Leuze electronic

the sensor people

COMPACT*plus*-b

Safety Light Curtains
Function Package "Blanking"

607012 - 2009/12
Subject to change without prior notice

CONNECTING AND OPERATING INSTRUCTIONS
Original Instructions

About this Connecting and Operating Instructions Manual

This connection and operating instructions manual contains information on the proper use and effective application of COMPACT*plus*-b Safety Light Curtains. It is included with delivery.

All the information contained herein, in particular the safety notes, need to be carefully observed.

This connecting and operating instructions manual must be stored carefully. It must be available for the entire operating time.

Notes regarding safety and warnings are marked by this symbol .

Notes regarding important pieces of information are marked by the symbol  .

Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use. Knowledge of the connecting and operating instructions is an element of proper use.

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1 General

COMPACT*plus* Safety Light Curtains, Multiple Light Beam Protective Devices and Transceivers are type 4 **A**ctive **O**pto-electronic **P**rotective **D**evices (AOPD) in accordance with IEC/EN 61496-1 and IEC/(pr)EC 61496-2. COMPACT*plus* represents an extension of the tried, tested and proven COMPACT series and is optically and mechanically, with the exception of the connection cap, compatible with this series. All versions have start/restart interlock that can be selected and deselected, plus the contactor monitoring function and a number of additional functions. They have a variety of inputs, signal outputs, LEDs and 7-segment displays.

The devices are delivered as standard with safety-related transistor outputs and cable screws. The receiver is optionally available with relay outputs or with connection to a safety bus, for example.

In order to offer an optimal solution for each specific application, the devices of the COMPACT*plus* series are available in different ranges of functionality.

Overview of function packages:

COMPACT*plus*-b

Safety light curtains with the "Blanking" function package with additional functions fixed and/or floating blanking of beams plus reduced resolution of the protective field.

COMPACT*plus*-m

Safety light curtains and multiple light beam protective devices with the "Muting" function package for bridging the protective device for a limited period, with, for example, proper material transport through the protective field.

COMPACT*plus*-i

Safety light curtains with the "Initiation" function package to not only protect with the protective device, but rather to also provide safety-related control of the production machine.

1.1 Certifications

Company

Leuze electronic GmbH & Co. KG in D-73277 Owen - Teck has a certified quality assurance system in accordance with ISO 9001.

Products

COMPACT*plus* Safety Light Curtains, Multiple Light Beam Protective Devices and Transceivers are developed and produced in compliance with applicable European directives and standards.

Europe: EC prototype test in compliance with
IEC/EN 61496 Part 1 and Part 2
carried out by:
TÜV PRODUCT SERVICE GmbH, IQSE
Ridlerstrasse 65
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1.2 Symbols and terms

Symbols used:

⚠	Warning sign – This symbol indicates possible dangers. Please pay especially close attention to these instructions!
i	Notes on important information.
➢	A note, which also refers to a course of action, provides information about special attributes or describes set-up procedures.
	Symbols of the COMPACT*plus* transmitter General transmitter symbol Transmitter not active Transmitter active

Table 1.2-1: Symbols

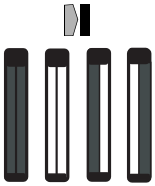
	Symbols of the COMPACT*plus* receiver Above: General receiver symbol Below from left to right: • Receiver active protective field not free, outputs in OFF state • Receiver active protective field free, outputs in ON state • Receiver active protective field not free, outputs still in ON state • Receiver active protective field free, outputs in OFF state
	Signal output Signal input Signal input and/or signal output

Table 1.2-1: Symbols (Forts.)

Terms used:

AOPD	Active Opto-electronic Protective Device
AOPD response time	Time between penetration in the active protective field of the AOPD and the actual switching off of the OSSDs.
AutoReset	When an error indication occurs, caused, for example, by faulty external wiring, the AOPD attempts to start again. If the error no longer exists, the AOPD returns to the normal state.
Contactor monitoring (EDM)	The EDM function monitors the normally closed contacts of downstream positive-guided contactors, relays or valves.
CP-b	COMPACT*plus* with "Blanking" function package
CPR-b	COMPACT*plus* Receiver with "Blanking" function package
CPT	COMPACT*plus* Transmitter
EDM	see „Contactor monitoring“ (**E**xternal **D**evice **M**onitoring)
Fixed blanking	One or more beams or beam packages are fixed blanked
Floating blanking	Beams are floating blanked, which means the blanked object may move in the defined beam zone.
FS	Factory setting (value of a parameter that can be changed with SafetyLab with ex-factory delivery)
MultiScan	Multiple evaluation: Beams must be interrupted in several consecutive scans, before the receiver switches OFF. MultiScan influences the response time!
Optional safety circuit	2-Channel contact-based safety circuit that can be connected directly to the local interface; after activation, it interrupts the same dangerous movement as the receiver does with penetration in the protective field.

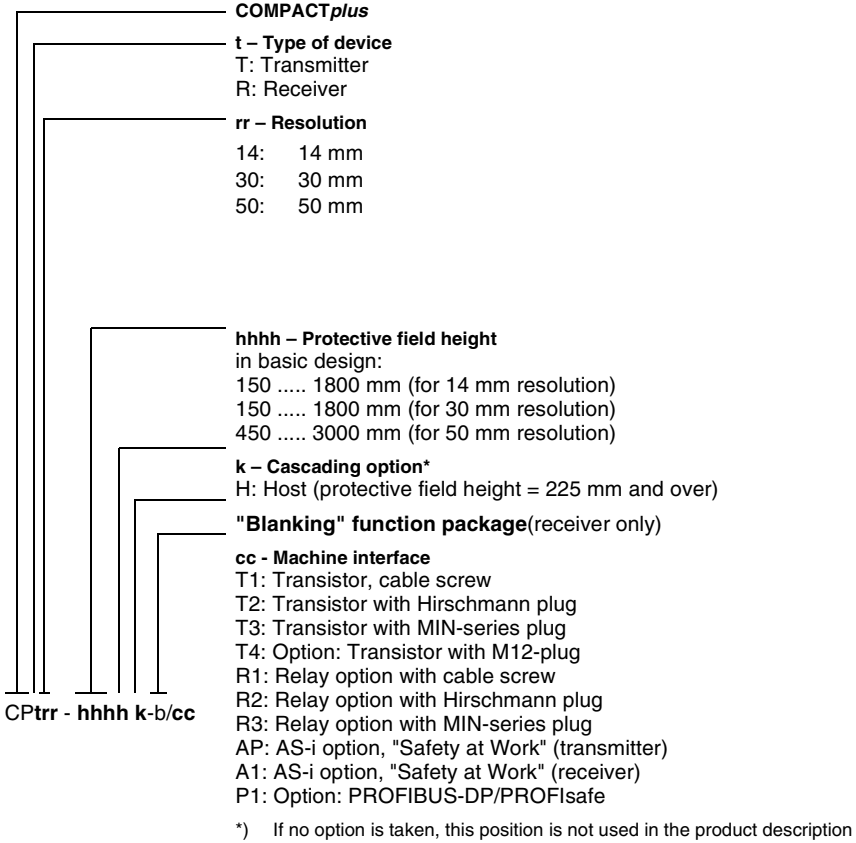
Table 1.2-2: Terms

OSSD1 OSSD2	Safety-related switching output **O**utput **S**ignal **S**witching **D**evice
Reduced resolution	Beams can be interrupted as long as the respective adjacent beams are received.
RES interlock	Start/restart interlock
Safeguarding danger areas	Requires detection in the foot/leg area, example: Chapter 3.4.2
Safeguarding danger points	Requires finger or hand detection, example: Chapter 3.4.1
SafetyKey	Additional components for instructing procedures (only for Light Curtains)
SafetyLab	Diagnostics and Parameterization Software (optional)
Scan	All beams, beginning with the synchronization beam, are pulsed by the transmitter in cycles one after the other.
Start/restart interlock	Prevents automatic start after supply voltage is switched on; after the protective field has been penetrated; or after the optional safety circuit has been reset.

Table 1.2-2: Terms

1.3 Naming system for COMPACT*plus*

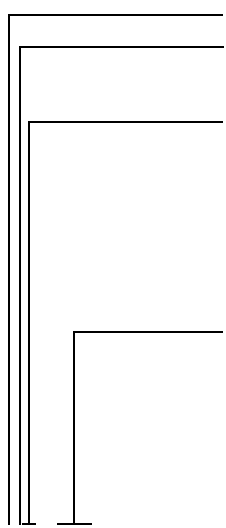
1.3.1 Safety Light Curtains – Basic Design/Host



*) If no option is taken, this position is not used in the product description

Fig. 1.3-1: Selecting COMPACT*plus*-b Safety Light Curtains

1.3.2 Safety Light Curtains – Guests



COMPACT

t – Type of device
T: Transmitter
R: Receiver

rr – Resolution
14: 14 mm
30: 30 mm
50: 50 mm
90 90 mm

hhhh – Protective field height
in basic design:
150 ..... 1800 mm (for 14 mm resolution)
150 ..... 1800 mm (for 30 mm resolution)
450 ..... 3000 mm (for 50 mm resolution)
750 ..... 3000 mm (for 90 mm resolution)

*) If no option is taken, this position is not used in the product description

C**trr** - **hhhh** S

Fig. 1.3-2: Selecting COMPACT Guests

Examples:

COMPACT*plus*-b Safety Light Curtain in basic design, without options

CPT14-1500/T1		**CPR14-1500-b/T1**	
COMPACT*plus*	Safety Light Curtain	COMPACT*plus*-b	Safety Light Curtain
Device type:	Transmitter	Device type:	Receiver
Physical resolution:	14 mm	Physical resolution:	14 mm
Detection range:	6 m	Detection range:	6 m
Height of protective field:	1500 mm	Height of protective field:	1500 mm
Design type:	Basic design	Design type:	Basic design
		Function package:	Blanking
		Safety output:	2 OSSD transistor outputs
Connection system:	Cable screw	Machine interface Connection system:	Cable screw

Table 1.3-1: Example 1, selection CP-b safety light curtain

COMPACT*plus*-b Safety Light Curtain in host/guest design combination with options

CPT30-1200H/T2		**CPR30-1200H-b/R2**	
COMPACT*plus*	Safety Light Curtain	COMPACT*plus-s*	Safety Light Curtain
Device type:	Transmitter	Device type:	Receiver
Physical resolution:	30 mm	Physical resolution:	30 mm
Detection range:	18 m	Detection range:	18 m
Height of protective field	1200 mm	Height of protective field:	1200 mm
Design type:	Host	Design type:	Host
		Function package:	Blanking
		Safety output:	2 OSSD transistor outputs
Connection system option:	Hirschmann plug	Connection system option:	Hirschmann plug
Connection system for guest transmitter:	Connection socket M12, 8-pin	Connection system for guest receiver:	Connection socket M12, 8-pin

Table 1.3-2: Example 2, selection CP-b safety light curtain

CT50-750S		CT50-750S	
COMPACT	Safety light curtain	COMPACT	Safety light curtain
Device type:	Transmitter	Device type:	Receiver
Physical resolution:	50 mm	Physical resolution:	50 mm
Detection range:	18 m	Detection range:	18 m
Height of protective field	750 mm	Height of protective field:	750 mm
Design type:	Guest with 250 mm connection cable	Design type:	Guest with 250 mm connection cable
Connection system for host transmitter:	250 mm connection cable with M12, 8-pin plug	Connection system for host receiver:	250 mm connection cable with M12, 8-pin plug

Table 1.3-2: Example 2, selection CP-b safety light curtain

2 Safety

Before using the safety sensor, a risk evaluation must be performed according to valid standards (e.g. EN ISO 1411, EN ISO 12100-1, ISO 13849-1, IEC 61508, EN 62061). The result of the risk assessment determines the required safety level of the safety sensor (see Table 2.1-1). For mounting, operating and testing, document "COMPACT*plus*-b Safety Light Curtains, blanking function package" as well as all applicable national and international standards, regulations, rules and directives must be observed. Relevant and supplied documents must be observed, printed out and handed to the affected personnel.

