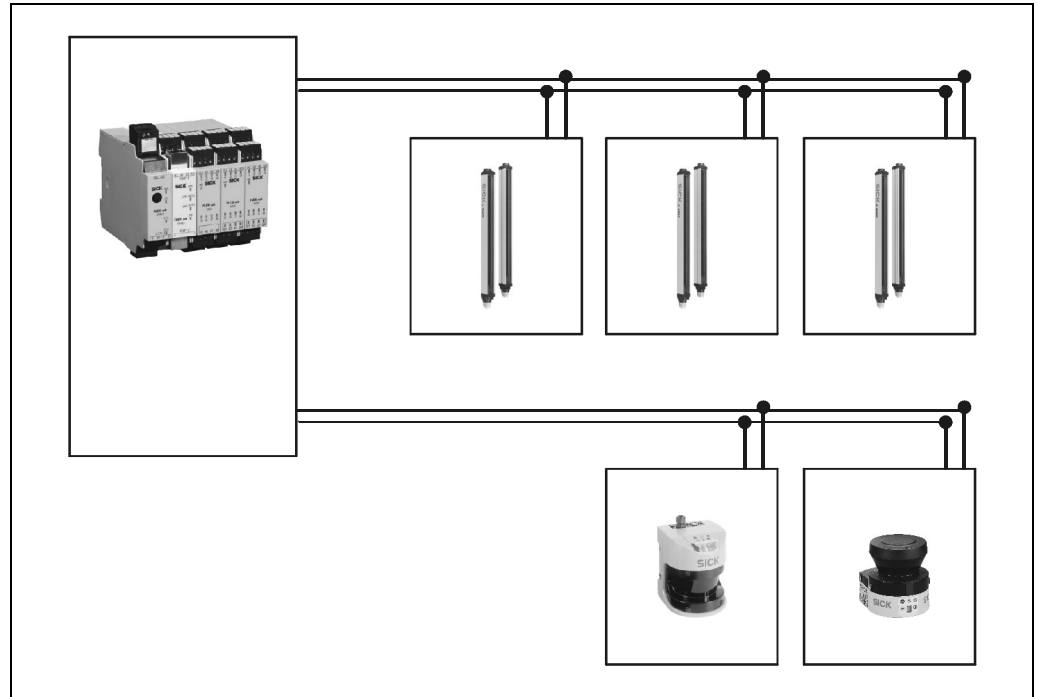
Twisted-pair cable with a characteristic impedance of 108 … 132 Ω is used as the bus medium (see also chapter 6 "Technical specifications" on page 54).

4.1   Data exchange via EFI

To enable data to be exchanged via EFI, each device connected has a unique address.

Fig. 11: Example data exchange between two S3000
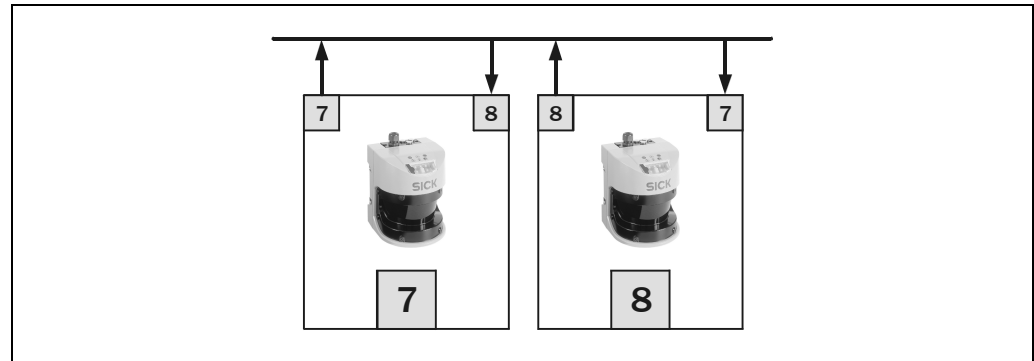
In the example the S3000 Host has the address 7, the S3000 Guest the address 8. The host receives via address 8 the status information on the OSSDs and the diagnostics messages from the guest on contamination. The guest however receives the incremental encoder values from the host over the address 7.

The safety controllers receive via these addresses status information on the electrosensitive protective devices (C4000, S3000 etc.) or they control functions on the ESPE via these addresses (muting, operating mode switching etc.).

If an EFI system is connected via an EFI gateway to a PROFINET IO, these data can be forwarded to an (F)PLC or control tasks performed by the (F)PLC.

Fig. 12: Example data exchange between an (F)PLC and an M4000 via an EFI gateway
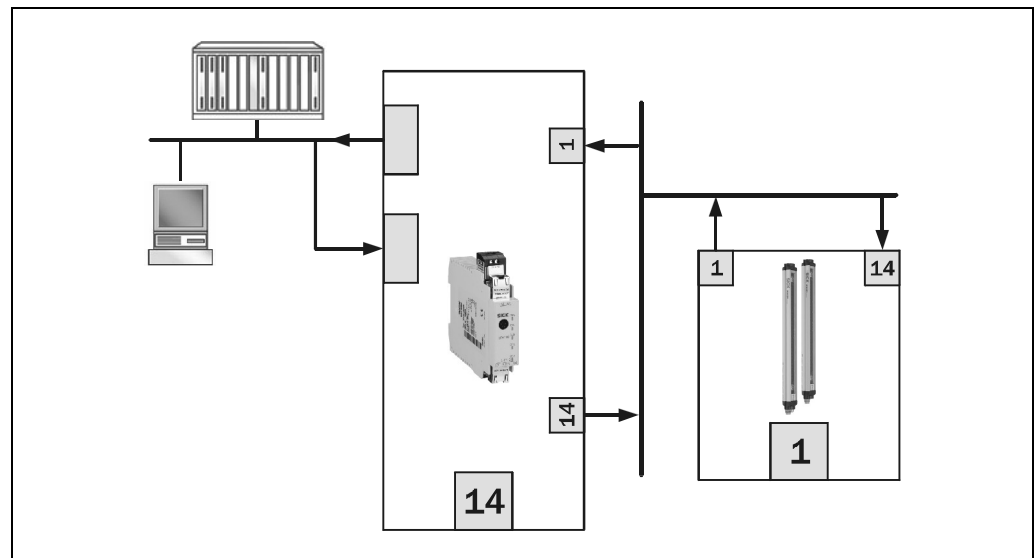
In the example the (F)PLC can write data to the M4000 via the routing in the EFI gateway (address 14). I.e. muting signals can be simulated by the control system. Conversely, status information including the output information from the M4000 (address 1) can be transferred to the (F)PLC via the routing in the EFI gateway.

4.1.1 Addressing

The SICK product families have the following addresses on the EFI:

Product families	Device address
C4000 receiver (Host)	1
C4000 receiver (Guest 1)	2
C4000 receiver (Guest 2)	3
C4000 sender (Host)	4
C4000 sender (Guest 1)	5
C4000 sender (Guest 2)	6
M4000 receiver	1
M4000 sender	4
S3000 (Host/Guest)	7/8
S300 (Host/Guest)	7/8
S300 Mini (Host/Guest)	7/8
UE402	14
UE403	11/12/13/14
Flexi Soft FX3-CPU1, -CPU2, -CPU3	11/12/13/14
UE4740 EFI gateway	13/14

Notes
- Devices with the same address cannot be operated on the EFI at the same time.

- If there are several C4000 safety light curtains on the EFI string, the addresses for the cascaded system are assigned automatically.

  The addresses are saved in non-volatile memory in the device memory in the C4000. The device can no longer be used as a standalone device or in a different system position.

  Reset the system position saved in the C4000 using the CDS configuration software or using the Host-Guest Plug available as an accessory.

- In an EFI system with two safety laser scanners, set the address of one of the scanners to guest! The procedure for addressing is described in the related operating instructions in the chapter "Electrical installation" (S300 Mini, S300, S3000).

- For the UE4740 EFI gateway, the UE403 and the Flexi Soft FX3-CPU1, -CPU2, -CPU3 the EFI device address can be modified using CDS or Flexi Soft Designer.

  To change the addresses of the EFI gateway, connect to the EFI gateway in the CDS. Right click the symbol for the EFI gateway and on the context menu choose **Operate service/gateway with control system**.

  To change the addresses of the Flexi Soft FX3-CPU1, -CPU2, -CPU3, connect to the Flexi Soft Designer and the CPU. Right click the symbol for the CPU, a menu then appears where you can select the required EFI device address.

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4.1.2 Sending and receiving of information

Send

Each device sends exactly one item of status information with a length of up to 26 bits of data (C4000 and M4000 senders do not provide any information, this is provided by the C4000 or M4000 receivers).

The status information is not addressed to a specific user on the EFI string, i.e. all users on the EFI string can receive the status information.

Receive

The product families differ in the number of items of status information received.

The maximum number of items of status information received and their addresses are listed in the following table by product family. The table shows the items of status information received per EFI string.

Tab. 2: Maximum number of items of status information received

Product family	Device address	Max. number of items of status information received	Device addresses from which items of status information are received
M4000 receiver	1	1	11, 12, 13 or 14
C4000 receiver (Host)	1	3	2, 3 and 14
C4000 receiver (Guest 1)	2	–	–
C4000 receiver (Guest 2)	3	–	–
S3000 (Host)	7	1	8, 13 or 14
S3000 (Guest)	8	1	7, 13 or 14
S300 (Host)	7	1	8, 13 or 14
S300 (Guest)	8	1	7, 13 or 14
S300 Mini (Host)	7	1	13 or 14
S300 Mini (Guest)	8	1	7, 13 or 14
UE402	14	1	1
UE403	14	1	1
Flexi Soft FX3-CPU1, -CPU2, -CPU3	11-14	3	1-8, 11-14
UE4740 EFI gateway	13/14	3	1-8, 13/14

Notes
- The maximum number of items of status information received defines the number of devices from which a device can receive information (e.g. C4000 Host from the two guests and a safety controller).

- The devices addresses in column 4 define the devices to which a device can be connected. The C4000 Host receives, e.g., only the addresses 2 and 3 (C4000 Guests) and 14 (safety controllers or EFI gateways). The connection of an M4000 (1) or an S3000 (7) is not possible.

- Also pay attention to the information given in section 4.2 "Firmware compatibility of the EFI devices" on page 17.

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4.2 Firmware compatibility of the EFI devices

The following tables show which ESPE can be connected to which device.

4.2.1 C4000 safety light curtain

Tab. 3: Firmware compatibility C4000/UE devices

		C4000 receiver												C4000 sender				
		C4000 Advanced	C4000 Standard	C4000 Guest / C4000 Advanced	C4000 Guest / C4000 Standard	C4000 Advanced / C4000 Advanced	C4000 Standard / C4000 Standard	C4000 Entry/Exit	C4000 Palletizer	C4000 Palletizer II	C4000 Fusion	C4000 Guest		C4000 Standard/Advanced	C4000 Guest / C4000 Standard/Advanced	C4000 Strd./Adv. / C4000 Standard/Advanced	C4000 Entry/Exit	C4000 Palletizer
	Firm-ware	V3.31	V3.31	V3.31	V3.31	V3.31	V3.31	V5.05	V5.05	V6.11	V7.21	V3.33	Firm-ware	V6.00	V6.00	V6.00	V6.00	V6.00
Flexi Soft	V1.00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	V1.00	✓	✓	✓	✓	✓
UE4740	V1.11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	V1.11	✓	✓	✓	✓	✓
UE402	V1.10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	–	✗	✗	✗	✗	✗
UE403	–	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	–	✗	✗	✗	✗	✗

Legend

✓ Possible

✗ Not possible

? On request

4.2.2 M4000 multiple light beam safety device

Tab. 4: Firmware compatibility M4000/UE devices

| | | M4000 receiver | | | M4000 sender | | |
| | | M4000 Advanced / M4000 Advanced Curtain / M4000 Advanced A/P / M4000 Area | UE403 — M4000 Advanced / M4000 Advanced Curtain / M4000 Advanced A/P / M4000 Area | | M4000 Advanced Curtain | M4000 Advanced | M4000 Area |
	Firm-ware	V1.50	V1.50	**Firm-ware**	V1.10	V1.10	V1.10
Flexi Soft	V1.11	✓	✓	V1.00	✓	✓	✓
UE4740	V1.12	✓	✓	V1.11	✓	✓	✓
UE402	–	✖	✖	–	✖	✖	✖
UE403	V1.51	✓	✖	–	✖	✖	✖

Legend

✓   Possible

✖   Not possible

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4.2.3   S300/S3000 safety laser scanners

Tab. 5: Firmware compatibility S300/S3000/UE devices

		— Standalone device on an EFI partner device												Host/Guest on an EFI partner device								
		S3000 in compatibility mode	S3000 Coldstore in compatibility mode	S300 in compatibility mode	S3000 i in compatibility mode	S3000 Coldstore in compatibility mode	S300 i in compatibility mode	S300 Mini Remote	S300	S3000 Coldstore	S3000 Anti Collision	S3000	**Guest →** S3000 Anti Collision	S3000	S3000 Coldstore	S300	S300	S300 Mini Remote	S300 Mini Remote, S3000 or S300	S3000, S300, S300 Mini Remote	S300, S300 Mini Remote
													Host → S3000 Anti Collision	S3000	S3000 Coldstore	S300	S3000 or S300	S300 Mini Remote	S3000 Expert	S3000	S300
Flexi Soft	V1.00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (V1.11)	✓	✓	✓	✓	✓	✓	✓	✓	✓
UE4740	V1.11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (V1.11)	✓	✓	✓	✓	✓	✓	✓	✓	✓
UE402	–	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗ (–)	✗	✗	✗	✗	✗	✗	✗	✗	✗
UE403	–	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗ (–)	✗	✗	✗	✗	✗	✗	✗	✗	✗

Legend

✓   Possible

✗   Not possible

Note   Compatibility with the S3000 is provided if the sensor head as well as the I/O module have a serial number of 1221XXX or later.