Before working with the safety sensor, completely read and understand the documents applicable to your task.

In particular, the following national and international legal regulations apply for the start-up, technical inspections and work with safety sensors:

- Machinery directive 2006/42/EC
- Low voltage directive 2006/95/EC
- Electromagnetic compatibility directive 2004/108/EC
- Use of Work Equipment Directive 89/655/EEC supplemented by Directive 95/63 EC
- OSHA 1910 Subpart 0
- Safety regulations
- Accident-prevention regulations and safety rules
- Ordinance on Industrial Safety and Health and Labor Protection Act
- Device Safety Act

Notice!

For safety-related information you may also contact the local authorities (e.g., industrial inspectorate, employer's liability insurance association, labor inspectorate, occupational safety and health authority).

2.1 Approved purpose and foreseeable improper operation

Warning!

A running machine can cause severe injuries!
Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted again.

2.1.1 Proper use

The safety sensor must only be used after it has been selected in accordance with the respectively applicable instructions and relevant standards, rules and regulations regarding labor protection and occupational safety, and after it has been installed on the machine, connected, commissioned, and checked by a competent person.

When selecting the safety sensor it must be ensured that its safety-related capability meets or exceeds the required performance level PL_r ascertained in the risk assessment.

The following table shows the safety-related characteristic parameters of the COMPACT*plus*-b Safety Light Curtain.

Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
SILCL in accordance with IEC/EN 62061	SILCL 3
Performance Level (PL) in accordance with EN ISO 13849-1: 2008	PL e
Category in accordance with ISO 13849	Cat. 4
Average probability of a failure to danger per hour (PFH_d) For protective field heights up to 900 mm, all resolutions For protective field heights up to 1800 mm, all resolutions For protective field heights up to 3000 mm, all resolutions	 2.26×10^{-8} $^1/_h$ 2.67×10^{-8} $^1/_h$ On request
Service life (T_M)	20 years
Number of cycles until 10 % of the components have a failure to danger (B_{10d}) Version /R with relay output, DC13 (5 A, 24 V, inductive load) Version /R with relay output, AC15 (3 A, 230 V, inductive load)	 630,000 1,480,000

Table 2.1-1: Safety-related characteristic parameters of the COMPACT*plus*-b Safety Light Curtain

- The safety sensor protects persons at access points or at points of operation of machines and plants.
- The safety sensor with vertical mounting detects the penetration by fingers and hands at points of operation or by the body at access points.
- The safety sensor only detects persons upon entry to the danger zone; it does not detect persons who are located within the danger zone. For this reason, a start/restart interlock is mandatory.
- The safety sensor with horizontal mounting detects persons who are located within the danger zone (presence detection).
- The construction of the safety sensor must not be altered. When manipulating the safety sensor, the protective function is no longer guaranteed. Manipulating the safety sensor also voids all warranty claims against the manufacturer of the safety sensor.
- The safety sensor must be tested regularly by competent personnel.
- The safety sensor must be exchanged after a maximum of 20 years. Repairs or the exchange of parts subject to wear and tear do not extend the service life.

2.1.2 Foreseeable misuse

In principle, the safety sensor is not suitable as a protective device in case of:

- danger of objects being expelled or hot or dangerous liquids spurting from the danger zone
- applications in explosive or easily flammable atmospheres

2.2 Competent personnel

Prerequisites for competent personnel:

- he has a suitable technical education
- he knows the rules and regulations for occupational safety, safety at work and safety technology and can assess the safety of the machine
- he knows the instructions for the safety sensor and the machine
- he has been instructed by the responsible person on the mounting and operation of the machine and of the safety sensor

2.3 Responsibility for safety

Manufacturer and operating company must ensure that the machine and implemented safety sensor function properly and that all affected persons are adequately informed and trained.

The type and content of all imparted information must not lead to unsafe actions by users.

The manufacturer of the machine is responsible for:

- safe machine construction
- safe implementation of the safety sensor
- imparting all relevant information to the operating company
- adhering to all regulations and directives for the safe starting-up of the machine

The operator of the machine is responsible for:

- instructing the operating personnel
- maintaining the safe operation of the machine
- adhering to all regulations and directives for occupational safety and safety at work
- regular testing by competent personnel

2.4 Exemption of liability

Leuze electronic GmbH + Co. KG is not liable in the following cases:

- safety sensor is not used as intended
- safety notices are not adhered to
- reasonably foreseeable misuse is not taken into account
- mounting and electrical connection are not properly performed
- Proper function is not tested (see Chapter 10)
- changes (e.g., constructional) are made to the safety sensor

2.5 Safety information on the "Blanking" function package

Warning!

COMPACT*plus*-b *allows a freely definable number of beams to be blanked out of the protective field (fixed and floating blanking) through a "teaching-in" procedure or per PC parameterization via SafetyLab. The functions can only be used with a special tool (SafetyKey), a key lock with two changeover switches, which the machine manufacturer must install in the control panel, or password-protected with a PC and SafetyLab.*

Fixed and floating blanking require that blanked objects be spread over the complete width of the protective field between transmitter and receiver so that nobody can access the danger area beside the object. If blanked objects do not have the necessary width, appropriate locking devices must be fixed to the object.

Fixed and floating blanking are only allowed for safeguarding danger points with normal approach to the protective field. For safeguarding danger areas with parallel approach to the protective field, fixed and floating blanking would present bridges, from which the safety distance to the danger area would be too small.

It is the operator's responsibility to only issue SafetyKey or switch keys or SafetyLab and password to personnel that have the necessary technical expertise and whose job is to set up the protective field. The same applies for the reduced resolution function. It should be ensured here for both the floating blanking function and for the reduced resolution function that the safety distance is recalculated if they are changed.

When calculating the safety distance, the **effective** resolution must always be used. If the effective resolution deviates from the physical resolution, this must be documented near the receiver on a plate in a lasting, wipe-resistant manner.

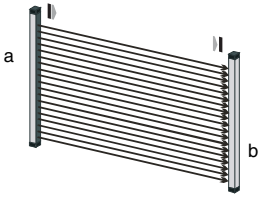
The technical expert placed in charge of setting parameters for the protective field must know the contents of these operating instructions and the safety notes in Chapters 4 and 9 regarding the topics, fixed and floating Blanking as well as reduced resolution and, if necessary, pass this knowledge on to operating personnel.

3 System design and possible uses

3.1 The opto-electronic protective device

Mode of operation

COMPACT*plus*-b consists of a transmitter and a receiver. Beginning with the first beam (synchronization beam) directly after the display panel, the transmitter pulses beam for beam in rapid succession. The synchronization between transmitter and receiver is performed optically.



a = Transmitter
b = Receiver

Fig. 3.1-1: Principle of the opto-electronic protective device

The receiver recognizes the specially formed pulse bundles of the transmitter beams and opens the corresponding receiver elements in sequence in the same rhythm. A protective field is consequently formed in the area between the transmitter and receiver, the height of which depends on the geometrical dimensions of the optical protective device, the width of which depends on the distance selected between the transmitter and receiver within the permissible detection range.

To improve the availability under difficult environmental conditions, it can be useful to wait after a beam interruption has been detected to see if this interruption is still present in the next scan(s), before the receiver switches the OSSDs off. This type of evaluation is called "MultiScan Mode" and it influences the receiver response time.

If MultiScan is active, it works scan-related, i.e. the receiver switches to the OFF state regardless of which of the beams is affected, as soon as a defined number of consecutive scans (Hx) have been interrupted (scan-related).

This MultiScan factor used is briefly displayed on the 7-segment display of the receiver (Hx) with start after power-on. The resulting response time is subsequently displayed with tx xx, whereby the response time x xx is displayed in milliseconds.

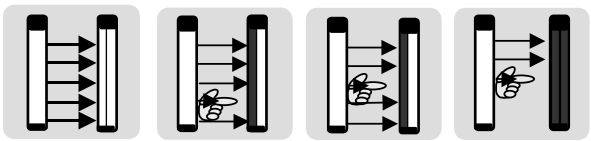


Fig. 3.1-2: Example: MultiScan, scan-related, MultiScan factor H = 3

In the factory setting, scan-related MultiScan applies with the following MultiScan factor (AutoScan mode):

- Safety Light Curtains (8..240 beams): H = 1

The values for the MultiScan factor can be selected within limits with SafetyLab (Chapter 13.2).

Warning!

An increase in the MultiScan factor causes an extension of the response time and makes a recalculation of the safety distance necessary in accordance with Chapter 6.1!

Basic functions such as start/restart interlock or contactor monitoring (EDM) and a series of additional functions can be optionally assigned to the receiver so that there is generally no need for a downstream safety interface.

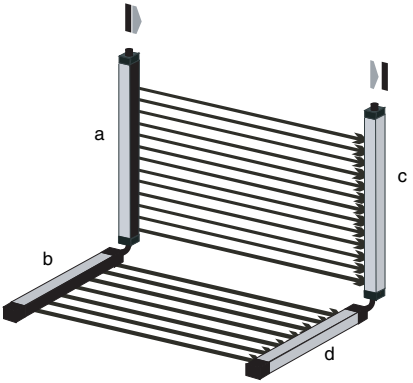
In the Blanking functional package, you have the possibility of phasing certain beams out of the protective field either statically or dynamically. The beams that are phased out must however be occupied by materials positioned on the corresponding point, so that the OSSDs will be able to switch to ON when the protective field is in other respects free.

Warning!

You also have the option of operating the light curtains with reduced resolution. You must however take note that in a case of dynamic phasing out and reduced resolution the safety distance between the protective field and the danger point must be recalculated and observed on the basis of the resolution that is effective in the altered circumstances.

3.2 Cascading option

To implement multiple linked protective fields, COMPACT*plus* Safety Light Curtains can be cascaded one after the other via plug-in cable connections. This allows devices with different physical resolutions to be combined with each other.



a = CPT transmitter, Host (H)
b = CT transmitter, Guest (S)
c = CPR-b receiver, Host (H)
d = CR receiver, Guest (S)

Fig. 3.2-1: Structure of a cascaded system

Cascading devices makes it possible to implement adjacent protective fields, for rear area protection without any additional expense for control and connection, for example. The host system is responsible here for all processor tasks, displays and the receiver-side interfaces to the machine and control devices.

The following limits must be observed:

- The height of the protective field for the first light curtain (host) must be at least 225 mm.
- Ensure that the required detection range of the cascaded system falls within the maximum detection range of all individual components.
- The number of beams of all components must not exceed 240. For the number of beams n, for the individual components, please refer to the tables in Chapter 12.
- The cables between the individual components are part of the guest. The standard length is 250 mm. The connection to the host is made with an M12 plug.

3.3 Deflecting mirror as accessory

Several sides of a danger point or a danger area can be protected using deflection mirrors. The maximum width of the protective field is reduced by approximately 15% per mirror.

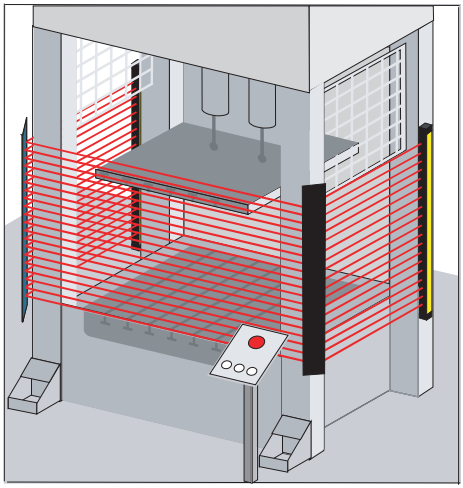


Fig. 3.3-1: Example: Multiple-side protection of a danger point using deflection mirrors.

Warning!

If blanking is necessary at one side, for example for a material feeder, all other sides must be protected by locking devices to prevent gaps in the protective field. Those locking devices must reach over the complete protective field from transmitter to receiver and must be fixed mechanically so that they cannot be removed separately.