4.3   Description of the bytes and bits of the EFI communication

4.3.1   Bytes of the EFI communication

Tab. 6: Bytes of the EFI communication

Byte	Description
Byte 0	General data
Byte 1	General and device-specific data
Byte 2	Device specific data
Byte 3	Device specific data
Byte 4	CRC LB[1]
Byte 5	CRC HB[2]

[1]   CRC (covers data and device code) Low Byte.
[2]   CRC (covers data and device code) High Byte.

Technical realization

Description of bit 0 to 7 of byte 0

Byte 0	0.0 [3]	0.1 [3]	0.2 [3]	0.3	0.4	0.5	0.6	0.7
General	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD1	OSSD2	Warning Field 1	Weak (pollution warning)	Reset Switch Input (button pressed)
C4000 receiver	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD1 (HW OSSD State)	OSSD2 (virtual)	Not used	Weak (pollution warning)	Reset Switch Input
M4000 receiver	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD1 (HW OSSD State)	OSSD2 (virtual)	Not used	Weak (pollution warning)	Reset Switch Input ≥V01.20 Reset/RES/ OVR Switch Input (MI2)
S3000 in compatibility mode [4]	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD S3000_1	OSSD S3000_2	Status Warning Field	Weak (pollution warning)	Reset (button pressed)
S3000	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD	Speed Valid	Status Warning Field 1	Weak (pollution warning)	Reset (button pressed)
S3000 Anti Collision	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD	Speed Valid	Not used	Weak (pollution warning)	Reset (button pressed)
S300 in compatibility mode [4]	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD S300_1	OSSD S300_2	Status Warning Field 1	Weak (pollution warning)	Reset (button pressed)
S300	Dynamic Counter	Dynamic Counter	Dynamic Counter	OSSD	Speed Valid	Status Warning Field	Weak (pollution warning)	Reset (button pressed)
S300 Mini	Dynamic Counter	Dynamic Counter	Dynamic Counter	Not used	Not used	Status Warning Field	Weak (pollution warning)	Not used
UE402	Dynamic Counter	Dynamic Counter	Dynamic Counter	0	0	Input Pin B1 conditional Override (identical to bit info tech in terminal status)	Input Pin B2 conditional Override (identical to bit info tech in terminal status)	0
UE403	Dynamic Counter	Dynamic Counter	Dynamic Counter	0	0	Not used (Input Pin B1 Bypass)	Not used (Input Pin B2 Bypass)	RES/OVR Switch Input (UI2)
UE4740	Dynamic Counter	Dynamic Counter	Dynamic Counter	Byte 0, Bit 3	Byte 0, Bit 4	Byte 0, Bit 5	Byte 0, Bit 6	Byte 0, Bit 7
Flexi Soft	Dynamic Counter	Dynamic Counter	Dynamic Counter	Byte 0, Bit 3	Byte 0, Bit 4	Byte 0, Bit 5	Byte 0, Bit 6	Byte 0, Bit 7

Tab. 7: Byte 0 of the EFI communication

[3] Bit is device internal predefined. Read only.
[4] For information on the compatibility mode see the operating instructions for the devices.

Description of bit 0 to 7 of byte 1

Byte 1	1.0	1.1[5]	1.2[6]	1.3[6]	1.4	1.5	1.6	1.7
General	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Specific device data	Specific device data	Specific device data	Specific device data
C4000 receiver	Reset Required State	I/O error	Diagnostic classification	Diagnostic classification	User Modes	User Modes	User Modes	EStop status
M4000 receiver	Reset Required State	I/O error	Diagnostic classification	Diagnostic classification	Not used	Not used	Not used	C1/CBS Switch Input (MI1)
S3000 in compatibility mode[7]	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1	Input Pin A2	Input Pin B1	Input Pin B2
S3000	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1	Input Pin A2	Input Pin B1	Input Pin B2
S3000 Anti Collision	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1	Input Pin A2	Input Pin B1	Input Pin B2
S300 in compatibility mode[7]	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1	Input Pin A2	Input Pin B1	Input Pin B2
S300	Reset Required (Reset Lamp)	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1/ Input Pin C1[8]	Input Pin A2/ Input Pin C2[8]	Input Pin B1	Input Pin B2
S300 Mini	Not used	I/O error	Not used	Not used	Not used	Not used	Not used	Not used
UE402	0	I/O error	Diagnostic classification	Diagnostic classification	Input Pin A1	Input Pin A2	Input Pin A3	Input Pin A4
UE403	Muting/Override Lamp Error Status	I/O error	Diagnostic classification	Diagnostic classification	Not used (Input Pin A1)	Not used (Input Pin A2)	Not used (Input Pin A3)	Not used (Input Pin A4)
UE4740	Byte 1, Bit 0	Byte 1, Bit 1 (I/O Error)	Diagnostic classification	Diagnostic classification	Byte 1, Bit 4	Byte 1, Bit 5	Byte 1, Bit 6	Byte 1, Bit 7
Flexi Soft	Byte 1, Bit 0	Byte 1, Bit 1 (I/O Error)	Diagnostic classification	Diagnostic classification	Byte 1, Bit 4	Byte 1, Bit 5	Byte 1, Bit 6	Byte 1, Bit 7

Tab. 8: Byte 1 of the EFI communication

[5] The bit cannot be freely used.
[6] Bit is device internal predefined. Read only.
[7] For information on the compatibility mode see the operating instructions for the devices.
[8] Configuration dependent: Without speed routing/with speed routing.

Description of bit 0 to 7 of byte 2

Byte 2	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7
General	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data
C4000 receiver	Teach-In active	Key-Switch state	Take snapshot	Field status (red/green)	Field status	Field status	EStop Channel 1	EStop Channel 2
M4000 receiver	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
S3000 in compatibility mode [7]	Input Pin C1	Input Pin C2	Input Pin D1	Input Pin D2	Not used	Not used	Not used	Not used
S3000	Input Pin C1/ Speed Bit 0 [9]	Input Pin C2/ Speed Bit 1 [9]	Input Pin D1/ Speed Bit 2 [9]	Input Pin D2/ Speed Bit 3 [9]	Speed Bit 4	Speed Bit 5	Speed Bit 6	Speed Bit 7
S3000 Anti Collision	Input Pin C1/ Speed Bit 0 [9]	Input Pin C2/ Speed Bit 1 [9]	Input Pin D1/ Speed Bit 2 [9]	Input Pin D2/ Speed Bit 3 [9]	Speed Bit 4	Speed Bit 5	Speed Bit 6	Speed Bit 7
S300 in compatibility mode [7]	Input Pin C1	Input Pin C2	Not used	Not used	Not used	Not used	Not used	Not used
S300	Input Pin C1/ Speed Bit 0 [9]	Input Pin C2/ Speed Bit 1 [9]	Speed Bit 2	Speed Bit 3	Speed Bit 4	Speed Bit 5	Speed Bit 6	Speed Bit 7
S300 Mini	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
UE402	Input Pin A5	Input Pin A6	Input Pin A7	Input Pin A8	0	0	0	0
UE403	Not used (Input Pin A5)	Not used (Input Pin A6)	Not used (Input Pin A7)	Not used (Input Pin A8)	Muting Sensor A1	Muting Sensor A2	Muting Sensor B1	Muting Sensor B2
UE4740	Byte 2, Bit 0	Byte 2, Bit 1	Byte 2, Bit 2	Byte 2, Bit 3	Byte 2, Bit 4	Byte 2, Bit 5	Byte 2, Bit 6	Byte 2, Bit 7
Flexi Soft	Byte 2, Bit 0	Byte 2, Bit 1	Byte 2, Bit 2	Byte 2, Bit 3	Byte 2, Bit 4	Byte 2, Bit 5	Byte 2, Bit 6	Byte 2, Bit 7

Tab. 9: Byte 2 of the EFI communication

[9] Configuration dependent: Without speed routing/with speed routing.

Description of bit 0 to 7 of byte 3

Byte 3	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7
General	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data	Specific device data
C4000 receiver	ADO[10]	CoState Bypass State	Not used	Not used	Not used	Not used	Virtual photoelectric switch 2	Virtual photoelectric switch 1
M4000 receiver	ADO[10]	Not used	Muting State	Muting Lamp status	Delivery Status Flag	PU Data Valid Flag	Mode Switch state on PU	Select Switch state on PU
S3000 in compatibility mode[11]	Not used	Not used	Not used	Not used	Switch off 1. monitoring area	Status Warning Field 1. monitoring area	Switch off 2. monitoring area	Status Warning Field 2. monitoring area
S3000	Speed Bit 8	Speed Bit 9	Speed Bit 10	Speed Bit 11	Protective Field 1/ Protective Field 1/ Protective Field 1[12]	Warning Field 1/ Protective Field 2/ Warning Field 1[12]	Sim. Protective Field 1/Sim. Protective Field 1/–[12]	Warning Field 2/Sim. Protective Field 2/ Warning Field 2[12]
S300 Anti Collision	Speed Bit 8	Speed Bit 9	Speed Bit 10	Speed Bit 11	Protective Field 1/ Protective Field 1[13]	Collision Protection Field 1 / Collision Protection Field[13]	Sim. Protective Field 1/–[13]	Sim. Collision Protection Field 1/ Collision protection field 2[13]
S300 in compatibility mode[11]	Not used	Not used	Not used	Not used	Switch off 1. monitoring area	Status Warning Field 1. monitoring area	Not used	Not used
S300	Speed Bit 8	Speed Bit 9	Speed Bit 10	Speed Bit 11	Protective Field 1	Warning Field 1	Not used	Warning Field 2
S300 Mini	Not used	Not used	Not used	Not used	Protective Field 1	Warning Field 1	Not used	Warning Field 2
UE402	Lock-out Info	Lock-out Info	Lock-out Info	Lock-out Info	Input Pin B1	Input Pin B2	Input Pin B3	Input Pin B4
UE403	Not used	Not used	Not used	Not used	C1/CBS/OVR Switch Input (UI1)			
UE4740	Byte 3, Bit 0	Byte 3, Bit 1	Byte 3, Bit 2	Byte 3, Bit 3	Byte 3, Bit 4	Byte 3, Bit 5	Byte 3, Bit 6	Byte 3, Bit 7
Flexi Soft	Byte 3, Bit 0	Byte 3, Bit 1	Byte 3, Bit 2	Byte 3, Bit 3	Byte 3, Bit 4	Byte 3, Bit 5	Byte 3, Bit 6	Byte 3, Bit 7

Tab. 10: Byte 3 of the EFI communication

[10] ADO can be used for non-safety-related evaluations, e.g. weak signal output.
[11] For information on the compatibility mode see the operating instructions for the devices.
[12] Dual (1 protective field, 1 warning field)/Dual protective fields (2 protective fields)/Triple (1 protective field, 2 warning fields).
[13] Dual collision protection (1 protective field, 1 collision protection field)/Triple collision protection (1 protective field, 2 collision protection fields)

Description of bit 0 to 7 of byte 4

Byte 4	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7
General	CRC Low Byte[14]	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
C4000 receiver	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
M4000 receiver	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S3000 in compatibility mode[15]	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S3000	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S3000 Anti Collision	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S300 in compatibility mode[15]	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S300	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S300 Mini	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
UE402	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
UE403	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
UE4740	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
Flexi Soft	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte

Tab. 11: Byte 4 of the EFI communication

[14] CRC (covers data and device code) Low Byte.
[15] For information on the compatibility mode see the operating instructions for the devices.

Description of bit 0 to 7 of byte 5

Byte 5	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7
General	CRC High Byte[16]	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
C4000 receiver	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
M4000 receiver	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
S3000 in compatibility mode[17]	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
S3000	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S3000 Anti Collision	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S300 in compatibility mode[17]	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
S300	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
S300 Mini	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte	CRC Low Byte
UE402	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
UE403	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
UE4740	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte
Flexi Soft	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte	CRC High Byte

Tab. 12: Byte 5 of the EFI communication

[16] CRC (covers data and device code) High Byte.
[17] For information on the compatibility mode see the operating instructions for the devices.

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4.4 Status information and control options for the EFI devices

Status information and control commands are exchanged between the devices via EFI. The following tables show the status information that can be accessed and the control commands that are possible for ESPE, safety controllers as well as EFI gateways.

Note   The information in square brackets reflects the names used in the CDS and in the Flexi Soft Designer.

4.4.1 C4000 safety light curtain

*Tab. 13: Status information of the C4000 (data **from the** C4000)*

Status information	Meaning/effect
OSSD on [OSSD]	• Logical 1, if the OSSD of the C4000 is switched on (green) • Logical 0, if the OSSD of the C4000 is switched off (red) **Notes:** Host: In the case of a cascaded system, the OSSD bit is a group indication for the entire host/guest or host/guest/guest cascade Guest 1/guest 2: The OSSD bit corresponds to the status of the related guest.
Contamination [Weak]	• Logical 1, on contamination of the front screen
Reset button pressed [Res. Pressed]	• Logical 1, if the reset button is pressed
Reset required [Res. Req.]	• Logical 1, if reset required
Status of the emergency stop [EStop Active]	Logical 1, if the button connected to the emergency stop input on the C4000 has been pressed.
Teach-in active [Teach Active]	• Logical 1, if a teach-in key-operated switch connected to the C4000 has been operated
Status application diagnostic output (ADO)[18] [ADO]	• Logical 1, if the configurable application diagnostic output (ADO) on the C4000 is signaling, e.g., the contamination status, the OSSD status or the emergency stop status **Note:** The message type depends on the configuration of the C4000.
Status bypass [Bypass Active]	• Logical 1, if a key-operated pushbutton for bypass connected to the C4000 has been operated
Virtual photoelectric switch 2 [VLS2]	• Logical 1 = beam unoccupied • Logical 0 = beam interrupted
Virtual photoelectric switch 1 [VLS1]	• Logical 1 = beam unoccupied • Logical 0 = beam interrupted

Note   With the exception of the OSSD information, all status information always relates to the safety light curtain polled (host, guest 1 or guest 2).

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[18]   ADO can be used for non-safety-related evaluations, e.g. weak signal output.

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Subject to change without notice

EFI

*Tab. 14: Control features on the C4000 (data **to the** C4000)*

Control feature	Meaning/effect
Bypass B1 [In Bypass 1]	• Logical 1, stimulates bit B1 for the key-operated pushbutton for bypass
Bypass B2 [In Bypass 2]	• Logical 1, stimulates bit B2 for the key-operated pushbutton for bypass
Operating mode 1 [In A1]	• Logical 1, switches to operating mode 1 of the C4000 • Logical 0, makes it possible to select a different operating mode[19]
Operating mode 2 [In A2]	• Logical 1, switches to operating mode 2 of the C4000 • Logical 0, makes it possible to select a different operating mode
Operating mode 3 [In A3]	• Logical 1, switches to operating mode 3 of the C4000 • Logical 0, makes it possible to select a different operating mode
Operating mode 4 [In A4]	• Logical 1, switches to operating mode 4 of the C4000 • Logical 0, makes it possible to select a different operating mode
Operating mode 5 [In A5]	• Logical 1, switches to operating mode 5 of the C4000 • Logical 0, makes it possible to select a different operating mode
Operating mode 6 [In A6]	• Logical 1, switches to operating mode 6 of the C4000 • Logical 0, makes it possible to select a different operating mode
Overrun monitoring SCC [In SCC]	• Logical 1, stimulates the SCC bit for overrun monitoring on the C4000
Bottom dead center BDC [In BDC]	• Logical 1, stimulates the BDC bit for PSDI integration on the C4000
Top dead center TDC [In TDC]	• Logical 1, stimulates the TDC bit for PSDI integration on the C4000
I/O error [I/O Error]	• Logical 0, if there is no error on a connected device • Logical 1, if there is an error on a connected device

[19] If two bits are logical 1, there will be an error on the C4000.

4.4.2 M4000 multiple light beam safety device

*Tab. 15: Status information of the M4000 (data **from the** M4000)*

Status information	Meaning/effect
OSSD on [OSSD]	• Logical 1, if the OSSD of the M4000 is switched on (green) • Logical 0, if the OSSD of the M4000 is switched off (red)
Contamination [Weak]	• Logical 1, on contamination of the front screen
Reset button pressed [Res. Pressed]	• Logical 1, if the reset button is pressed on the M4000
Reset required [Res. Req.]	• Logical 1, if reset required
Status application diagnostic output (ADO)[20] [ADO]	• Logical 1, if the configurable application diagnostic output (ADO) for the M4000 is indicating the contamination status or the OSSD status
Muting status [Muting]	• Logical 1, if M4000 muting is active • Logical 0, if M4000 muting is inactive
Additional signal C1 or Belt stop [In BS/C1]	• Logical 1, if a function is activated on the M4000

*Tab. 16: Control features on the M4000 (data **to the** M4000)*

Control feature	Meaning/effect
Reset/override [In RES/OVR]	• Logical 1, stimulates the function configured in the M4000
Status muting lamp/override lamp	• Logical 1, stimulates an error message for the external muting lamp
Muting Sensor A1 [In A1]	• Logical 1, stimulates muting sensor A1 for M4000
Muting Sensor A2 [In A2]	• Logical 1, stimulates muting sensor A2 for M4000
Muting Sensor B1 [In B1]	• Logical 1, stimulates muting sensor B1 for M4000
Muting Sensor B2 [In B2]	• Logical 1, stimulates muting sensor B2 for M4000
Override or Additional signal C1 or Belt stop [In BS/C1]	• Logical 1, stimulates the related function configured in the M4000
I/O error [I/O Error]	• Logical 0, if there is no error on a connected device • Logical 1, if there is an error on a connected device

[20] ADO can be used for non-safety-related evaluations, e.g. weak signal output.

4.4.3   S3000 safety laser scanner

Status information	Meaning/effect
OSSD on [OSSD]	• Logical 1, if the internal OSSD of the S3000 is in the ON state (green) • Logical 0, if the OSSD of the S3000 is in the OFF state (red)
Warning field bit [WF LED]	• Logical 1, if warning field 1 and warning field 2 of the S3000 are unoccupied or not used
Contamination [Weak]	• Logical 1, if the front screen is contaminated
Reset required [Res. Req]	• Logical 1, if reset required
Reset button pressed [Res. Pressed]	• Logical 1, if the reset button is pressed on the S3000
I/O error [I/O Error]	• Logical 0, if there is no error on the S3000 • Logical 1, if there is an error on the S3000
Control input A1 [In A1]	• Logical 1, if the connection of control input A1 is HIGH[21] **Note:** The control inputs on the S3000 are used to switch the monitoring cases on the S3000.
Control input A2 [In A2]	• Logical 1, if the connection of control input A2 is HIGH[21]
Control input B1 [In B1]	• Logical 1, if the connection of control input B1 is HIGH[21]
Control input B2 [In B2]	• Logical 1, if the connection of control input B2 is HIGH[21]
Control input C1 [In C1]	• Logical 1, if the connection of control input C1 is HIGH[21]
Control input C2 [In C2]	• Logical 1, if the connection of control input C2 is HIGH[21]
Control input D1 [In D1]	• Logical 1, if the connection of control input D1 is HIGH[21]
Control input D2 [In D2]	• Logical 1, if the connection of control input D2 is HIGH[21]
Allocated protective field unoccupied [PF]	• In dual field mode, in dual protective field mode and in triple field mode and in dual and triple collision protection mode: Logical 1, if the active allocated protective field is unoccupied.

[21] Only if the inputs are activated in the CDS.

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Status information	Meaning/effect
Allocated warning field unoccupied [WF] or allocated protective field 2 unoccupied [PF2]	• In dual field mode: Logical 1, if the active allocated warning field is unoccupied • In dual protective field mode: Logical 1, if the active allocated protective field 2 is unoccupied • In triple field mode: Logical 1, if the active allocated warning field is unoccupied
Allocated collision protection field unoccupied [CPF1]	• In dual collision protection mode: Logical 1, if active allocated collision protection field is unoccupied • In triple collision protection field: Logical 1, if active allocated collision protection field is unoccupied
Simultaneous protective field unoccupied [Sim. PF]	• In dual field mode and in dual protective field mode: Logical 1, if the simultaneously monitored protective field is unoccupied • In triple field mode: No function • In dual collision protection mode: Logical 1, if the simultaneously monitored protective field is unoccupied • In triple collision protection mode: No function
Simultaneous warning field unoccupied [Sim. WF] or simultaneous protective field 2 unoccupied [Sim. PF2] or allocated warning field 2 unoccupied [WF2]	• In dual field mode: Logical 1, if the simultaneously monitored warning field is unoccupied • In dual protective field mode: Logical 1, if the simultaneously monitored protective field 2 is unoccupied • In triple field mode: Logical 1, if the active allocated warning field 2 is unoccupied
Simultaneous collision protection field unoccupied [Sim. CPF] or allocated collision protection field 2 unoccupied [CPF2]	• In dual collision protection field mode: Logical 1, if the simultaneously monitored collision protection field is unoccupied • In triple collision protection mode: Logical 1, if the active allocated collision protection field 2 is unoccupied
Velocity valid[22]	• Logical 1, if a valid velocity is present on the incremental encoder inputs • Logical 0, if an invalid velocity is present on the incremental encoder inputs
Velocity[22]	• 12 bits for the transmission of the velocity 100000110000 = –2000 cm/s 000000000000 = 0 cm/s 011111010000 = +2000 cm/s

[22] Not in the compatibility mode.

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*Tab. 18: Control features on the S3000 (data **to the** S3000)*

Control feature	Meaning/effect
Static input information A1 [In A1]	• Logical 1, stimulates control input A1 of the S3000
Static input information A2 [In A2]	• Logical 1, stimulates control input A2 of the S3000
Static input information B1 [In B1]	• Logical 1, stimulates control input B1 of the S3000
Static input information B2 [In B2]	• Logical 1, stimulates control input B2 of the S3000
Static input information C1 [In C1]	• Logical 1, stimulates control input C1 of the S3000
Static input information C2 [In C2]	• Logical 1, stimulates control input C2 of the S3000
Static input information D1 [In D1]	• Logical 1, stimulates control input D1 of the S3000
Static input information D2 [In D2]	• Logical 1, stimulates control input D2 of the S3000
Static input information E1 [In E1][23]	• Logical 1, stimulates control input E1 of the S3000
Static input information E2 [In E2][23]	• Logical 1, stimulates control input E2 of the S3000
Stand-by[23]	• Logical 1, stimulates operational status Stand-by (individually for host and guest)
Velocity valid[23]	• Logical 1, valid velocity is present on the incremental encoder inputs • Logical 0, invalid velocity is present on the incremental encoder inputs
Velocity[23]	• 12 bits for the transmission of the velocity 100000110000 = –2000 cm/s 000000000000 = 0 cm/s 011111010000 = +2000 cm/s
I/O error [I/O Error]	• Logical 0, if there is no error on the connected partner device • Logical 1, if there is an error on the connected partner device

[23] Not in the compatibility mode.

4.4.4   S300 safety laser scanner

Status information	Meaning/effect
OSSD on [OSSD]	• Logical 1, if the internal OSSD of the S300 is in the ON state (green) • Logical 0, if the OSSD of the S300 is in the OFF state (red)
Warning field bit [WF LED]	• Logical 1, if both warning fields of the S300 are unoccupied • Logical 0, if one of the warning fields of the S300 is infringed
Contamination [Weak]	• Logical 1, if the optics cover is contaminated
Reset required [Res. Req]	• Logical 1, if reset required
Reset button pressed [Res. Pressed]	• Logical 1, if the reset button is pressed on the S300
I/O error [I/O Error]	• Logical 0, if there is no error on the S300 • Logical 1, if there is an error on the S300
Control input A1 [In A1]	• Logical 1, if the connection of control input A1 is HIGH **Note:** The control inputs on the S300 are used to switch the monitoring cases on the S300.
Control input A2 [In A2]	• Logical 1, if the connection of control input A2 is HIGH
Control input B1 [In B1]	• Logical 1, if the connection of control input B1 is HIGH
Control input B2 [In B2]	• Logical 1, if the connection of control input B2 is HIGH
Control input C1 [In C1]	• Logical 1, if the connection of control input C1 is HIGH
Control input C2 [In C2]	• Logical 1, if the connection of control input C2 is HIGH
Protective field [PF]	• Logical 1, if the protective field is unoccupied
Warning field 1 [WF1]	• Logical 1, if the active allocated warning field is unoccupied
Warning field 2 [WF2]	• Logical 1, if the active allocated warning field is unoccupied
Velocity valid[24]	• Logical 1, if a valid velocity is present on the incremental encoder inputs • Logical 0, if an invalid velocity is present on the incremental encoder inputs
Velocity[24]	• 12 bits for the transmission of the velocity 100000110000 = –2000 cm/s 000000000000 = 0 cm/s 011111010000 = +2000 cm/s

[24] Not in the compatibility mode.

*Tab. 20: Control features on the S300 (data **to the** S300)*

Control feature	Meaning/effect
Static input information A1 [In A1]	• Logical 1, stimulates control input A1 of the S300
Static input information A2 [In A2]	• Logical 1, stimulates control input A2 of the S300
Static input information B1 [In B1]	• Logical 1, stimulates control input B1 of the S300
Static input information B2 [In B2]	• Logical 1, stimulates control input B2 of the S300
Static input information C1 [In C1]	• Logical 1, stimulates control input C1 of the S300
Static input information C2 [In C2]	• Logical 1, stimulates control input C2 of the S300
Static input information D1 [In D1][25]	• Logical 1, stimulates control input D1 of the S300
Static input information D2 [In D2][25]	• Logical 1, stimulates control input D2 of the S300
Static input information E1 [In E1][25]	• Logical 1, stimulates control input E1 of the S300
Static input information E2 [In E2][25]	• Lo gical 1, stimulates control input E2 of the S300
Stand-by[25]	• Logical 1, stimulates operational status Stand-by (individually for host and guest)
Velocity valid[25]	• Logical 1, valid velocity is present on the incremental encoder inputs • Logical 0, invalid velocity is present on the incremental encoder inputs
Velocity[25]	• 12 bits for the transmission of the velocity 100000110000 = –2000 cm/s 000000000000 = 0 cm/s 011111010000 = +2000 cm/s
I/O error [I/O Error]	• Logical 0, if there is no error on the connected partner device • Logical 1, if there is an error on the connected partner device

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[25] Not in the compatibility mode.