3.4 Application examples

3.4.1 Safeguarding danger points

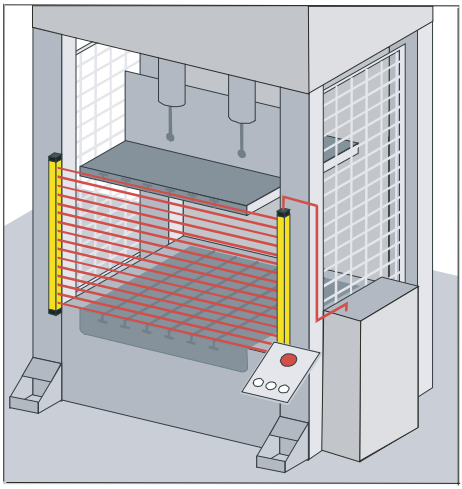


Fig. 3.4-1: COMPACT*plus*-b Safety Light Curtain – Application for a press

3.4.2 Safeguarding danger areas

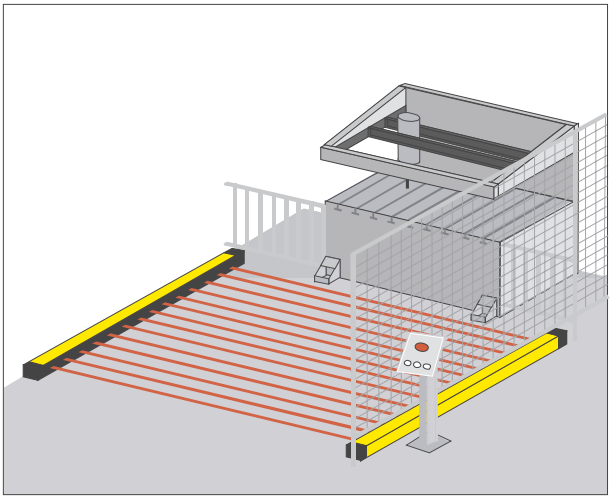


Fig. 3.4-2: COMPACT*plus*-b Safety Light Curtain – Application for a routing machine

4 "Blanking" function package

4.1 Parameterizable functions of CPT transmitter

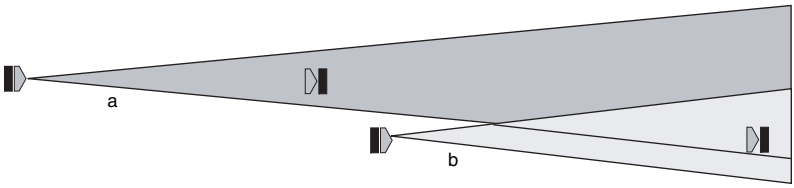
4.1.1 Transmission channel

The infrared beams are modulated with specially shaped pulse bundles so that they are distinct from ambient light and undisturbed operation is consequently ensured. Sparks from welding or warning lights from passing forklifts etc. do not have any effect on the protective field.

If two protective fields are located directly next to each other for two adjacent machines, measures must, however, be implemented so that the optical protective devices do not affect each other.

Both transmitters should first be assembled back to back so that the beams radiate in opposite directions. It is consequently impossible for them to affect each other.

Another possible way to suppress mutual influences is to switch one of the two protective devices from transmission channel 1 to 2, thereby switching them to differently formed pulse bundles. This option can then be selected when more than two optical protective devices are arranged next to each other.



a = AOPD "A" transmission channel 1
b = AOPD "B" transmission channel 2, not affected by AOPD "A"

Fig. 4.1-1: Transmission channel selection

The change from transmission channel 1 (factory setting) to 2 must be made both on the transmitter and the receiver of the optical protective device in question. You will find more detailed information in Chapter 8.

4.2 Parameterizable basic functions of receiver

You will find setting notes for parameterization using switches on the display and parameter module in the connecting and operating instructions. Further settings are also available with SafetyLab and PC. See the separate user manual for SafetyLab.

Note!

If required, information on further setting options with switches or on customer-specific presettings can be found on an attached data sheet or in additional connecting and operating instructions.

Warning!

After parameters are changed, be it with switch or with PC with SafetyLab, the functioning of the optical protective device must be carefully tested. You will find more information on this in Chapters 10 and 13.

4.2.1 Transmission channel

When delivered, both the receiver and the transmitter are set to transmission channel 1 (C1). If the corresponding transmitter is switched to transmission channel 2, the receiver must also be set to transmission channel 2 (C2). See Chapter 8 for more information.

4.2.2 Start/restart interlock

Warning!

*When delivered, the internal start/restart interlock of the COMPACTplus is **not** activated!*

The start/restart interlock function prevents the safety circuits from being released automatically when the machine is turned on or the power supply is restored after a power outage. The receiver only switches to the ON state by pressing and releasing the start-/restart button within a time window.

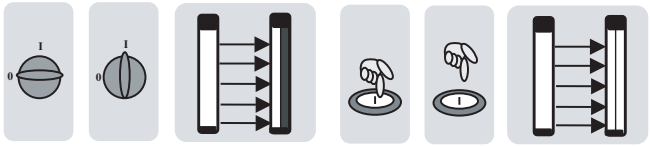


Fig. 4.2-1: Start/restart interlock function with supply voltage power-on

If the protective field is penetrated or an optional safety circuit is activated, the start/restart interlock function ensures that the receiver also remains in the OFF state after the protective field has been freed. The receiver will then not be switched back to the ON state until the start-/restart button is pressed and released again within a time window of 0.1 to 4 seconds (FS).

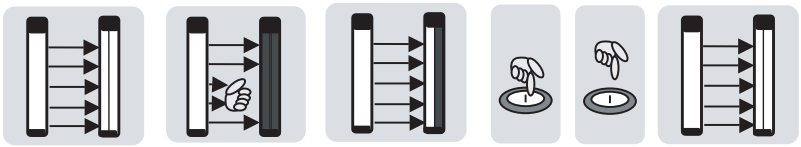


Fig. 4.2-2: Start/restart interlock function after interrupting the protective field

Without the start/restart interlock, the receiver outputs immediately switch to the ON state after the machine has been turned on or the power supply has been restored and after the protective field has been freed! Operation of the protective device without the start/restart interlock is only permitted in a very few exceptions and under the conditions of controlling protective devices in accordance with EN ISO 12100-1 and EN ISO 12100-2. It must also be ensured that it is impossible to walk or slip through the protective field.

If fixed or floating blanking functions are used, the start/restart interlock function is obligatory provided the introduced objects or locking devices are not monitored in their position. See note in Chapter 4.2.4.

How to activate the start/restart interlock:

➢ Internally in the COMPACT*plus* receiver (see Chapter 8.3.3)
➢ or in the downstream safety interface (e.g. MSI from Leuze)
➢ or in the downstream machine control unit
➢ or in the downstream Safety PLC

If the internal start/restart interlock is activated as described in Chapter 8.3.3, the interlock functions are monitored dynamically. The receiver is only switched back to the ON state after the start-/restart button has been pressed and released again. Additional requirements are, of course, that the protective field be free and that any connected additional safety circuits be in the ON state.

If both the internal and a subsequent start/restart interlock are activated, the receiver will only perform a reset function with its assigned start-/restart button.

4.2.3 Contactor monitoring (EDM)

Warning!
*The contactor monitoring function is **not** activated at the factory!*

The "Contactor monitoring" function dynamically monitors contactors, relays or valves downstream from the COMPACT*plus*. Precondition here are switching elements with positive-guided feedback contacts (normally closed).

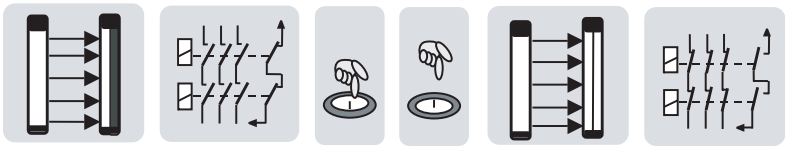


Fig. 4.2-3: Contactor monitoring function, combined in this example with start/restart interlock

Activate the contactor monitoring function via:

➢ The internal dynamic contactor monitoring in the receiver (see Chapter 8.3.1),
➢ or the external contactor monitoring of the downstream safety interface (e.g. MSI from Leuze)
➢ or via a possible downstream Safety PLC
(optional, connected via a safety bus)

If the contactor monitoring is activated via a switch it works dynamically, which means, in addition to the closed feedback circuit being checked before each switching-on of the OSSDs, it is checked to see if the feedback circuit has opened within 300 ms (WE) after release, and if it has closed again within 300 ms (WE) after the OSSD has been switched off. If this is not the case, the OSSDs return to the OFF state again after being briefly switched on. An error code appears on the 7-segment display and the receiver goes to the error locking status, from which it can only be return to normal operation by switching the supply voltage off and back on again.

Further selection options emerge with SafetyLab and PC.

4.2.4 Contact-based safety circuit

COMPACT*plus* offers additional inputs for safety sensors equipped with contacts to which the following components can be connected:

- Section Emergency STOP
- Door interlock without guard interlocking with 2 normally closed contacts
- Optical safety sensors, type 4 with 2 normally open contacts
- Position monitoring of fixed or floating blanked objects

Safety instructions for the Section Emergency STOP:

Section Emergency STOP buttons connected to the COMPACT*plus only affect the safety circuit that is assigned to the AOPD. It is therefore referred to as a* ***Section*** *Emergency STOP. The button's limited area of effect must be identified for the operating staff in such a way that is clearly visible.*

The requirements for emergency stop equipment, including EN 60204-1 and EN 418, apply to the Section Emergency STOP system. Section Emergency STOP buttons must have an interlock mechanism. After the interlock mechanism has been released, the dangerous movement may not immediately start up again. Instead, a separate procedure for starting up is required, via the start-/restart button, for example. Operation with start/restart interlock is therefore compulsory (with COMPACT*plus* or with a downstream machine interface).

The response time from opening the first of the two contacts until switching the OSSDs is 40 ms. Added to this is the response time of the output module:

- Transistor output: + 1.6 ms
- Relay output: + 16.6 ms
- AS-i output: + 6.6 ms

With the resetting, the two contacts must close within 0.5 seconds to be able to start the working process again.

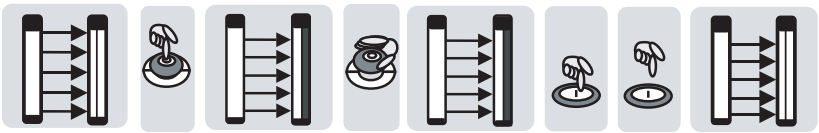


Fig. 4.2-4: Section Emergency STOP requires the start/restart interlock function

➢ Where required, activate the "contact-based safety circuit" function using switch S6 as described in Chapter 8.3.6.

ⓘ If the option "Contact-based safety circuit" is selected, COMPACT*plus* expects the usage of the corresponding inputs L3 and L4 on the local interface to release the OSSDs (see Chapter 7.1).

ⓘ This option can be used to monitor the position of objects or locking devices in the case of fixed or floating blanking, via coded plugs on short cables or via safety switches with separate actuator, for example. An unintended restart can therefore be prevented if objects are taken out of the protective field.

4.2.5 Teach-in override

The teach-in override function temporarily bridges the protective field and the start/restart interlock during teach-in. If Teach-in Override is activated, the OSSDs switch on, regardless of the state of the protective field and a possible locked restart interlock, in order, for example, to be able to "teach-in" large work pieces with floating blanking. Teach-in Override is time-limited and switches off after max. 60 s (FS).

This function is already enabled in the factory setting. To activate it, only a 2-channel key switch must be connected as described in Chapter 7.1 on L3 and L4 (FS) to exclusive signals, which switches both switch levels within 0.5 s.

Teach-in Override can not be used together with the optional safety circuit.

➢ Where required, activate the override function of the receiver according to your application (see Chapter 8.3.7).

Safety note:

The safety function of the optical protective device is powered off during the activation period of the override function. The safety of the operating personnel must therefore be ensured with other measures.

4.3 Parameterization of the protective field

COMPACT*plus*-b safety light curtains offer the possibility of blanking one or more blocks of beams of the optical protective device with the **fixed blanking** function, because a holding device extends beyond the protective field, for example. The first beam next to the display cannot be blanked (synchronization beam). Another requirement is that objects extend over the complete width of the protective field to prevent "shadows" of the object where somebody may enter undetected into the protective field.

The **floating blanking** function permits blanking in one or several zones where objects of a fixed size can move. The floating objects must also extend over the complete width of the protective field. Floating blanking influences the resolution of the AOPD at the marginal areas of the inserted objects. This must be taken into account in calculating the safety distance.

The **Reduced Resolution"** function, compared with safety light curtains with lower physical resolution, means that multiple objects of a defined maximum size will not be detected and thus can interrupt and move in the protective field without switching off the OSSD. Synchronization beam 1 may not be interrupted for longer than 10 seconds. The reduced resolution function requires that the safety distance be recalculated.

The fixed blanking function can be combined either with the floating blanking function or with the reduced resolution function.

Warning!

Blankings in the protective field or changes to the protective field's resolution may only be carried out by authorized personnel. It is the responsibility of the machine operator to only give corresponding tools, such as SafetyKey, keys for the 2-pin key switch or PC with SafetyLab and the password for the access level "Authorized Customer" to experienced, specialist staff.

Functions such as fixed blanking, floating blanking and reduced resolution may only be used if the objects introduced do not have any shiny surfaces or reflective top and/or under sides. Only matt surfaces are permitted! See Chapter 8 for notes on the parameterization of these functions.

4.3.1 Fixed and floating blanking

COMPACT*plus*-b can "teach-in" any number and any size of fixed and floating blanking zones. It must generally be ensured that the first beam after the display field cannot be blanked. It is used for continuous transmitter and receiver synchronization. "Taught-in" blanking zones must be separated by a minimum distance that corresponds with the resolution of the AOPD.

Warning!

Objects to be blanked fixed or floating, must extend across the entire width of the protective field or must be appropriately extended by mechanical barriers that also have matt surfaces so that nothing can enter from the side. Objects and mechanical locks must be firmly attached to each other and make it possible to only be taken out of the protective field together. Shadows caused by high standing parts or sloping installation cause unprotected zones in the protective field! This must always be prevented.

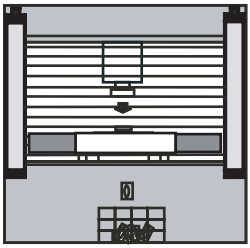


Fig. 4.3-1: Mechanical locks of equal sizes must prevent entry into the protective field from the side with fixed or floating objects.

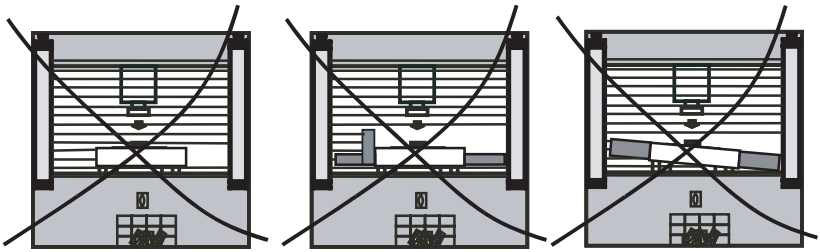


Fig. 4.3-2: Shadows in the protective field must always be prevented.

Warning!

*The fixed and floating blanking functions must be used **only in combination with start/restart interlock** (internally or in the downstream machine control system) to prevent the machine from unexpectedly restarting with a missing object, possibly caused by operator entry into the protective field at the point where the object is supposed to be! Exceptions are only allowed, if the objects and, where applicable, the locking devices are connected electrically via the intended inputs L3 and L4 of the local interface and their position is therefore constantly monitored.*

Fixed and floating blanking zones can be "taught in" with the SafetyKey (also supplied) or using a key lock with two changeover switches. Teaching-in floating blanking zones also requires that this function be switched in the receiver using switches S4/S5. With the factory setting of S4/S5, only fixed blanking zones are accepted during the "teaching-in" procedure.

Teaching-in fixed blanking zones

Objects for fixed blanking may not change their position during the teaching-in procedure. The object must be a minimum size that corresponds with the physical resolution of the AOPD. More instructions can be found in Chapter 8.3.

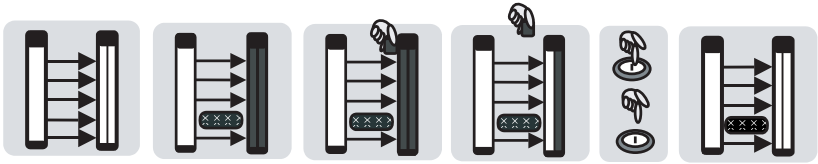


Fig. 4.3-3: Teaching-in of fixed blanking zones with the SafetyKey

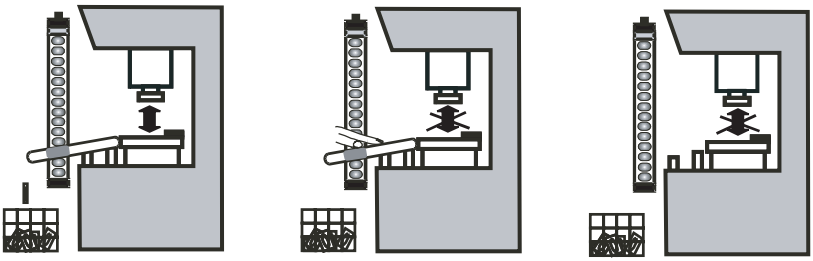


Fig. 4.3-4: Example of "Fixed blanking"

During teach-in the total number of uninterrupted beams is displayed on the 7-segment display.

A new teaching-in procedure overwrites the previously taught-in state. If the fixed blanking function is to be selected, this can be done by teaching in a free protective field (0 display with teach-in).

Teaching in floating blanking zones

Floating blanking zones are allowed if this function is activated with the switches S4/S5 and the object is moved during the teaching-in procedure within its zone. The object must be a minimum size that corresponds with the physical resolution of the AOPD. Removing the SafetyKey or resetting the 2-pin key lock terminates the teaching-in procedure.

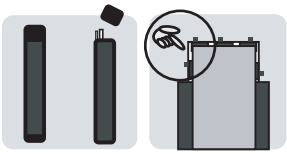


Fig. 4.3-5: Switching on the teaching-in option for floating blanking with S4/S5

Depending on the permitted movement of blanked objects, the number of interrupted beams changes by 1 beam, although the size of the object may not change.

Warning!

The resolution changes on the marginal areas above and below the introduced floating object or locking devices of the same size according to the following table. No table has been given for safeguarding danger area applications because blanked objects would be barriers for light curtains with approach parallel to the protective field or with bridges that are low mounted from which there would not be a sufficient safety distance to the danger point.

➢ After changing COMPACT*plus*-b to floating blanking, recalculate the **safety distance** with the **effective** resolution according to table 4.3-1 and correct the mounting distance to the danger point. The effective resolution must be indelibly noted on the receiver information plate so it cannot be wiped off (see Chapter 13.1).

The effective resolution is displayed on the 7-segment display after the teaching-in and the parameter transfer by SafetyLab and is to be understood as an information note on the test rod to be used. This display does not replace the testing of the effective resolution according to the following table. Where required, the safety distance must be recalculated and tested according to Chapter 6.1.

Floating Blanking Safeguarding danger points in accordance with EN 999, normal approach to the protective field				
Physical resolution	Permissible change with movement	Effective resolution at the margins of the object d	Permissible size change of blanked objects	Allowance C for safety distance C = 8 (d –14) See Chapter 6.1.1
14 mm	1 beam	**19 mm**	0 mm	40 mm
30 mm	1 beam	**38 mm**	0 mm	191 mm
14 mm	2 beams *	**29 mm**	9 mm	120 mm
30 mm	2 beams *	**57 mm**	Not permissible in Europe	Not permissible in Europe

*) Can only be set with SafetyLab

Table 4.3-1: Effective resolution with floating blanking

If the switches S4/S5 are in position R/L, fixed and floating blanking zones are taught-in at the same time. Previously taught-in zones are overwritten by the new teaching-in procedure. During the teaching-in procedure, objects that are assigned a floating blanking zone must be moved between the two beam zone limits.

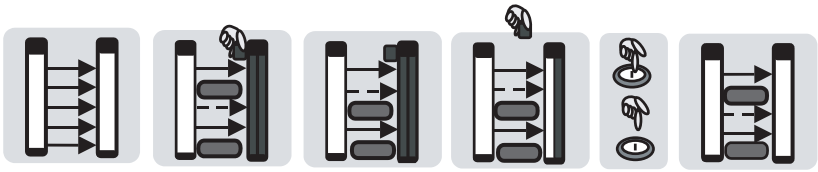


Fig. 4.3-6: Simultaneous teaching-in of a fixed and (after selection with S4/S5) a floating blanking zone

If the floating blanking function is to be disabled, this can be done by teaching-in a free protective field or a protective field with only fixed objects. If the floating blanking function is disabled using switches S4/S5, only fixed blanking zones stay active. In this switch position, no new floating blanking zones can be taught-in. Previously taught-in floating blanking zones are disabled, even after reactivating S4/S5; these floating blanking zones are lost.

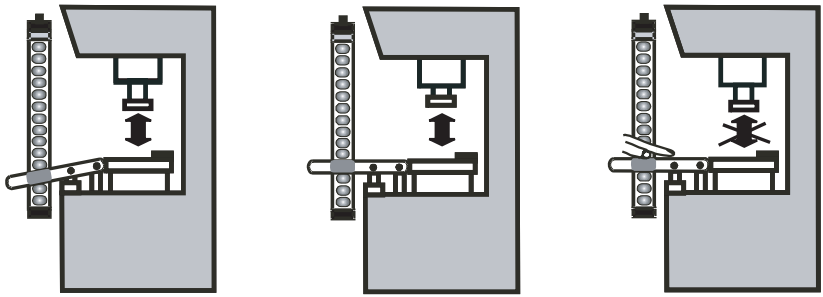


Fig. 4.3-7: Example of floating blanking

If the AOPD has taught in blanking zones, the receiver switches to the ON state after conclusion of the teaching-in procedure and pressing and releasing the start-/restart button with observance of the following conditions:

- Transmitter and receiver are aligned with one another
- and the first beam next to the display is free (synchronization beam)
- and fixed taught-in objects are in the same position at which they were taught in
- and floating taught-in objects are within the floating blanking zone and have the parameterized object size
- and there is always only one object in the respective taught-in blanking zone.

The receiver stays in or goes to the OFF state, if:

- additional beams are interrupted (e.g. by operator intervention),
- or the size or position of fixed taught-in objects changes,
- or the size of floating taught-in objects changes,
- or floating taught-in objects leave the taught-in blanking zone,
- or if taught-in blanking zones do not maintain the minimum distance between one another (minimum distance = physical resolution),
- or fixed or floating taught-in objects are removed from the beam paths.

Principally teaching in beam areas with floating blanking results in an additional extension of the receiver's response time, as in the least favorable instance the beam area with floating blanking must first be completely scanned in order to generate a switch-off command. The scan time required for the largest beam area with floating blanking must therefore be added to the scan time conditional on the number of beams and the response delay of the output module in order to calculate the response time.

The additional amount for the response time conditional on the floating blanking depends on the number of beams in the corresponding beam area, which is calculated according to the resolution and the length "L" of the biggest beam area with floating blanking as follows:

- For devices with 14 mm resolution
  t_{FB} = (L / 10 mm * 0.2 ms) + 3 ms
- For devices with 30 mm resolution
  t_{FB} = (L / 20 mm * 0.2 ms) + 3 ms

Warning!

Devices with a physical resolution greater than 30 mm are not permitted for applications with floating blanking.

If at least one beam area has been taught in with floating blanking, then the response time of the device can no longer be provided with "tx xx" (see chapter 5). "t" is displayed instead. The user must calculate the response time of the device as follows:

- ➢ Select or calculate the response time (incl. cascading) from the tables in chapter 12.2, column /T.
- ➢ Measure the length of the biggest beam area with floating blanking in mm. Calculate the additional amount t_{FB} according to the formulas listed above and add this value to the response time already selected or calculated.
- ➢ If required, add the response delay of the output module, if the receiver does not have a transistor output (relay = 15 ms; AS-i = 5 ms; PROFIBUS = 20 ms).