Technical realization

4.4.5   S300 Mini safety laser scanner

Status information	Meaning/effect
Warning field bit [WF]	• Logical 1, if both warning fields of the S300 Mini are unoccupied • Logical 0, if one of the warning fields of the S300 Mini is infringed
Protective field [PF]	• Logical 1, if the protective field is unoccupied
Warning field 1 [WF1]	• Logical 1, if the active allocated warning field is unoccupied
Warning field 2 [WF2]	• Logical 1, if the active allocated warning field is unoccupied
Contamination [Weak]	• Logical 1, if the optics cover is contaminated
I/O error [I/O Error]	• Logical 0, if there is no error on the S300 Mini • Logical 1, if there is an error on the S300 Mini

Control feature	Meaning/effect
Static input information A1 [In A1]	• Logical 1, stimulates control input A1 of the S300 Mini
Static input information A2 [In A2]	• Logical 1, stimulates control input A2 of the S300 Mini
Static input information B1 [In B1]	• Logical 1, stimulates control input B1 of the S300 Mini
Static input information B2 [In B2]	• Logical 1, stimulates control input B2 of the S300 Mini
Static input information C1 [In C1]	• Logical 1, stimulates control input C1 of the S300 Mini
Static input information C2 [In C2]	• Logical 1, stimulates control input C2 of the S300 Mini
Static input information D1 [In D1]	• Logical 1, stimulates control input D1 of the S300 Mini
Static input information D2 [In D2]	• Logical 1, stimulates control input D2 of the S300 Mini
Static input information E1 [In E1]	• Logical 1, stimulates control input E1 of the S300 Mini
Static input information E2 [In E2]	• Logical 1, stimulates control input E2 of the S300 Mini
Stand-by	• Logical 1, stimulates operational status Stand-by
Velocity valid	• Logical 1 signals a valid velocity being present on the incremental encoder inputs. • Logical 0 signals a invalid velocity being present on the incremental encoder inputs (velocity in a range that is not configured or difference allowed between the incremental encoders exceeded).
Velocity[25]	• 12 bits for the transmission of the velocity 100000110000 = –2000 cm/s 000000000000 = 0 cm/s 011111010000 = +2000 cm/s

4.4.6 Flexi Soft FX3-CPU1, -CPU2, -CPU3 safety controller

*Tab. 23: Status information on the Flexi Soft (data **from the** Flexi Soft)*

Status information	Meaning/effect
I/O error [Byte 1, Bit 1]	• Logical 0, if there is no error on the Flexi Soft CPU • Logical 1, if there is an error on the Flexi Soft CPU **Note:** This status is to be provided in the operational status "Executing/Run" on the Flexi Soft-CPU using programmed logic. If signals are pre-processed on the Flexi Soft station and forwarded to EFI users, it is necessary to program the error states from this pre-processing as status information. If this status information is not programmed, it is only allowed to send signals without pre-processing to the EFI users.
All except [Byte 1, Bit 1]	• Freely programmable signals correspond to the requirements for the EFI devices connected

*Tab. 24: Control features on the Flexi Soft (data **to the** Flexi Soft)*

Control feature	Meaning/effect
I/O error [Byte 1, Bit 1]	• Logical 0, if there is no error on a connected device • Logical 1, if there is an error on a connected device **Note:** Indicates that the data on this EFI interface are currently invalid and represent substitute values. This situation occurs, for example, on EFI gateways if the controlling (F)PLC is not (yet) operating.
All except [Byte 1, Bit 1]	• Freely useable information for usage in the Flexi Soft logic. **Note:** On the usage of this information the status of the received I/O error bits is also to be evaluated.

4.4.7 UE4740 EFI gateway

Status information	Meaning/effect
I/O error [Byte 1, Bit 1]	• Logical 0, if there is no error on the EFI gateway • Logical 1, if there is an error on the EFI gateway **Note:** The I/O error is calculated automatically from the validity of the data on the interfaces connected and as a function of the usage of the data (in the gateway routing). Indicates that the data on this EFI interface are currently invalid and represent substitute values. This situation occurs, for example, on EFI gateways if the controlling (F)PLC is not (yet) operating.
All except [Byte 1, Bit 1]	• Freely programmable signals correspond to the requirements for the EFI devices connected

Control feature	Meaning/effect
I/O error [Byte 1, Bit 1]	• Logical 0, if there is no error on a connected device • Logical 1, if there is an error on a connected device **Note:** Indicates that the data on this EFI interface are currently invalid.
All except [Byte 1, Bit 1]	• Freely useable information for further data routing. **Note:** On the usage of this information the status of the received I/O error bits is also to be evaluated.

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4.5 Application examples

4.5.1 EFI gateway with M4000 multiple light beam safety device

The (F)PLC can access the M4000 via the routing in the EFI gateway. In this way it can send muting signals to the M4000 and receive output information (e.g. from M4000 OSSDs).

Fig. 13: Example data exchange between an (F)PLC and an M4000 via an EFI gateway
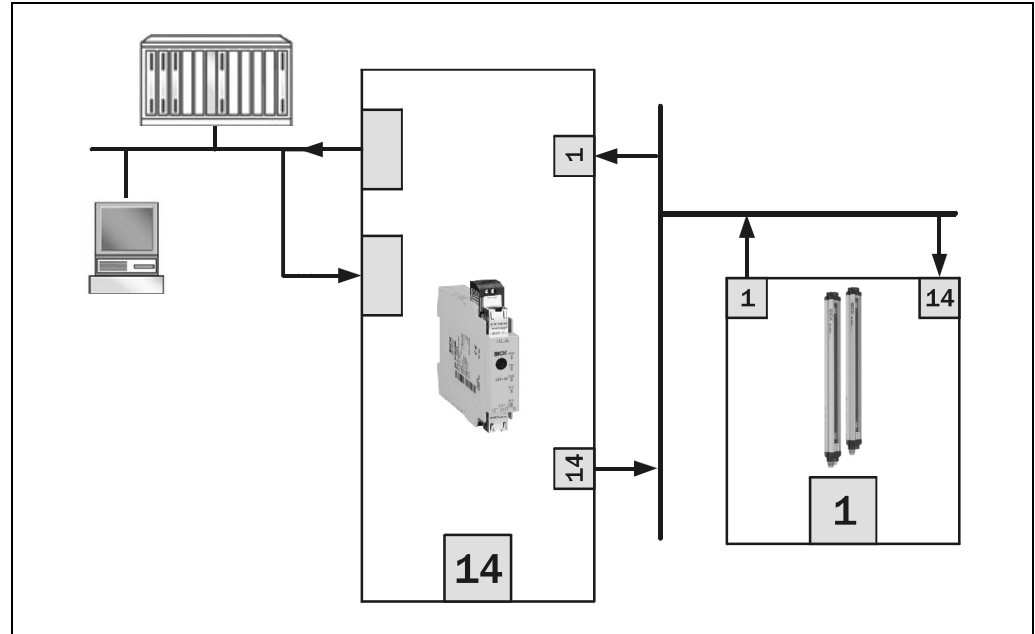
Used addresses via EFI: 14 for the EFI gateway, 1 for the M4000

4.5.2 EFI gateway with M4000 and UE403 switching amplifier

In this case the M4000 receives the muting signals from the UE403 (address 14). The EFI gateway receives the status information (e.g. on the OSSDs or on the muting lamp) from the M4000 (address 1) and from the UE403 (address 14). The EFI gateway routes this information to the (F)PLC.

Fig. 14: Example status polling by an (F)PLC on an UE403 and an M4000 via an EFI gateway
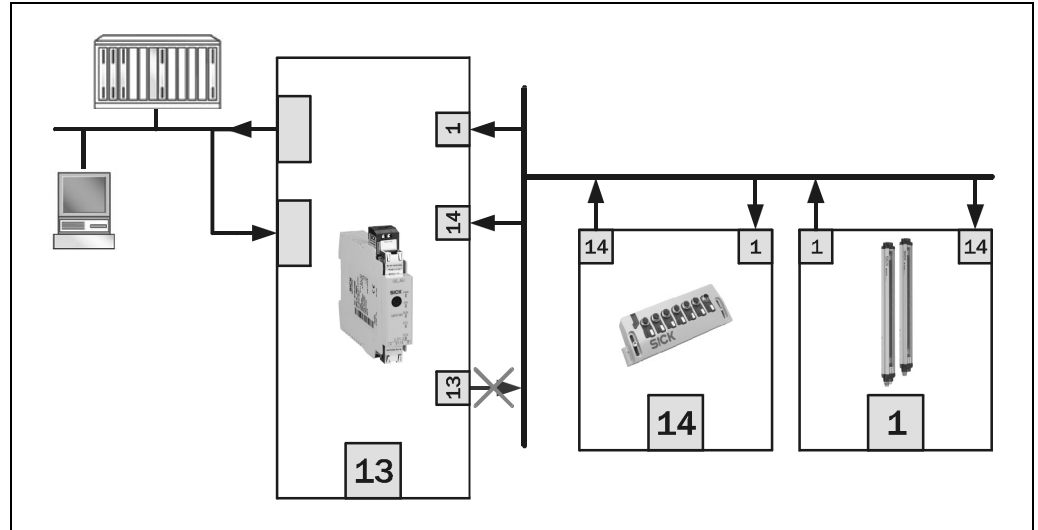
Note With M4000 firmware < 1.50 the device address of the EFI gateway must be re-configured to 13 before commissioning it with other devices, so that the exchange of data does not collide with the UE403. The address 13 is valid for both EFI strings. For this reason it is possible to connect to the second EFI string either an identical UE403/M4000 system or a product that can receive the address data from address 13. From firmware 1.50 this restriction no longer applies as the communication addresses between UE403 and M4000 can be changed.

The combination of M4000 and UE403 switching amplifier on one EFI string and a further M4000 on the second EFI string is, for example, with M4000 firmware < 1.50 not possible technically.

Fig. 15: Example of an invalid combination
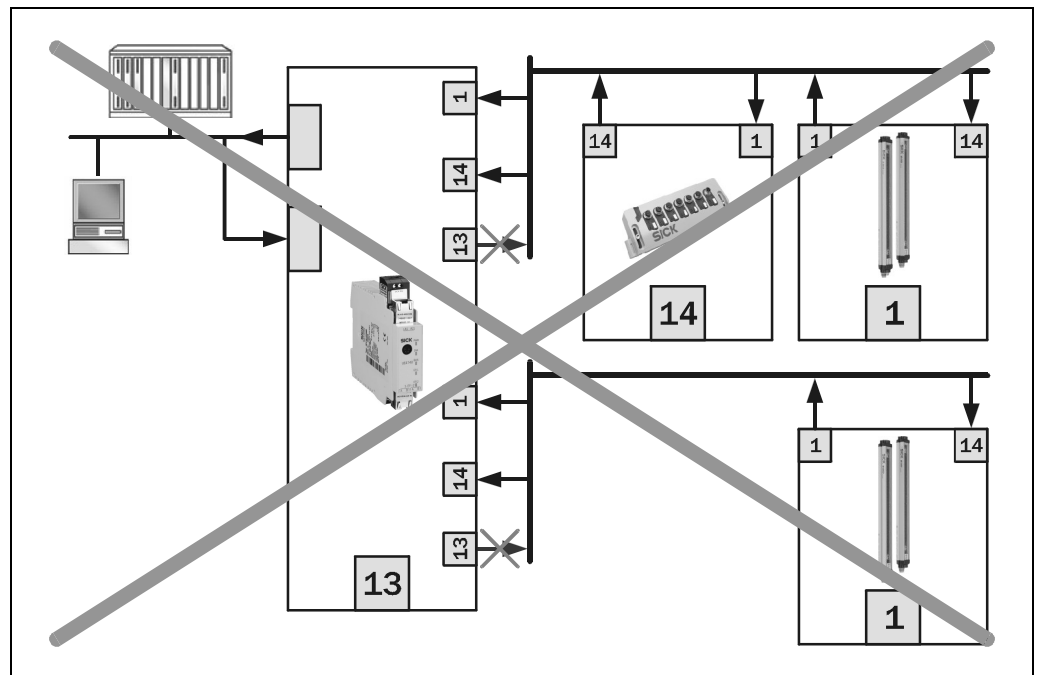
From M4000 firmware 1.50 there are further options by changing the communication addresses between UE403 and M4000. The address can be 11, 12, 13 or 14.

4.5.3   EFI gateway with two S3000 safety laser scanners

The protective field switching on the S3000 is performed via the (F)PLC. The control input signals for this purpose are routed to the S3000 via the EFI gateway (address 14). The status information from the S3000 is received by the EFI gateway (addresses 7 and 8) and routed to the (F)PLC.

Fig. 16: Example control of two S3000 via an EFI gateway using one (F)PLC
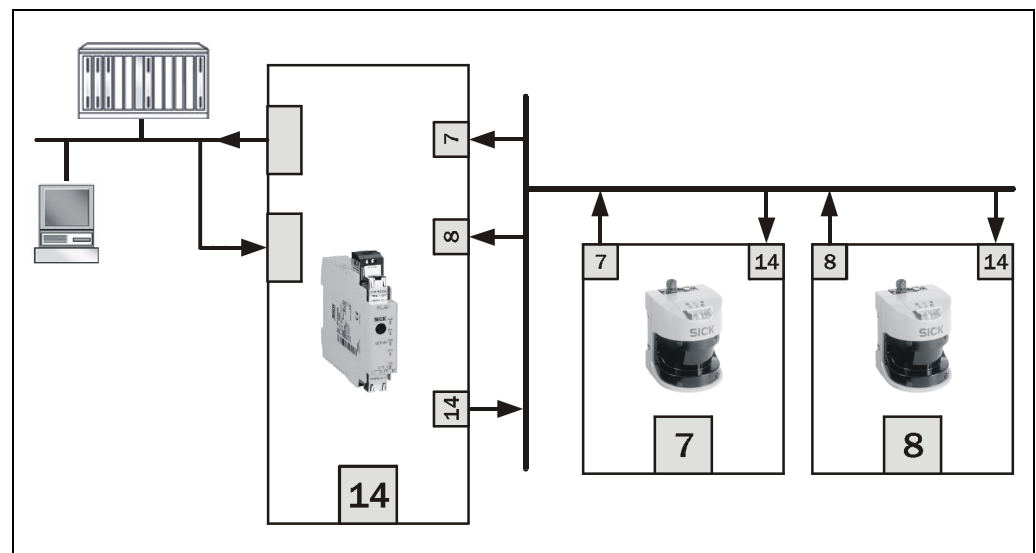
4.5.4   EFI gateways with S3000 or S300 host/guest systems with local inputs

Only the status information from the S3000 or S300 safety laser scanners is received by the EFI gateway (addresses 7 and 8) and routed to the (F)PLC. The protective field switching is performed using the local inputs on the host. This information is forwarded to the guest (address 7).

Fig. 17: Example status polling on an S3000/S300 host/guest system via an EFI gateway by an (F)PLC

Technical realization
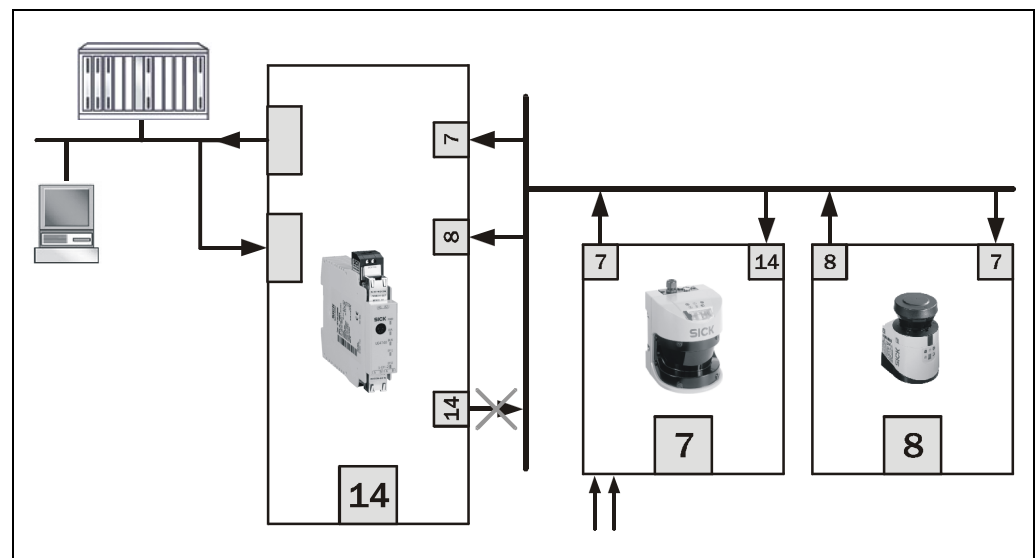
4.5.5   EFI gateway with two S300 safety laser scanners

The protective field switching is performed via the (F)PLC. The control input signals used for this purpose are routed to the two S300 over two separate EFI strings via the EFI gateway (each address 14). The status information from the S300 is received by the EFI gateway (each address 7) and routed to the (F)PLC.

Fig. 18: Example control of an S300 and an S300 Mini via an EFI gateway using one (F)PLC
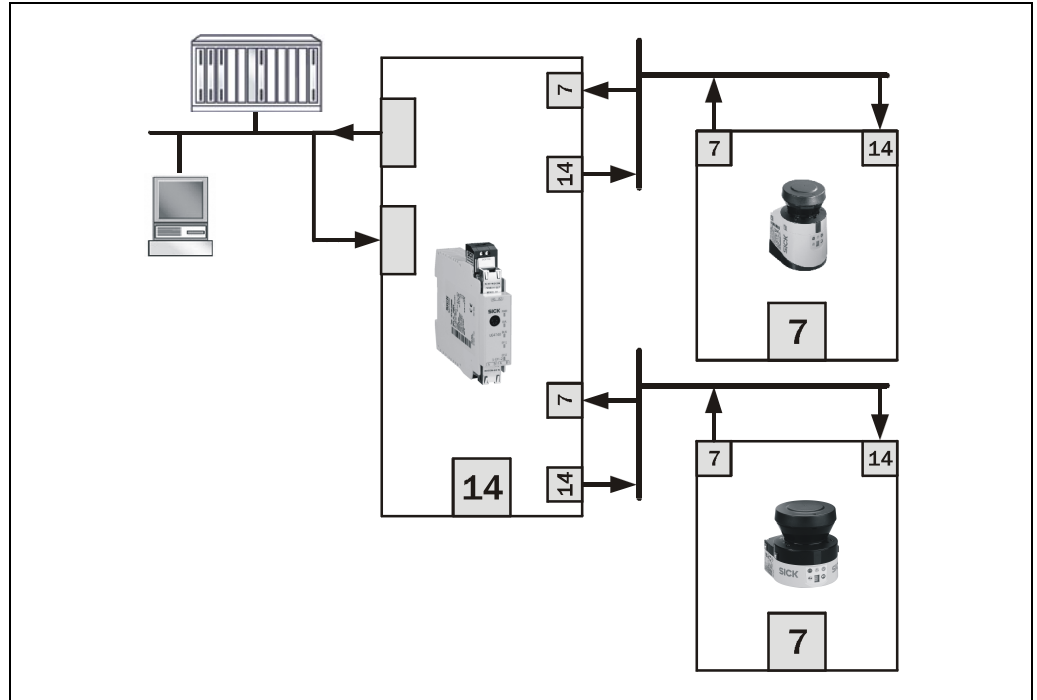
4.5.6 EFI gateway with safety controllers

A special case is if an EFI gateway and a safety controller are connected to an EFI string. The device address for the EFI gateway must then be re-configured to 13 so that the exchange of data does not collide with the safety controller (here Flexi Soft).

Fig. 19: Example data exchange between an (F)PLC and an M4000 and an S3000 via an EFI gateway
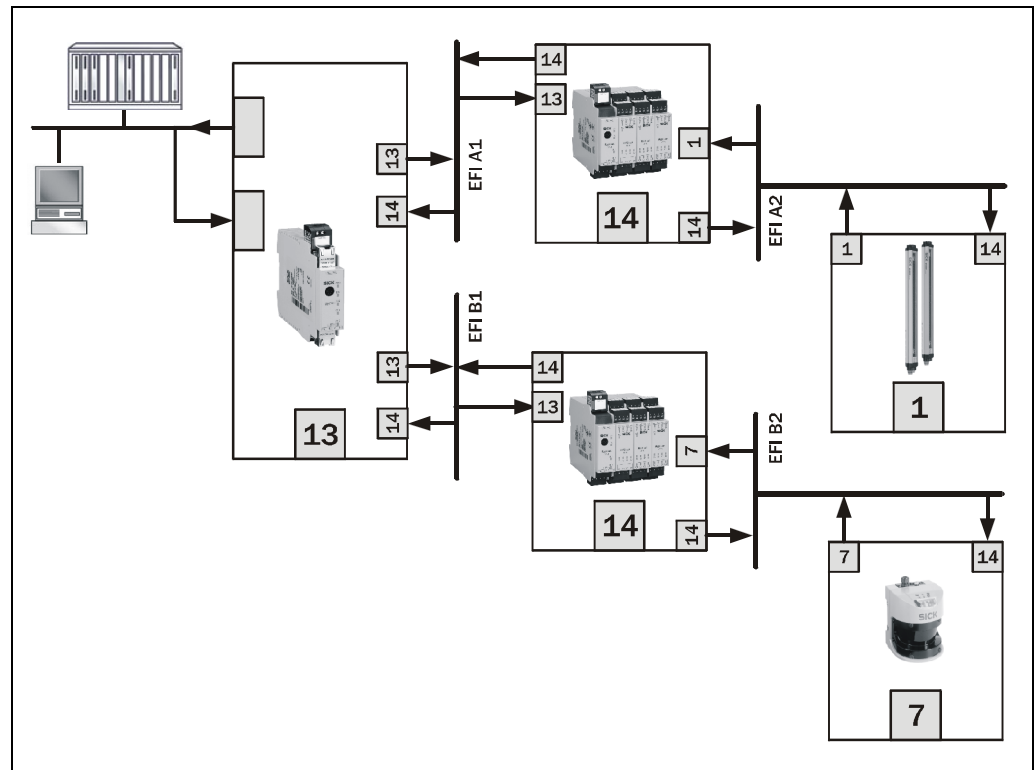
In the example the EFI gateway receives the (F)PLC control commands for the Flexi Soft and routes them to device address 13 on the first EFI string. The Flexi Soft in turn outputs its control commands for the ESPE connected via the second EFI string for the Flexi Soft to the ESPE (address 14).

The Flexi Soft receives via EFI the status information for the ESPE (address 1 on the M4000, address 7 on the S3000).

Via the related first EFI string the Flexi Soft in turn provides its status information to the EFI gateway, this device then routes the information to the (F)PLC.

4.5.7 Flexi Soft safety controller with M4000 multiple light beam safety device

The Flexi Soft safety controller can access the M4000 via EFI. In this way it can send muting signals to the M4000 (address 14) and receive output information, e.g. on the M4000 OSSDs (address 1).

Fig. 20: Example implementation of muting with M4000 and Flexi Soft
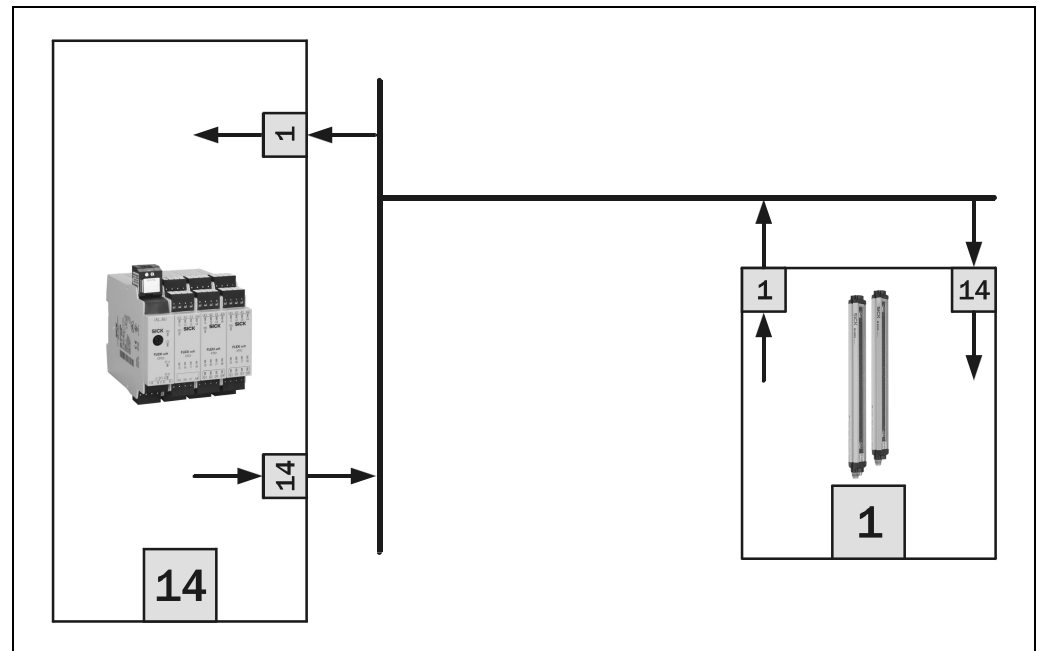
4.5.8   Flexi Soft safety controller with two S3000 or S300 Mini

The status information from the S3000 or S300 Mini safety laser scanners is received by the Flexi Soft safety controller (addresses 7 and 8) and evaluated. The protective field switching on the S3000 is performed via the Flexi Soft safety controller. The control input signals for this purpose are routed to the S3000 or S300 Mini via the EFI gateway (address 14).

Fig. 21: Example protective field switching via Flexi Soft
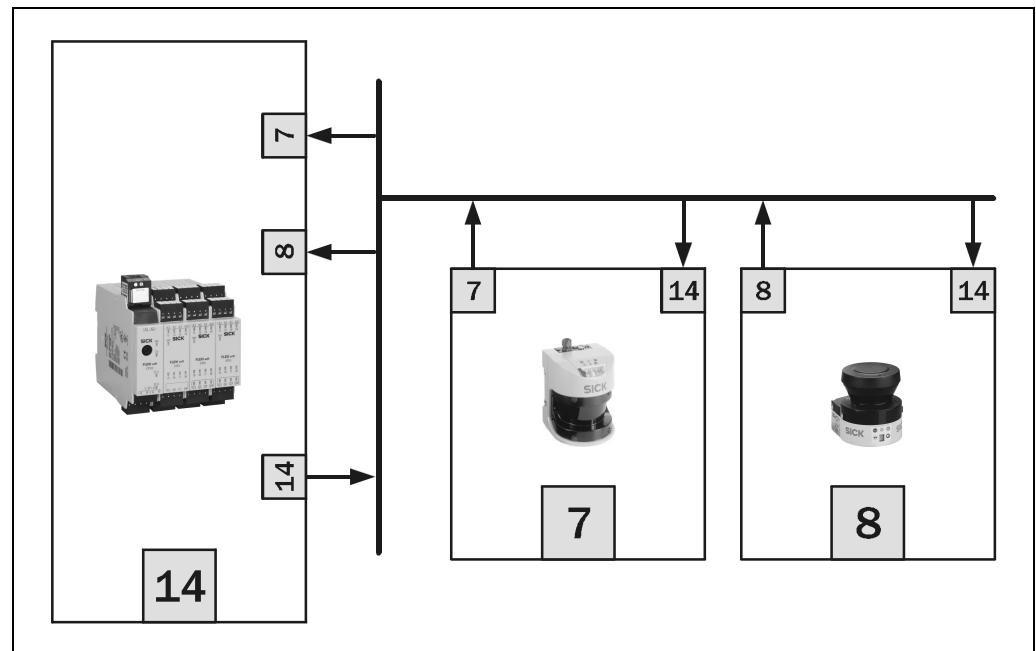
4.5.9   Flexi Soft safety controller with S3000 or S300 host/guest system (with local inputs)

Only the status information from the S3000 or S300 is received by the Flexi Soft safety controller (addresses 7 and 8) and evaluated. The protective field switching is performed using the local inputs on the host. This information is forwarded to the guest (address 7).

Fig. 22: Example protective field switching using local inputs
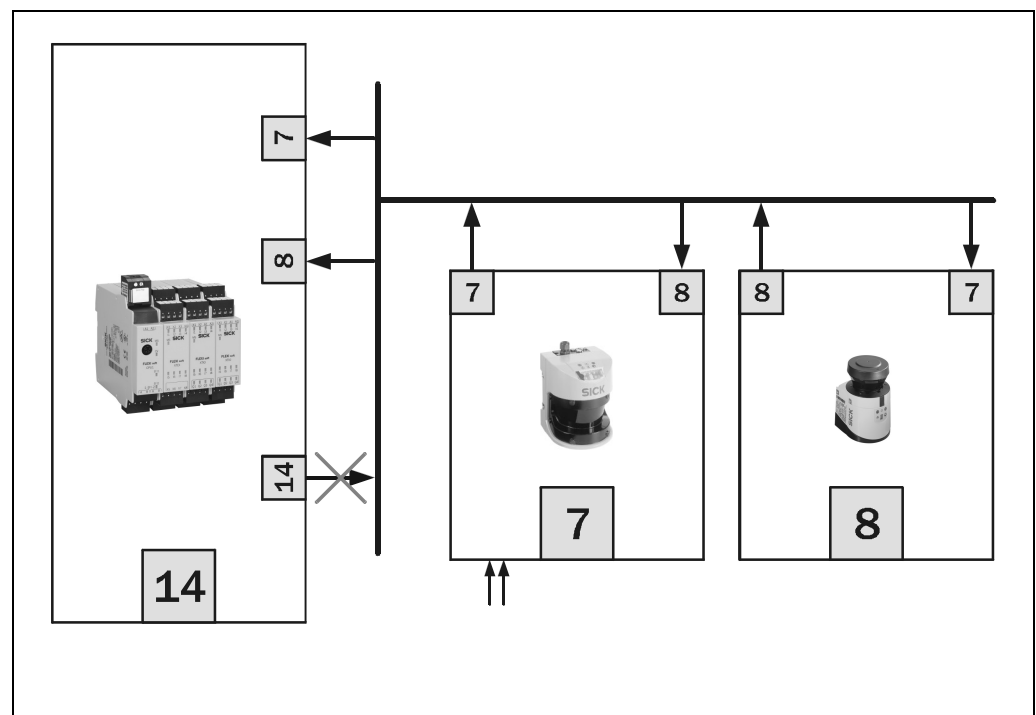
Velocity routing

If several safety laser scanners are connected to a Flexi Soft safety controller, then a velocity routing can be configured. In this way the velocity information that is determined e.g. by an S3000 or S300 Professional or Expert with the aid of incremental encoders is distributed to all safety laser scanners.