The resulting response time must be used as t_{AOPD} in the formulas for calculating the safety distance in chapter 6.1.

4.3.2 Reduced resolution

If the reduced resolution mode is selected, the optical safety device does not switch off as long as no more than a parameterized number of adjacent beams is interrupted, i.e. objects of a defined maximum size in the protective field are guaranteed not to result in switch-off. Objects are not monitored according to presence or number, which means that objects can be removed from the protective field and brought back in without the optical protective device switching off.

Multiple objects of a defined size can move through the protective field at the same time as long as the respective adjacent beams next to the interrupted beams are free, and the first beam next to the display panel is not covered for longer than 10 seconds (synchronization beam).

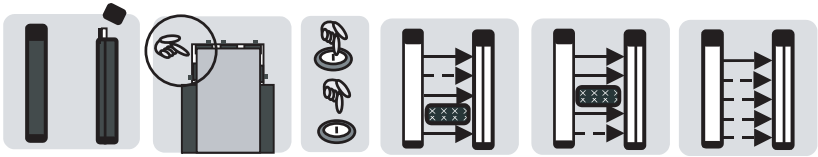


Fig. 4.3-8: Turning on reduced resolution with the switches S4/S5, example with start/restart interlock

The reduced resolution function works in the entire protective field if it is turned on using switches S4/S5 on the CPR-b receiver (see Chapter 8.3.5).

- ➢ After changing COMPACT*plus*-b to reduced resolution, recalculate the safety distance or, where required, the minimum heights of the protective field with the effective resolution according to table 4.3-2 and correct the mounting distance to the danger point and the height of the protective device above the reference plane. The effective resolution must be indelibly noted on the receiver information plate so it cannot be wiped off.

Reduced resolution, safeguarding danger points in accordance with EN 999, normal approach to the protective field					
Physical resolution	Reduction of beams	Effective resolution d	Size of blanked objects		Allowance C for safety distance C = 8 (d –14), see Chapter 6.1.1
			Worst case with max. transmitter-receiver distance	Best case with min. transmitter-receiver distance	
14 mm	0	**14 mm**	0 mm	0 – 4 mm	0 mm
30 mm	0	**30 mm**	0 mm	0 – 10 mm	128 mm
14 mm	1	**24 mm**	0 – 4 mm	0 – 13 mm	80 mm
14 mm	2	**33 mm**	0 – 14 mm	0 – 22 mm	152 mm

Reduced resolution, safeguarding danger area in accordance with EN 999, normal approach to the protective field					
Physical resolution	Reduction of beams	Effective resolution d	Size of blanked objects		Minimum height of protective field above floor H = (d-50)x15, see Chapter 6.1.2
			Worst case with max. transmitter-receiver distance	Best case with min. transmitter-receiver distance	
50 mm	0	**49 mm**	0 mm	0 – 10 mm	0 mm
30 mm	1	**49 mm**	0 – 7 mm	0 – 28 mm	0 mm
50 mm	1	**87 mm**	0 – 26 mm	0 – 46 mm	555 mm
30 mm	2	**68 mm**	0 – 26 mm	0 – 46 mm	270 mm
14 mm	3 *	**43 mm**	0 – 23 mm	0 – 32 mm	0 mm
30 mm	3 *	**87 mm**	0 – 47 mm	0 – 65 mm	555 mm

Reduced resolution, protecting access in accordance with EN 999, normal approach to the protective field					
Physical resolution	Reduction of beams	Effective resolution d	Size of blanked objects		Allowance C for safety distance
			Worst case with max. transmitter-receiver distance	Best case with min. transmitter-receiver distance	
50 mm	2	**124 mm**	0 – 64 mm	0 – 84 mm	850 mm
50 mm	3 *	**162 mm**	0 – 101 mm	0 – 121 mm	850 mm

*) Can only be set with SafetyLab

Table 4.3-2: Reduced resolution

Warning!

The reduced resolution function may only be used if the objects entering the beams do not have any shiny or reflective top and/or under side. Only matt surfaces are permitted!

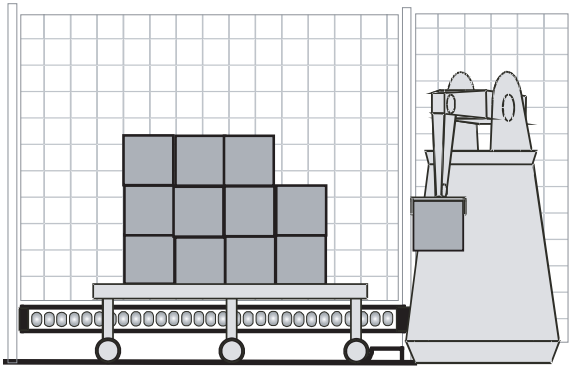


Fig. 4.3-9: Example: Reduced resolution permits beam interruptions of defined sizes.

4.4 Additional functions can be set with SafetyLab

In addition to diagnostics of the protective field, the Diagnostics and Parameterization Software SafetyLab enables:

- Graphic representation of the beam state and the beam parameterization
- Display of internal and external signals, e.g. from muting sensors.
- Position of switches S1 to S6
- Internal voltage and current values
- Reading out event recorder
- Data recorder for logging the sequence of selected signals

As the settings with SafetyLab could contradict the per switch settings, a priority rule becomes inevitable. In order, therefore, to allow the values set with SafetyLab to become effective, all switches must be set to the ex-factory setting, L. Only then can the values marked with SW in Table 8.3-1 be overwritten by the values sent by SafetyLab. If one of the switches is not in position L after the parameterization by SafetyLab, then the receiver is in an error state E17, which can be resolved as follows:

➢ Either all switches are switched back to position L → the SafetyLab settings become effective again.

➢ Or the receiver is reset by SafetyLab and the password to the basic setting → now the switches can be used again as described in Chapter 8.

Here is an overview of the functions that can be set with SafetyLab.

- Definition of the optics
- Protective field parameterization
- Transmission channel
- MultiScan mode
- Display
- Start/restart interlock
- Contactor monitoring
- Optional safety circuit
- Indicating signal output
- Teaching-in control
- Teach-in Override

Further details on diagnostics and parameterization can be found in the user manual of the Diagnostics an Parametrization software SafetyLab.

5 Display elements

5.1 Status displays for CPT transmitter

If the 7-segment transmitter display is lit, this indicates that the power supply is connected.

Fig. 5.1-1: Transmitter status displays

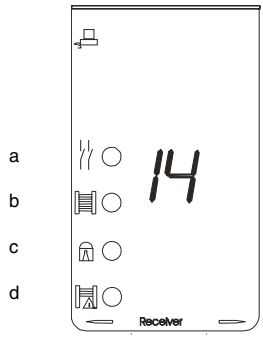
Current status of the transmitter:

7-Segment display	Meaning
8.	Hardware reset when turned on
S	Self test running (for approx. 1 s)
1	Normal operation, set to channel 1
2	Normal operation, set to channel 2
.	Dot next to the number: "Test on", the transmitter does not supply any pulses (bridge 3 – 4 not closed)
F **x**	F = Device fault x = Fault number, alternating with "F"

Table 5.1-1: Transmitter 7-segment display

5.2 Status displays for receiver

Four LEDs and two 7-segment displays report the receiver's operating status.



a = LED1, red/green
b = LED2, orange
c = LED3, yellow
d = LED4, blue

Fig. 5.2-1: Receiver status displays

5.2.1 7-Segment displays

After the supply voltage is switched on, the following data appears on both 7-segment displays of the receiver:

7-Segment display	Meaning
88	Hardware reset and self test after restart or power-on
	Sequence of parameter displays during startup for 1 s each
2y **xx**	Display of function package (2 = Blanking) y.xx = firmware version
Hx	MultiScan display x = Number of scans per evaluation cycle
tx **xx**	Response time of the AOPD after interruption of the active protective field x xx = Response time in ms or - = response time extended due to floating blanking.
Cx	Transmission channel display x = transmission channel set (1 or 2, WE = 1)
	Permanent parameter display after startup
rr	Effective resolution in basic design/host rr = 14, 19, 24, 29, 33, ...; with resolutions > 99: Display = "r r"
	Temporary status displays in setup mode
	Alignment display: One horizontal bar represents one beam: a 1: The first beam of the basic device/host a n: The last beam of the basic device/host b 1: The first beam of the guest device b n: The first beam of the guest device Chapter 9.2 describes this process in detail.
	Temporary event displays during teach-in mode
nn	Number of interrupted beams during teaching-in to adjust position of objects to be blanked out
	Temporary event displays alternating with the permanent parameter display, 1 second per display
Ux	Display of interlocking of external safety circuit (parameterizable with SafetyLab). x = Index of the additional safety circuit
Ex **xx**	Locking status display, "Malfunction", which can be released by the user (see Chapter 11) x xx Error code (e.g. no correct signal from contactor monitoring)
Fx **xx**	Locking status display of device faults, receivers must be replaced

Tab. 5.2-1: Receiver 7-segment displays

5.2.2 LED displays

LED	Color	Meaning	
LED 1	Red/ green	RED = GREEN = No display =	Safety outputs in the OFF state Safety outputs in the ON state Device without supply voltage
LED 2	Orange	**Operating mode with internal RES in OFF state (LED1 red):**	
		ON =	Active protective field free
		Operating mode with/without internal RES in ON state (LED1 green):	
		ON =	Weak beam indication with free protective field
		In setup mode:	
		ON =	All beams free
LED 3	Yellow	**OFF state (LED1 red = ON):**	
		ON =	Internal restart interlock locked
		OFF =	Internal restart interlock unlocked/not active
LED 4	Blue	OFF =	No special function
		ON =	Special "Blanking" function and/or reduced resolution active
		Flashing =	Setup mode, teaching-in with SafetyKey, key locks or activated by SafetyLab
		Rapid flashing =	Error with teaching-in => repeat teaching-in

Table 5.2-2: Receiver LED displays

6 Installation

In this chapter you will find important information on installing the COMPACT*plus*, the effective protection of which is only guaranteed if the following installation specifications are complied with. These installation specifications are based on the respective applicable versions of European standards such as EN 999 and EN 294. It must also be ensured that the specifications applicable when using COMPACT*plus* in non-European countries are observed.

Installation is dependent on the type of protection as described in Chapter 3.4, "Application examples". The situations:

- Safeguarding danger points
- Safeguarding danger areas

will therefore be considered separately in the following chapters. The applicable distance between the protective device and reflective surfaces in the environment will then be listed for all types of protection.

6.1 Calculating minimum distances

Optical safety devices can only fulfill their protective requirements if they are installed with a sufficient safety distance.

The calculation formulas for the safety distance depend on the type of protection. In the harmonized European standard EN 999, "Positioning of protective devices with regard to approach speeds of parts of the human body", the installation situations and calculation formulas for safety distance are described for the protection types named above.

The formulas for the necessary distance from reflective surfaces are determined in accordance with the European standard for "Active Opto-electronic Protective Devices (AOPD)" prEN IEC 61496-2.

6.1.1 Safety distance for safeguarding danger points

Safety distance calculation for a safety light curtain for safeguarding danger points with an effective resolution of 14 to 40 mm:

The safety distance "S" for safeguarding danger points can be calculated in accordance with EN 999 using the formula:

$$S\,[mm] = K\,[mm/s] \times T\,[s] + C\,[mm]$$

S = Safety distance in mm
If the result is less than 100 mm, a min. distance of 100 mm must be used.

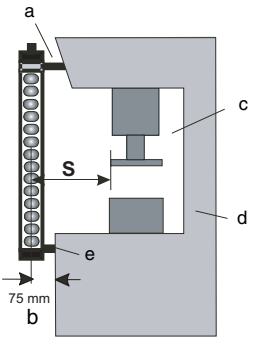
K = Approach speed in mm/s
In the close range of 500 mm, 2000 mm/s is used for the calculation. If a distance greater than 500 mm is calculated, K = 1600 mm/s may be used. However, in this case a minimum safety distance of 500 mm is applied.

T = Total time delay in seconds;
sum of:

Protective device response time t_{AOPD},	See Chapter 12
Additional amount for t_{AOPD} with floating blanking	See Chapter 4.3.1
Response delay of the output module	See Chapter 12 or enclosed connecting and operating instructions
Safety interface, if any, $t_{Interface}$,	Interface technical data
And the machine's stopping time, $t_{Machine}$.	Technical data of the machine or stopping time measurement

C = 8 x (d-14) in mm
Allowance depending on the depth of penetration into the protective field before turning on the AOPD

d = **Effective** resolution of the AOPD



a = Measures to prevent access from above
b = Maximum distance to prevent walking behind.
If a distance greater than 75 mm results because of the safety distance "S", other measures must be taken against walking behind.
c = Measures to prevent access from the sides
d = Measures to prevent access from the rear
e = Measures to prevent access from below

Fig. 6.1-1: Safety distance "S" for safeguarding danger points

$$S\ [mm] = 2000\ [mm/s] \times (t_{AOPD} + t_{Interface} + t_{Machine})\ [s] + 8 \times (d-14)\ [mm]$$

Calculation example for safeguarding danger points:

A CP14-1500 safety light curtain with a transistor output is in direct use on a press with a 150 ms stopping time. MultiScan faktor H = 1 (FS).

Approach speed K in the close range	= 2000 mm
Machine stopping time, tMachine	= 150 ms
Response time, tAOPD	= 35 ms
Response time, tInterface	= 20 ms
Resolution d, of AOPD	= 14 mm
T = 0.150 + 0.035 + 0.020	= 0.205 s
S = 2000 x 0.205 + 8 x (14 -14)	= 410 mm

Because material is brought through the light curtain, reduced resolution is activated. The calculation must consequently be carried out again with the **effective** resolution in accordance with table 4.3-2. The resolution is reduced to 24 mm in accordance with this table.

S = 2000 x 0.205 + 8 x (**24**-14) = 490 mm

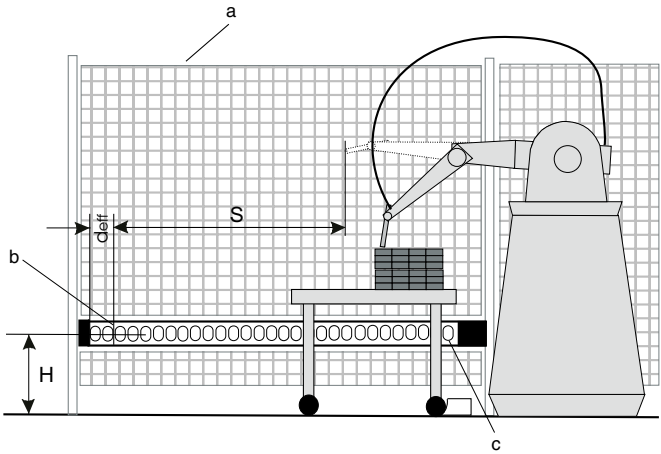
The safety distance increases in this example by 80 mm; the mounting distance of the safety light curtain to the danger point must be increased accordingly.

Ensure with the installation that the possibility of reaching over, under or around or of walking behind the safety light curtain has been definitively ruled out.

To prevent someone from walking behind the protective device, the distance between the machine table and the light curtain may only be a max. 75 mm. Walking undetected behind can be prevented, for example, by mechanical barriers or with a host/guest arrangement of the safety light curtain. If removable mechanical barriers are selected, they must be electrically integrated into the safety-related control circuit.

6.1.2 Safety distance for safeguarding danger areas

Calculating the safety distance and the resolution required for a safety light curtain for safeguarding danger areas.



a = Measures to prevent access from the sides
b = Switching position: End of protective field minus effective resolution d_{eff}
c = Position of 1st beam

Fig. 6.1-2: Safety distance "S" and height "H" for safeguarding danger areas

The height of the protective field "H" above the reference plane and the resolution "d" of the AOPD have the following relationship:

H_{min} [mm] = 15 x (d – 50) [mm] or d [mm] = H/15 + 50 [mm]

H = Height of the protective field above the reference plane, maximum 1000 mm
Heights equal to or less than 300 mm are considered too low to crawl under

d = Effective resolution of the AOPD

The safety distance "S" for safeguarding danger areas is calculated in accordance with EN 999 using the formula:

S [mm] = K [mm/s] x T [s] + C [mm]

S = Safety distance in mm

K = Approach speed 1600 in mm/s.

T = Total time delay in seconds;
sum of:

The response time of the protective device, t_{AOPD}	See Chapter 12
Safety interface, if any, $t_{Interface}$,	interface technical data
and the machine's stopping time, $t_{Machine}$.	Technical data of the machine or stopping time measurement

C = (1200 mm – 0.4 H), but not less than 850 mm (arm length)

H = Height of protective field above floor

$$S\,[mm] = 1600\,[mm/s] \times (t_{AOPD} + t_{Interface} + t_{Machine})\,[s] + (1200 - 0.4\,H)\,[mm]$$

Calculation example for safeguarding danger areas:

The area in front of a robot welding station is to be protected. The workpiece cart wheels should not be detected here.

It is decided to use CP50-xxx-b with transistor output, whereby the length of the protective device is at first not known before the calculation of the safety distance. The reduced resolution mode is selected because the castor wheels with a 25 mm diameter are to be blanked in the protective field.

According to table 4.3-2 the effective resolution of the AOPD is reduced from 50 mm to 86 mm. This makes it possible to calculate the minimum height above the floor:

H_{min} = 15 x (86 – 50) = 540 mm

The AOPD can therefore be set up at heights between 540 and 1000 mm. Further calculation of the safety distance "S" is based on the assumption that the light curtain is actually mounted at a height of Hmin = 540 mm. The stopping time of the robot is determined at 290 ms. The length of the light curtain must be estimated in order to calculate T. A length of 1650 mm is assumed. According to table 12.1-1, this results in the value t_{AOPD} = 11 ms There is no additional safety interface because the start/restart interlock and contactor monitoring are already integrated in COMPACT*plus*.

T = 11 + 290 = 301 ms

C = 1200 – 0.4 x 540 = 984 mm
The calculated value is higher than the minimum value of 850 mm

S = 1600 x 0.301 +984 = 1466 mm

The switching position of the light curtain must therefore be positioned at least 1466 mm from the outermost danger point of the robot. If robot control is planned for automated operation without interruption, the first light beam (synchronization beam) close to the robot must not be interrupted when the castor-wheeled cart is automatically moved in.

The switching position at the end of the AOPD varies with the resolution of the AOPD. As described in chapter 4.3-2, the value of the effective resolution must be taken into consideration. The protective field height in the example above must therefore be at least:

$S + d_{\mathbf{eff}}$ = 1466 + 86 mm = 1552 mm

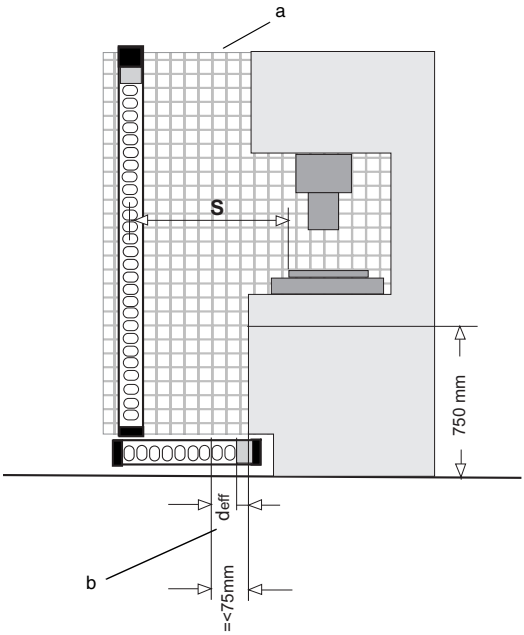
Selection is therefore made for COMPACT*plus* CP50-1650-b/T1.

6.1.3 Switching position at the end of the protective field

While the switching position of the first beam (synchronization beam) is positioned just next to the display panel, the switching position at the end of the protective field depends on the effective resolution of the light curtain.

Warning!

The determination of the position of the switching point is important in all cases of rear area protection, e.g. in host/guest applications and/or with danger point protection with parallel approach to the protective field.



a = Measures to protect access from the sides
b = Switching position: End of protective field minus effective resolution d_{eff}

Fig. 6.1-3: Example: Host/guest application

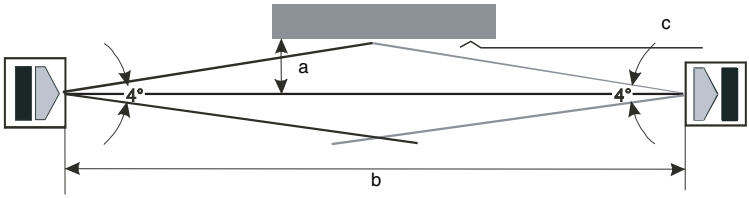
The presence of a person between the protective device and machine table must be definitely detected. Therefore the distance between the switching point of the protective device and the machine table (at a height of 750 mm) must not exceed 75 mm.

The same applies if a danger point is protected with a light curtain that is mounted horizontally or inclined up to 30° and the end of the protective field points toward the machine.

6.1.4 Minimum distance from reflective surfaces

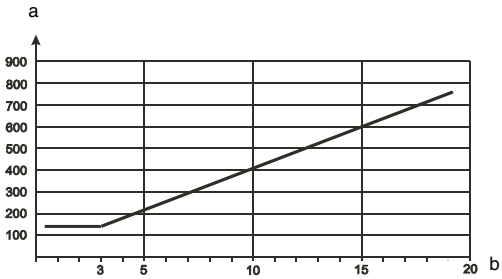
Warning!

Reflective surfaces near optical protective devices can indirectly deflect the transmitter's beams into the receiver. This can cause non-recognition of an object in the protective field! All reflective surfaces and objects (material containers, cans, etc.) must therefore be kept at a minimum distance "a" from the protective field. The minimum distance "a" is dependent on the distance "b" between the transmitter and the receiver.



a = Minimum distance from reflective surfaces
b = Protective field width
c = Reflective surface

Fig. 6.1-4: Minimum distances to reflective surfaces



a = Required minimum distance from reflective surfaces [mm]
b = Protective field width [m]

Fig. 6.1-5: Minimum distance from reflective surfaces depending on protective field width

6.2 Mounting notes

Special notes on mounting a Safety Light Curtain for safeguarding **danger points**:

- ➢ Calculate the safety distance according to the formula in Chapter 6.1.1.
- ➢ When calculating safety distances, always use the **effective** resolution. When using the functions such as floating blanking or reduced resolution, the effective resolution deviates from the physical resolution (see Chapter 4).
- ➢ Ensure that it is impossible to reach under, over, around or walk behind the safety light curtain.
- ➢ Observe the maximum distance between machine table and protective field of 75 mm, with reference to a table height of 750 mm. If this is not possible because the safety distance is too big, a mechanical barrier or a host/guest arrangement must be provided.
- ➢ Observe the minimum required distance to reflective surfaces.

Special notes on mounting a COMPACT*plus* for safeguarding **danger areas**:

- ➢ Calculate the safety distance according to the formula in Chapter 6.1.2.
- ➢ The **effective** resolution determines the minimum height of the protective field above the floor. The calculation formula can be found in Chapter 6.1.2.
- ➢ Ensure that the maximum height of the protective field above the reference plane of 1000 mm is not exceeded and only heights equal to or less than 300 mm are to be considered to prevent an adult from crawling under (also see EN 999).
- ➢ When assembling, ensure that it is impossible to pass onto the housings of the optical components (thereby allowing entrance into the danger area).
  - ⓘ Positioning behind corresponding cutouts on the hard guards on the sides prevents stepping onto transmitter or receiver housings.
- ➢ Consider the position of the last light beam before the machine. It must not be possible to stand undetected between this light beam and the machine.