Note   The velocity routing is not available in the compatibility mode.

Fig. 23: Example for velocity routing on an AGV
① S300 Expert on EFI1.1
② Incremental encoder
③ S300 Mini on EFI2.2
④ Flexi Soft
⑤ S300 Mini on EFI1.2
⑥ S300 on EFI2.1
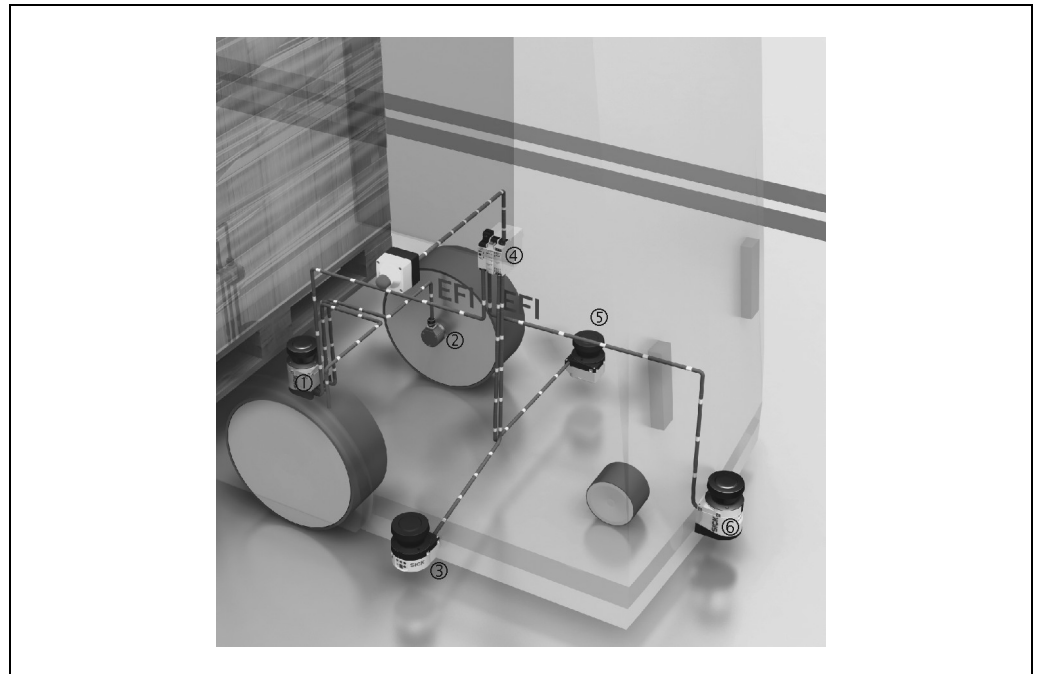
On the S300 Expert on EFI1.1 ① incremental encoders ② are connected. These generate the necessary velocity signals. The signals are distributed by the Flexi Soft safety controller ④ to all **four** safety laser scanners (① and ⑤ as well as ③ and ⑥) and are available on all **four** safety laser scanners for monitoring case switching.

Fig. 24: Connection diagram for velocity routing
① S300 Expert on EFI1.1
② Incremental encoder
③ S300 Mini on EFI2.2
④ Flexi Soft
⑤ S300 Mini on EFI1.2
⑥ S300 on EFI2.1

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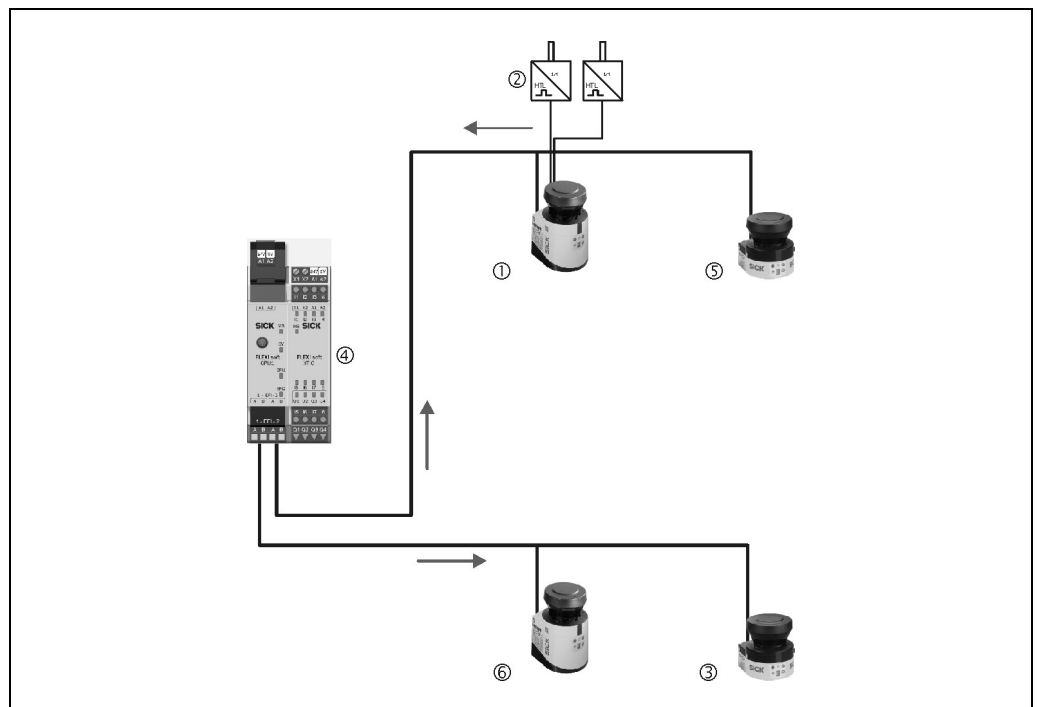
How to configure a velocity routing in the Flexi Soft Designer:

➢ Configure the velocity routing in the Flexi Soft Designer for instance as in the following figure.

Fig. 25: Example for velocity routing in the Flexi Soft Designer

Input signals from the S300 Expert with incremental encoders

12 + 1 bit pattern duplicated and placed on the n:n function blocks EFI1.1 ①

Output signals to all safety laser scanners

EFI string 1 (safety laser scanner on EFI1.1 ① and EFI1.2 ⑤)

EFI string 2 (safety laser scanner on EFI2.1 ⑥ and EFI2.2 ③)
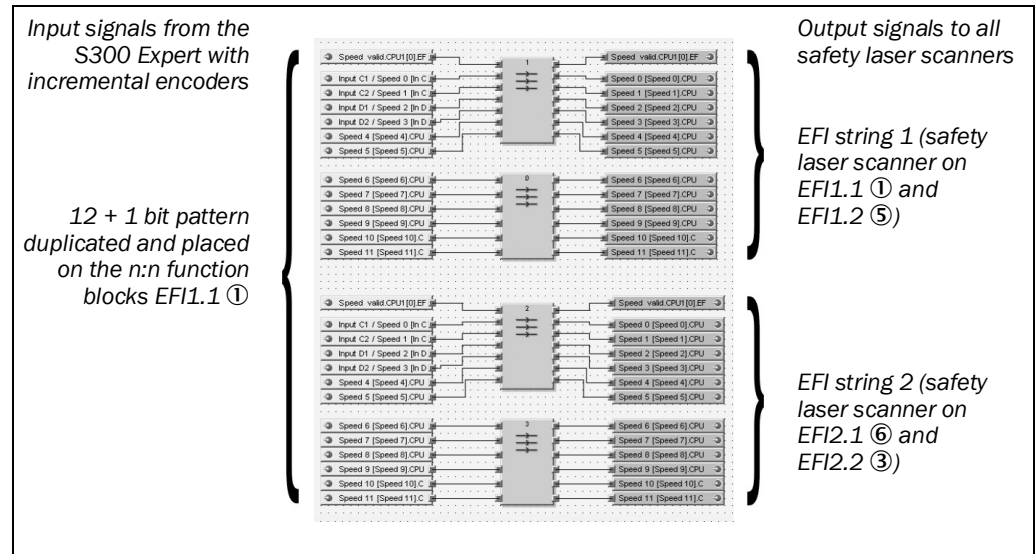
The velocity signals of the S300 Expert are broken down into a 12 + 1 bit pattern, 12 velocity bits and one bit for validation. These signals are available as input signals, are duplicated and placed **twice** on the n:n function blocks (0 and 1 as well as 2 and 3).

The outputs of the function blocks are placed on EFI string 1 or on EFI string 2. As a result they are available to all four safety laser scanners.

⚠ WARNING

The "Velocity valid" status information is relevant for safety!

Ensure that the **Velocity valid** input signal is connected to the **Velocity valid** output signal.

How to configure the safety laser scanners in the CDS:

➢ On the **Incremental encoder** tab for the S300 Expert to which the incremental encoders are connected, select the **Indicate velocity** option.

All safety laser scanners, also the sending devices, must use these velocity signals via EFI.

➢ For this reason activate **on all** safety laser scanners on the **Inputs** tab the option **Use Flexi Soft CPU1/2**.

➢ Then, select **on all** safety laser scanners on the **Inputs** tab the **Use velocity** option.

5 Configuration options via EFI

To ensure the devices fulfil their application-specific function and can exchange data with each other, configuration is necessary. ESPE, safety controller and EFI gateway are configured using the configuration software CDS, the Flexi Soft modular safety controller using the configuration software Flexi Soft Designer.

Depending on the composition of a system configuration, there are different points for accessing the overall configuration of the safety controllers and safety sensors.

If only safety controllers and safety sensors are used on an EFI connection or only one active EFI connection is used, a specific procedure for the configuration is not necessary. The PC to be used for the configuration can be connected to any device in the EFI system.

In the case of device groups with more than one active EFI string, however, a specific procedure for the configuration must be followed, as sensors in the group cannot be detected across EFI strings and as a result configuration will be prevented.

5.1 Device groups with one EFI string

5.1.1 Cascaded system with the safety light curtain C4000

You can configure a cascaded system with three C4000 safety light curtains from the C4000 Host (1), from the C4000 Guest 1 (2) as well as from the C4000 Guest 2 (3).

Fig. 26: Configuration of a cascaded system
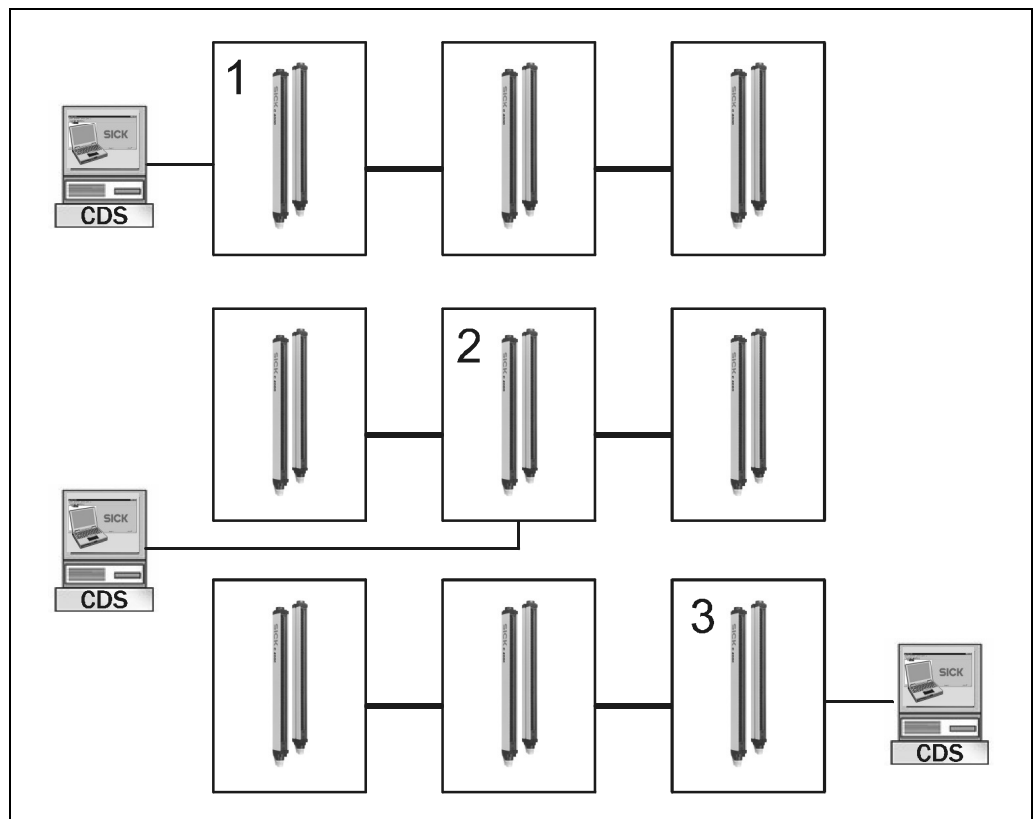
5.1.2 Host/guest system with the S300/S300 Mini/S3000 safety laser scanners

You can configure a host/guest system with two S300/S300 Mini/S3000 safety laser scanners both from the host (1) as well as from the guest (2).