6.3 Mechanical mounting

ⓘ For setting functions using switches, it is best to do so before installation, as the transmitter and/or receiver should be opened in as clean a room as feasibly possible. It is therefore recommended that the necessary settings be made before starting installation (Chapters 4 and 8).

What should generally be taken into consideration during installation?

- ➢ Ensure that transmitter and receiver are mounted on an even surface at the same height.
- ➢ Transmitter and receiver must be mounted at the same height. Their connections must be pointing in the same direction.
- ➢ When mounting, use screws that can only be loosened by a tool.
- ➢ Fix the transmitter and receiver in position so that they cannot be shifted. Securing against turning is particularly important in the close range below a protective field width of 0.3 m for devices with 6 m detection range and 0.8 m for devices with 18 m detection range protective field for safety reasons.
- ➢ The safety distance between the protective field and the danger point must be observed.
- ➢ Ensure that access to the danger point/danger area is only possible through the protective field. Additional access points must be protected separately (e.g. by hard guards, additional light curtains or doors with locking devices).

6.3.1 Standard mounting

Four standard mounting brackets (with sliding nuts and screws) are included in the delivery. If the shock and vibration load mentioned in the technical data is exceeded, swiveling brackets with shock absorbers must be used.

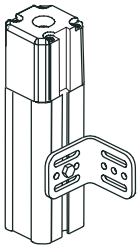


Fig. 6.3-1: Standard mounting bracket

6.3.2 Option: Mounting with swiveling brackets

Four swiveling brackets with shock absorbers can be ordered optionally. They are not included in the delivery. The swiveling range is ± 8°.

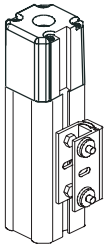


Fig. 6.3-2: Swiveling support with shock absorber

7 Electrical connection

- The electrical connection must be performed by experienced personnel. Knowledge of all safety notes contained in these operating instructions is part of this competence.
- The external supply voltage of 24 V DC ± 20% must guarantee safe isolation from the mains voltage and be able to bridge a power outage period of at least 20 ms for devices with transistor outputs. Leuze offers suitable power supply units (see accessory list in Appendix). It must provide at least 2 current reserve. Transmitters and receivers must be fused against overcurrent.
- Basically both safety switch outputs OSSD1 and OSSD2 must be looped into the work circuit of the machine. Relay contacts must be protected externally in order to prevent the contacts from welding together (for technical data, see chapter 12.1.7).
- Signal outputs may not be used for switching downstream safety circuits.
- The start-/restart button for unlocking the start-/restart interlock must be mounted in such a way that it cannot be reached from the danger zone and the entire danger zone is fully visible from its installation position.
- It is vital during the electrical installation that the power of the machine or system to be protected is switched off locked, so that the dangerous movements cannot be started up again unintentionally.
- It must additionally be ensured with devices with safety-related relay outputs that the voltage feed to the relay contacts is also interrupted and secured against restarting. If this is not observed, the **danger of electric shock** from the adjacent voltages arises when opening devices!

All COMPACT*plus* receivers have a local interface and a machine interface. Optional local control elements and/or sensors can be connected to the local interface via an M12 connection. The cables required for this are listed as accessories and are not included in the delivery.

The interface to the machine is available in the following design types:

Design type	Transmitter interface	Machine interface Receiver	
	Connection system	**OSSD outputs**	**Connection system**
/T1	MG cable screw, M20x1.5 (standard)	Transistor	MG cable screw, M20x1.5
/T2	Hirschmann plug, 11+1-pin	Transistor	Hirschmann plug, 11+1-pin
/T3	MIN-series plug, 3-pin	Transistor	MIN-series plug, 7-pin
/T4	M12-plug 5-pin	Transistor	M12-plug, 8-pin
/R1	With transmitter /T1	Relay	MG cable screw, M20x1.5
/R2	With transmitter /T2	Relay	Hirschmann plug, 11+1-pin
/R3	With transmitter /T3	Relay	MIN-series plug, 12-pin
/A1	M12 plug, 3-pin /AP	AS Interface Safety at Work	M12 plug, 5-pin
/P1	With transmitter /AP or /T4	PROFIBUS DP PROFIsafe	3 cable tails with M12-plug and socket 5-pin

Table 7.0-1: Machine interface selection table

Note!

Information on connecting further interface versions can be found, if required, on an attached data sheet or in additional connecting and operating instructions.

7.1 Receiver – Local interface

One characteristic of all COMPACT*plus* receivers is the 8-pin M12-local connection socket in the connection cap. This makes it possible to have short cables leading to components in the immediate vicinity of the optical protective device. In the COMPACT*plus*-b version, the start-/restart button, the optional key lock with a 2-pin changeover switch for teaching in fixed and floating blanking zones, and the optional 2-channel safety circuit, e.g. for a safety door locking without guard interlocking can be connected.

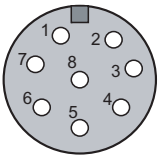
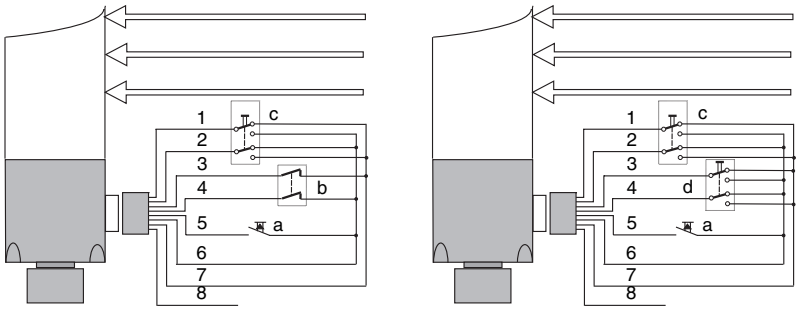


Fig. 7.1-1: Receiver – local connection socket, M12, 8-pin

Pin	Cable Color	Assignment		Inputs/outputs (FS), can be arranged via SafetyLab
1	White	⇐	L1, local input	Teaching-in, changeover contact 1, 0V → 24V expected
2	Brown	⇔	L2, local input/ output	Teaching-in, changeover contact 2: +24V → 0V expected
3	Green	⇐	L3, local input	Safety sensor or override switch, contact 1
4	Yellow	⇐	L4, local input	Safety sensor or override switch, contact 2
5	Gray	⇔	L5, local input/ output	RES_L, local start-/restart button
6	Pink	⇒	Local output	+24 V DC
7	Blue	⇒	Local output	0 V
8	Red	⇒	Local output	FE = Function end
*) Cables are not included in the delivery, see Table 13.2-1 for accessories				

Table 7.1-1: Local connection socket, 8-pin cable connector assignment



1 to 8 =PIN number of the local connection socket
a = Start-/restart button
b = Optional safety circuit
c = Teaching-in key lock
d = Override key lock

Fig. 7.1-2: Connection example local connection socket

ENGLISH

7.2 Standard: Machine interface /T1, MG cable screw M20x1.5

7.2.1 Transmitter interface /T1

The terminal field for the transmitter connection cable is located inside the connection cap.

➢ After you have loosened the 4 fastening screws, pull the connection cap out in as straight a direction as possible. Use insulated conductor sleeves.

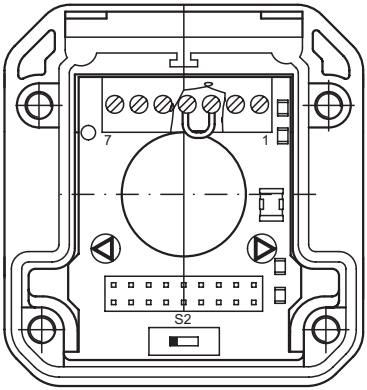


Fig. 7.2-1: Transmitter connection cap/T1 removed, terminal field inside view

Terminal	Assignment		Inputs/outputs	
1	⇐	Supply voltage	+24 V DC	
2	⇐	Supply voltage	0 V	
3	⇒	Test out	Jumper to 4	Jumper set in factory
4	⇐	Test in	Jumper to 3	
5		Reserved		
6		Reserved		
7	⇐	Functional earth, shield	FE	

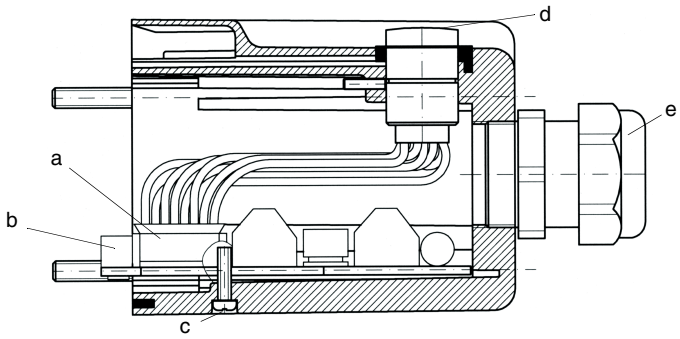
Table 7.2-1: Transmitter interface /T1, terminal field connection assignment

7.2.2 Receiver machine interface /T1

The receiver has safety-related transistor outputs. The connecting circuit board with the terminal field for the machine interface connection cable fixed with the M20x1.5 cable screw is located inside the connection cap.

➢ After you have loosened the 4 fastening screws, pull the connection cap out in as straight a direction as possible.

➢ Loosen the fixing screw at the rear side of the connection cap and slightly pull out the printed circuit board.



a = Plug connection to the local connection socket
b = Connecting circuit board
c = Fixing screw
d = Local connection socket
e = Cable screw M20x1.5

Fig. 7.2-2: Receiver cap /T1 removed

➢ If required, loosen the plug connection for the cable to the local connection socket.

➢ Pull the terminal field out completely, the connecting terminals are free.

➢ Use insulated conductor sleeves.

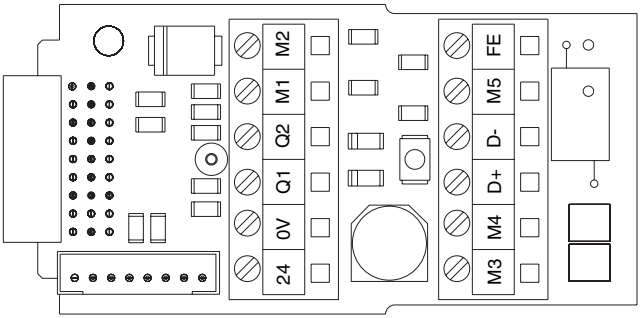
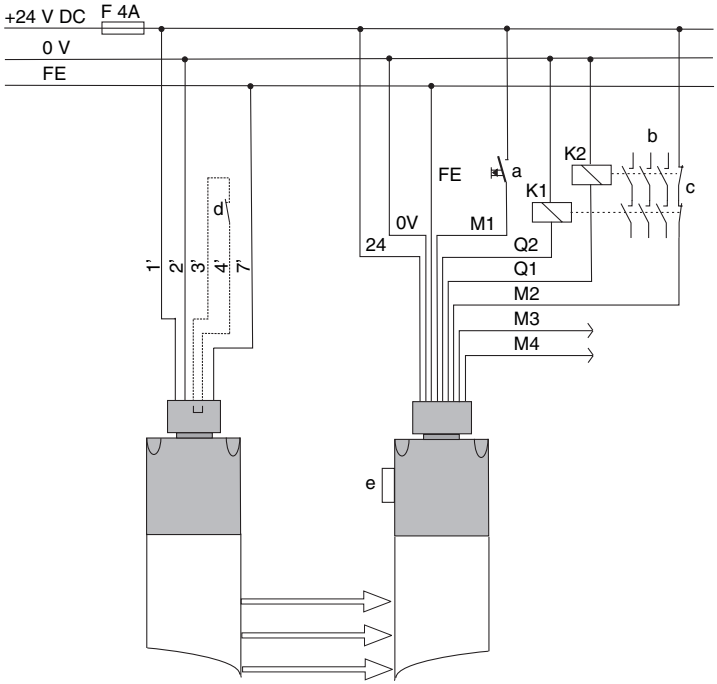


Fig. 7.2-3: Receiver machine interface /T1, terminal field

Terminal	Assignment		**Inputs/outputs** M1 .. M5 (FS), can be differently arranged via SafetyLab
24	⇐	Supply voltage	+24 V DC
0V	⇐	Supply voltage	0 V
Q1	⇒	OSSD1 Output	Transistor output
Q2	⇒	OSSD2 Output	Transistor output
M1	⇐	M1 input	RES_M, machine interface start-/restart button*
M2	⇐	M2 input	EDM, contactor monitoring against +24 V DC
M3	⇒	M3 input/output	Active protective field free/ready for unlocking
M4	⇒	M4 input/output	Collective malfunction/dirt signal
D+		Reserved	
D-		Reserved	
M5		M5 input/output	Free
FE	⇐	Functional earth, shield	FE

*) alternative to L5 of the local interface: start-/restart button on the machine interface (M1). In FS same effect as via L5

Table 7.2-2: Receiver machine interface /T1, terminal field connection assignment



a = Start-/restart button
b = Release circuits
c = EDM, feedback contacts contactor monitoring
d = Optional: External test, if factory-set jumper is removed
e = Local connection socket
1' to 4',7' = Transmitter terminal field numbers

ⓘ

Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.
The safety-related transistor outputs carry out the spark extinction. With devices with transistor outputs, it is therefore not necessary to use the spark extinction elements recommended by contactor/valve manufacturers etc. (RC modules, varistors or recovery diodes). These extend the delay times of inductive switching elements.