Fig. 27: Configuration of a host/guest system
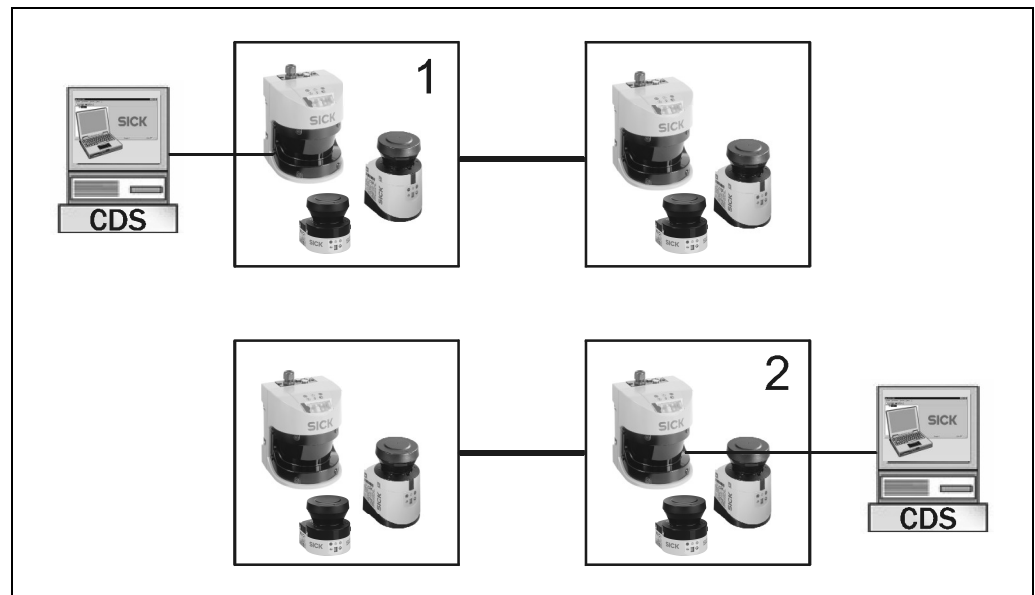
5.1.3 M4000 with UE403 switching amplifier

You can configure an M4000 with a UE403 switching amplifier both from the M4000 (1) as well as from the UE403 (2).

Fig. 28: Configuration on an ESPE with switching amplifier

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Subject to change without notice
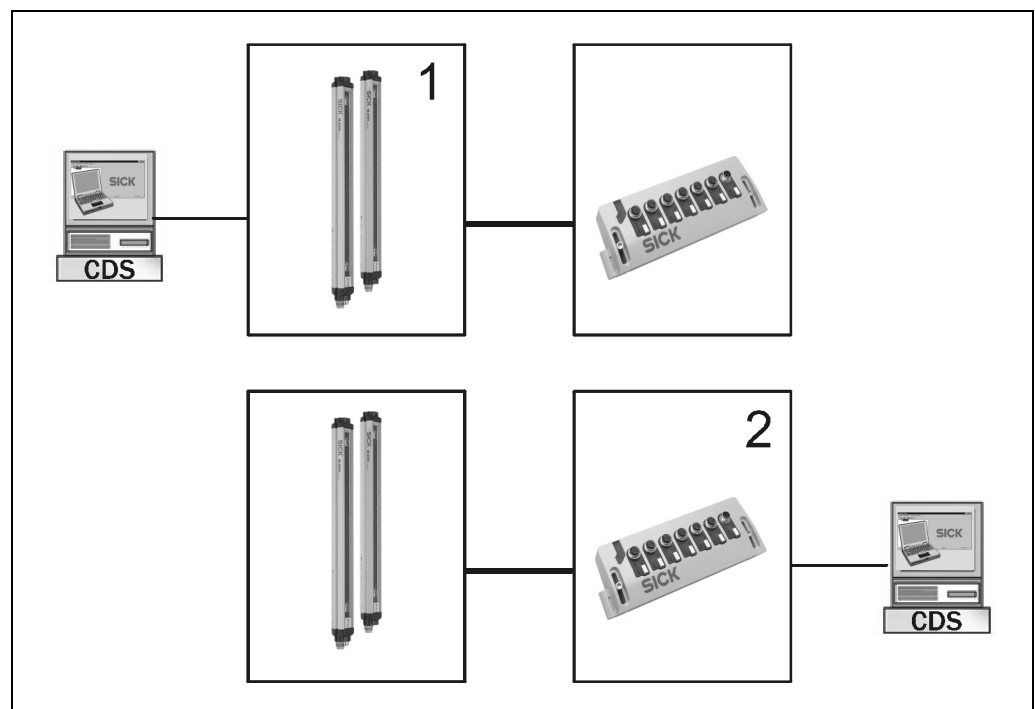
5.1.4 Safety controller with one ESPE

You can configure a safety controller and the ESPE connected from the safety controller (1).

Fig. 29: Configuration of a safety controller with ESPE
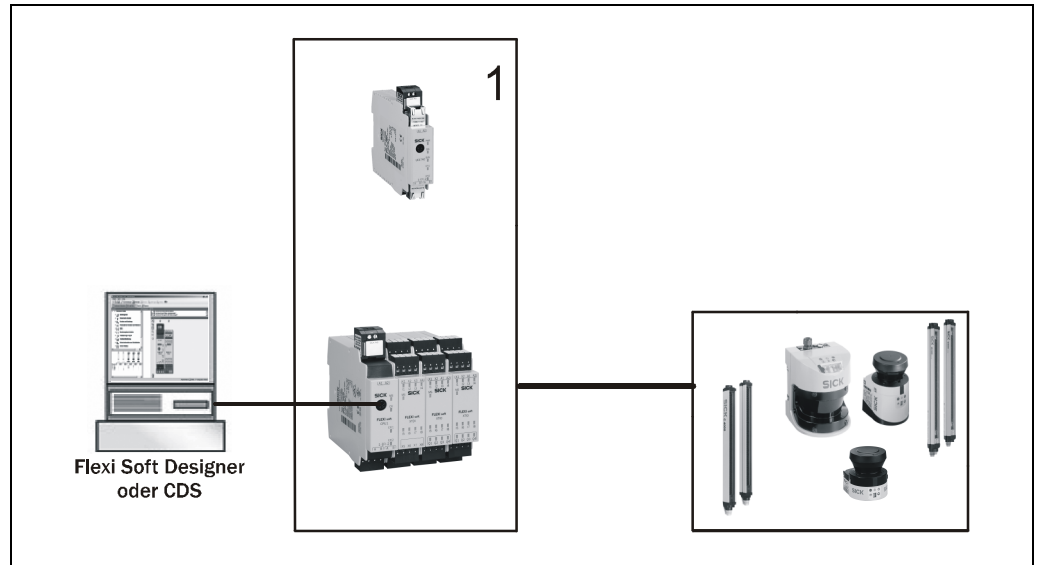
5.1.5 EFI gateway with ESPE(s) connected

You can configure an EFI gateway and the ESPE connected to it from the higher level network (e.g. PROFIsafe).

Fig. 30: Configuration of an EFI gateway with S3000 connected
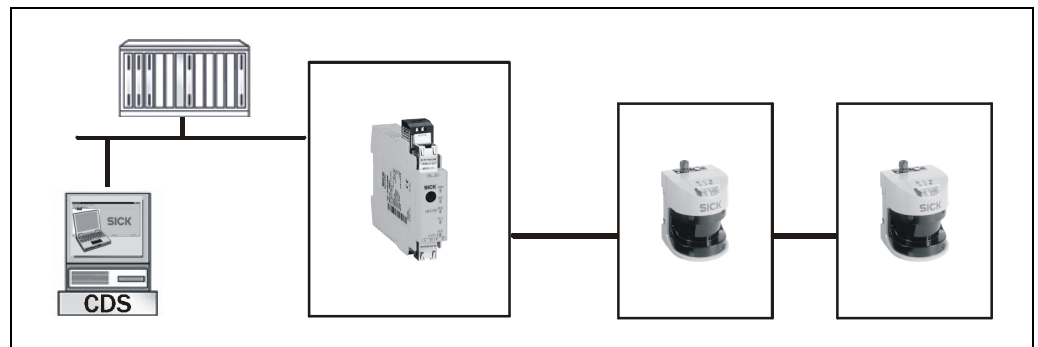
5.2   Device groups with two EFI strings

5.2.1   Safety controller with two ESPE

You can completely configure a safety controller (1) with two ESPE connected via EFI (2a and 2b) from the safety controller.

Fig. 31: Configuration of a safety controller with two ESPE
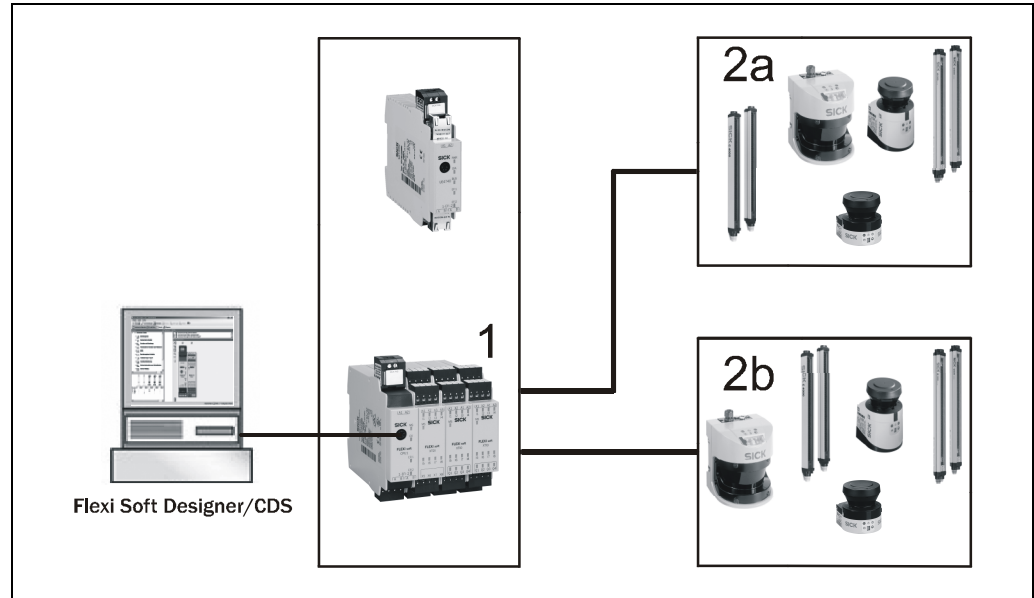
If you connect the PC to the RS-232 interface on an ESPE (2a), you can only configure this device. Although the safety controller (1) and the second ESPE (2b) are visible in the CDS, they cannot be configured and diagnostics are not possible.

Fig. 32: Configuration of an ESPE, e.g., on a safety controller
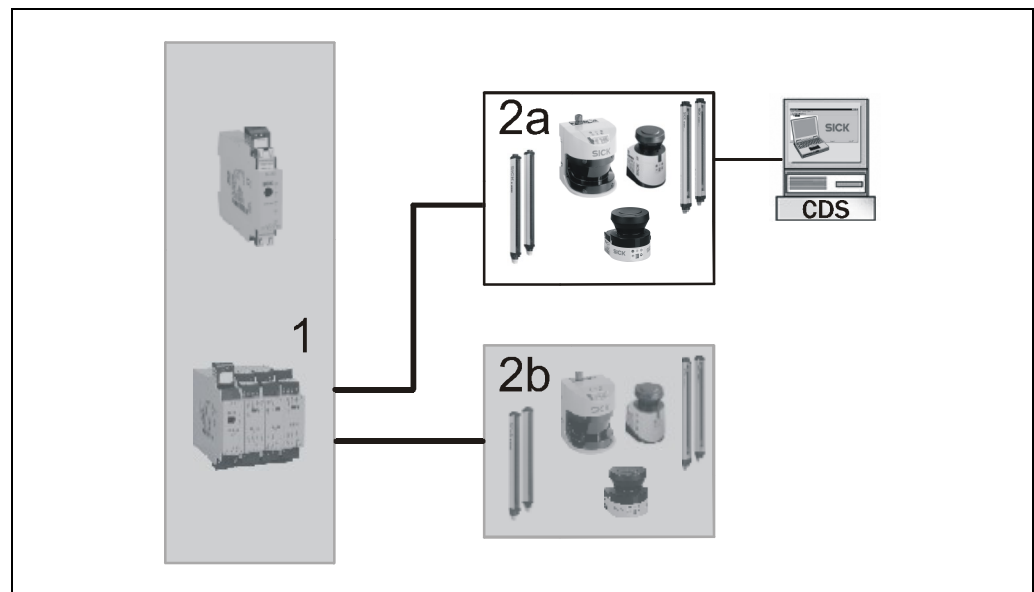
5.2.2   EFI gateway with safety controller and ESPE connected

If a safety controller with an ESPE is integrated via an EFI gateway, then you can configure the EFI gateway (2) and the ESPE (3) via the safety controller (1).

Fig. 33: Configuration of an EFI gateway via a safety controller with ESPE
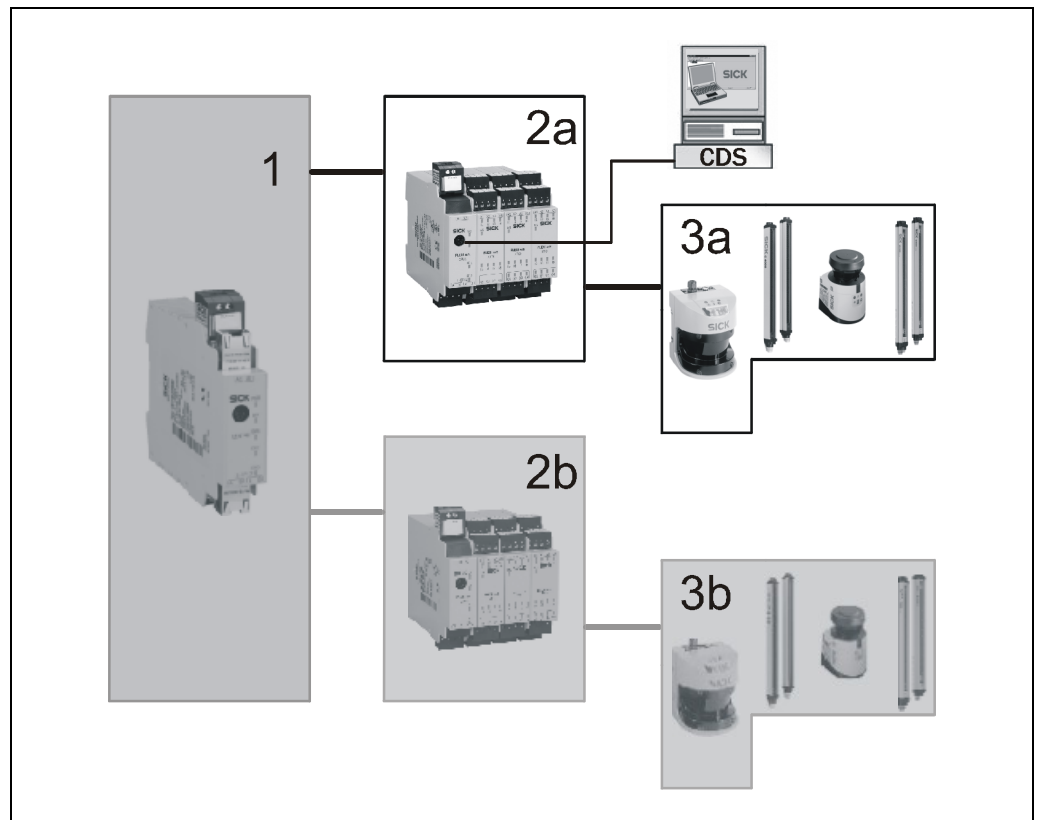
It is only possible to configure the EFI gateway via the EFI gateway (2). Although the safety controller (1) and the ESPE (3) are visible in the CDS, they cannot be configured and diagnostics are not possible.

Fig. 34: Configuration of an EFI gateway via the EFI gateway
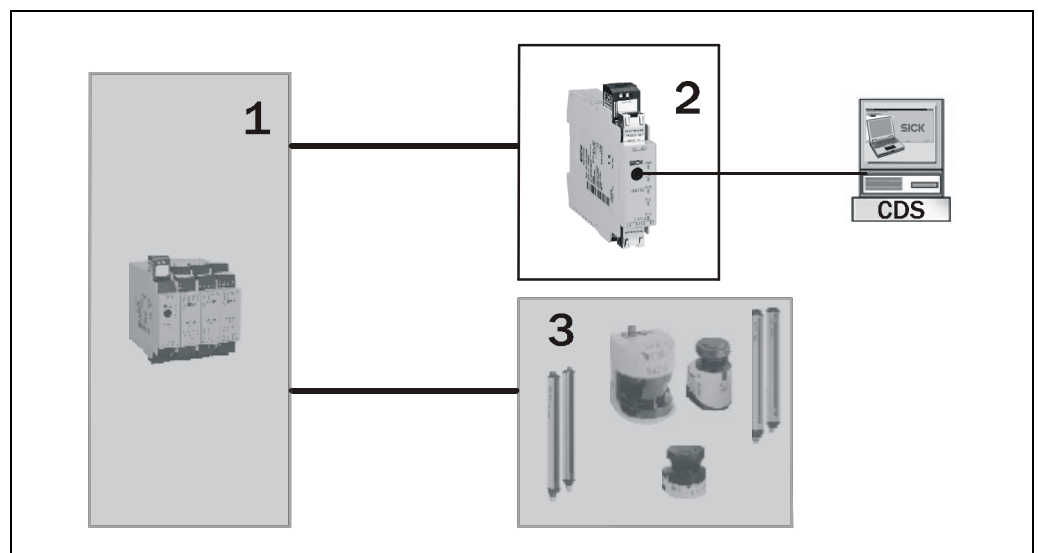
5.2.3 EFI gateway with two safety controllers with ESPE connected

If two safety controllers each with an ESPE are integrated via an EFI gateway into PROFINET, the system configuration must be performed in three steps.

First the safety controller and the ESPE connected to the first EFI string on the EFI gateway are configured (2a and 3a).

Fig. 35: Configuration of the first safety controller with ESPE
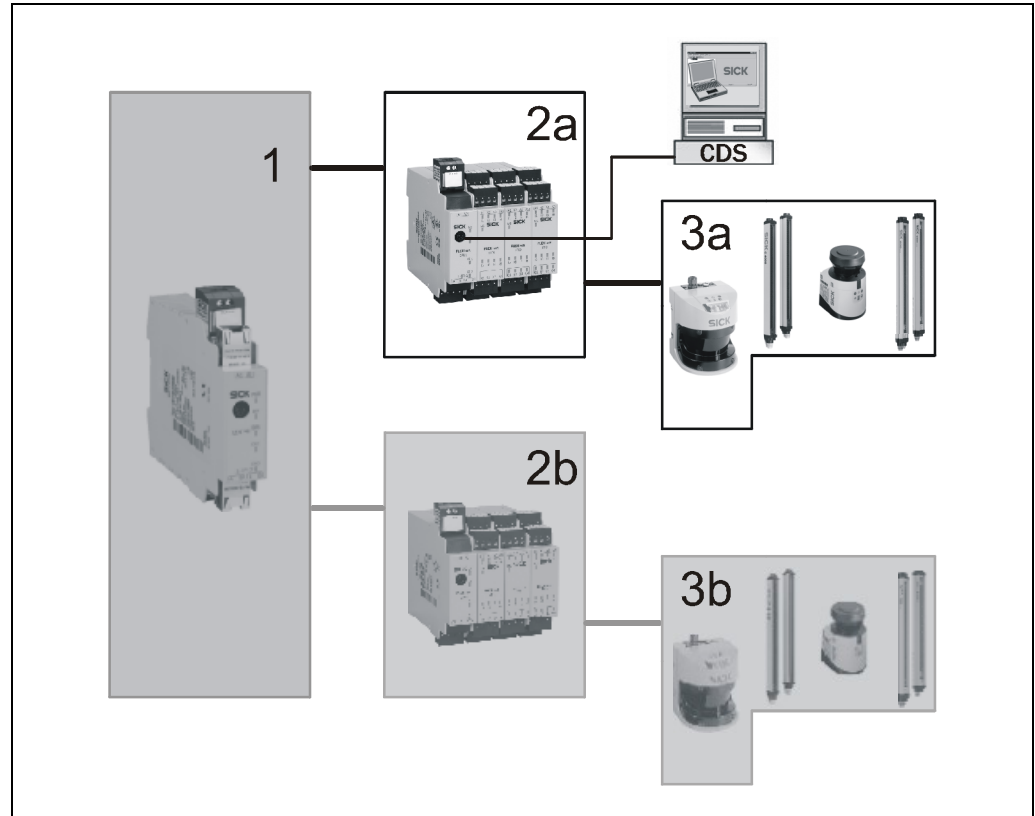
Then the safety controller and the ESPE connected to the second EFI string on the EFI gateway are configured (2b and 3b).

Fig. 36: Configuration of the second safety controller with ESPE
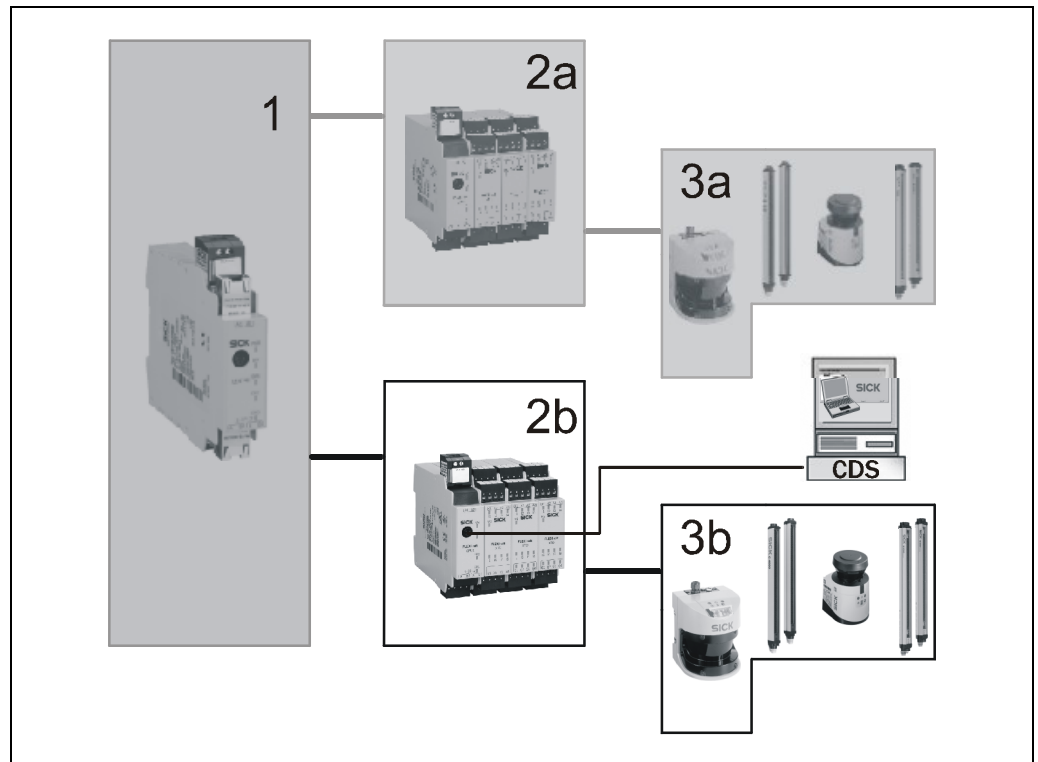
Finally the EFI gateway and the safety controllers connected to it are configured (1, 2a and 2b).

Fig. 37: Configuration of the EFI gateway
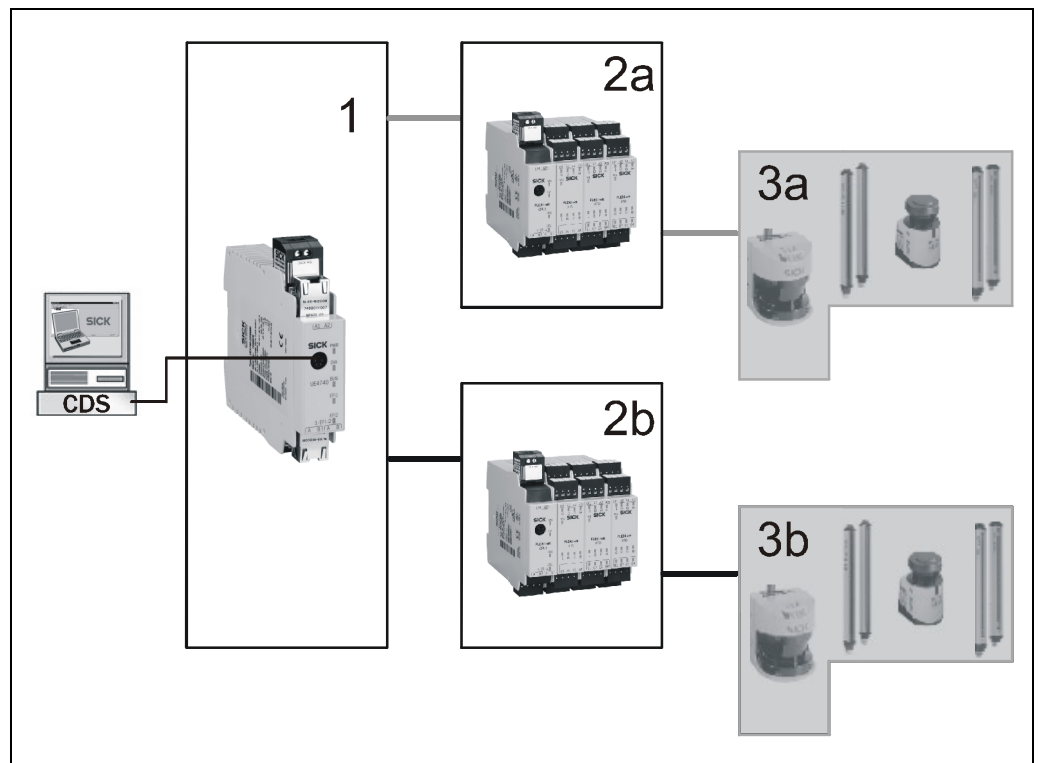
6 Technical specifications

6.1 Electrical installation

If you connect devices together using EFI, connect EFI_A on the first device to EFI_A on the second device and EFI_B on the first device to EFI_B on the second device. Use the same earthing concept for the devices.

⚠
WARNING

Prevent electromagnetic interference!

Follow the information on the prevention of electromagnetic interference in the operating instructions for the related devices.

- connecting cable type: twisted pairs with copper braid screen
- cable length at 0.22 mm^2 cables: 50 m
- galvanic isolation
- characteristic impedance of the connecting cable: 120 Ω
- wire cross-section of the connecting cable: ≥0.22 mm^2
- line wiring

Note   You will find suitable connecting cables in the comprehensive range of SICK accessories (e.g. fieldbus cable 4-core (supply/bus) part no. 6030921).

6.2 Interfaces

Various interface are available for the configuration of the devices:

- RS-232 interface
  All EFI devices have a serial RS-232 interface for configuration and diagnostics. (For PCs/notebooks that only have USB ports, a RS-232-USB adapter is available as an accessory with the part no. 6035396.)

- PROFINET IO
  This connection can be used together with the UE4740 EFI gateway for PROFINET IO PROFIsafe.

7 Annex

7.1 List of tables

7.2 List of illustrations

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