Fig. 7.2-4: Connection example machine interface /T1, MG cable screw M20x1.5

7.3 Option: Machine interface /T2, Hirschmann plug, M26 11-pin+FE

The COMPACT*plus-s* /T2 device design is equipped to connect both the transmitter and receiver machine interface with a 12-pin Hirschmann plug. This has no effect on the option of connecting local control elements or additional sensor equipment to the M12x8-pin local interface, as described in Chapter 7.1. The corresponding cable sockets in straight or angled version incl. crimp contacts and complete connection cable in varying lengths are available as accessories.

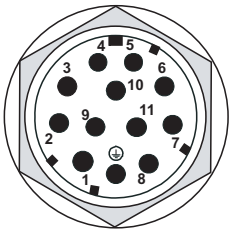


Fig. 7.3-1: Transmitter and receiver machine interface /T2 (view of the pins)

7.3.1 Transmitter interface /T2

Pin	Wire colors CB-8N-xxxxx-12GF	Assignment		Inputs/outputs	
1	Brown	⇐	Supply voltage	+24 V DC	
2	Pink	⇐	Supply voltage	0 V	
3	Blue	⇒	Test out	External jumper to 4	Factory setting: **No** internal jumper set
4	Gray	⇐	Test in	External jumper to 3	
5	Black		Reserved		
6	Orange		Reserved		
7	Red		Reserved		
8	Purple		Reserved		
9	White		Reserved		
10	Beige		Reserved		
11	Clear		Reserved		
⏚	Green/ yellow	⇐	Functional earth, shield	FE	

Table 7.3-1: Transmitter interface /T2, Hirschmann cable socket connection assignment

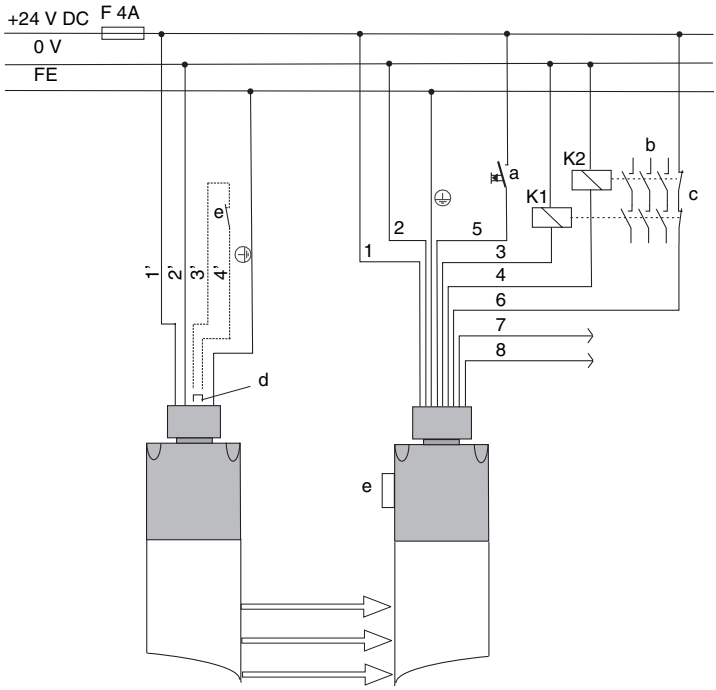
7.3.2 Receiver machine interface /T2

The receiver has safety-related transistor outputs.

Pin	Wire colors CB-8N-xxxxx-12GF	Assignment		Inputs/outputs M1 .. M5 (FS), can be differently arranged via SafetyLab
1	Brown	⇐	Supply voltage	+24 V DC
2	Pink	⇐	Supply voltage	0 V
3	Blue	⇒	OSSD1 Output	Transistor switch output
4	Gray	⇒	OSSD2 Output	Transistor switch output
5	Black	⇐	M1 input	RES_M, machine interface start-/restart button*
6	Orange	⇐	M2 input	EDM, contactor monitoring against +24 V DC
7	Red	⇔	M3 input/output	Active protective field free/ready for unlocking
8	Purple	⇔	M4 input/output	Collective malfunction/dirt signal
9	White		Reserved	
10	Beige		Reserved	
11	Clear	⇔	M5 input/output	Free
⏚	Green/ yellow	⇐	Functional earth, shield	FE

*) alternative to L5 of the local interface: start-/restart button on the machine interface (M1). In FS same effect as via L5

Table 7.3-2: Receiver machine interface /T2, Hirschmann cable socket connection assignment



a = Start-/restart button
b = Release circuits
c = EDM, feedback contacts contactor monitoring
d = Optional: External test, if factory-set jumper is removed
e = Local connection socket
1‘ to 4‘, ⏚
= Pin numbers, Hirschmann plug, transmitter
1 to 8, ⏚
= Pin numbers, Hirschmann plug, receiver

ⓘ Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.
The safety-related transistor outputs carry out the spark extinction. With devices with transistor outputs, it is therefore not necessary to use the spark extinction elements recommended by contactor/valve manufacturers etc. (RC modules, varistors or recovery diodes). These extend the delay times of inductive switching elements.

Fig. 7.3-2: Connection example machine interface /T2, Hirschmann plug

7.4 Option: Machine interface /T3, MIN-series plug

The COMPACT*plus* /T3 device design is equipped to connect the transmitter with a 3-pin and receiver machine interface with a 7-pin MIN-series plug. This has no effect on the option of connecting local control elements or additional sensor equipment to the local interface, as described in Chapter 7.1. Connection cables are not included in the delivery.

7.4.1 Transmitter interface /T3

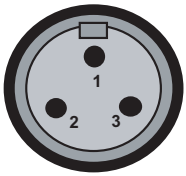


Fig. 7.4-1: Transmitter interface /T3, MIN-series plug, 3-pin – view of the plug pins

Pin	Wire Color	Assignment		Inputs
1	Green	⇐	Functional earth, shield	FE
2	Black	⇐	Supply voltage	0 V
3	White	⇐	Supply voltage	+24 V DC

Table 7.4-1: Transmitter interface /T3, connection assignment, MIN-series cable socket 3-pin

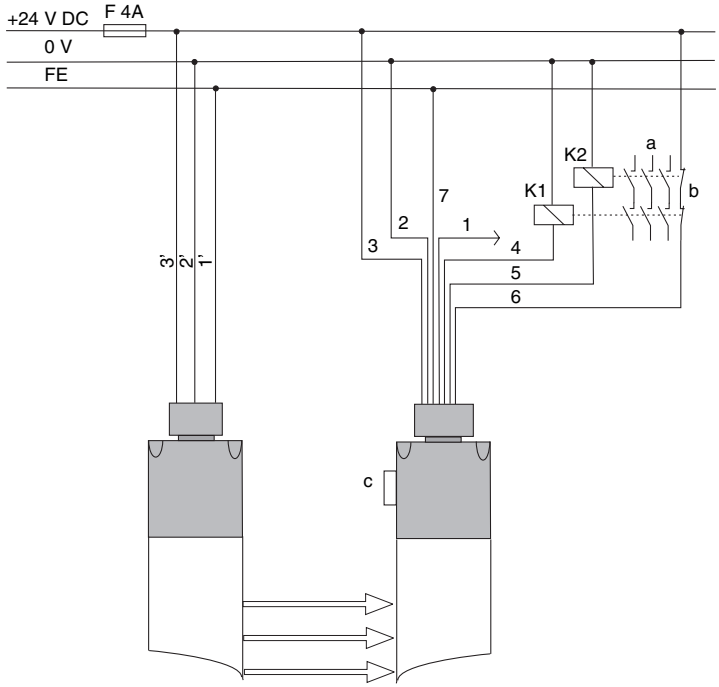
7.4.2 Receiver machine interface /T3

The receiver has safety-related transistor outputs.

Fig. 7.4-2: Receiver machine interface /T3, MIN-series plug, 7-pin – view of the plug pins

Pin	Wire Color	Assignment		**Inputs/outputs** M2, M3 (FS), can be differently arranged via SafetyLab
1	White/black	⇔	M3 input/output	Active protective field free
2	Black	⇐	Supply voltage	0 V
3	White	⇐	Supply voltage	+24 V DC
4	Red	⇒	OSSD1 Output	Transistor output
5	Orange	⇒	OSSD2 Output	Transistor output
6	Blue	⇐	M2 input	EDM, contactor monitoring against +24 V DC
7	Green	⇐	Functional earth, shield	FE

Table 7.4-2: Receiver machine interface /T3, connection assignment MIN-series cable socket 7-pin



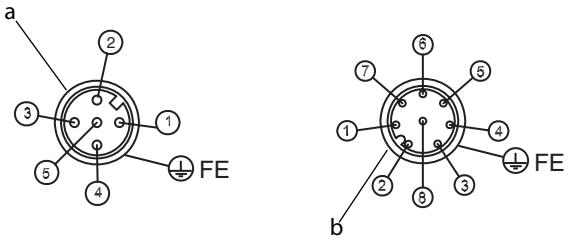
a = Release circuit
b = EDM, feedback contacts contactor monitoring
c = Local connection socket
1‘ to 3‘
= Pin numbers, MIN-series plug 3-pin, transmitter
1 to 7
= Pin numbers, MIN-series plug 7-pin, receiver

ⓘ Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.
The safety-related transistor outputs carry out the spark extinction. With devices with transistor outputs, it is therefore not necessary to use the spark extinction elements recommended by contactor/valve manufacturers etc. (RC modules, varistors or recovery diodes). These extend the delay times of inductive switching elements.

Fig. 7.4-3: Connection example machine interface /T3, MIN-series plug

7.5 Option: Machine interface /T4, M12 plug

The COMPACTplus/T4 design type is equipped to connect the transmitter interface with an 5-pin M12 plug and the receiver/transceiver machine interface with an 8-pin M12 plug. Connection cables in different lengths are available.



a = Transmitter encoding
b = Receiver encoding

Fig. 7.5-1: Transmitter and receiver machine interface /T4 (view of the pins)

7.5.1 Transmitter interface /T4

Pin	Wire colors, CB-M12-xxxxS-5GF	Assignment		Inputs/outputs
1	brown	⇐	Supply voltage	24 V DC
2	white	⇒	Test out	ext. jumper to 4
3	blue	⇐	Supply voltage	0 V
4	black	⇐	Test in	ext. jumper to 2
5	Shield		Functional earth, shield	FE

Table 7.5-1: Transmitter interface /T4 connection assignment M12 plug

7.5.2 Receiver machine interface /T4

The receiver has safety-related transistor outputs.

Pin	Wire colors, external	Assignment		Inputs/outputs M2, M4, M5 (WE), adjustable by Safetylab
1	White	⇐ ⇒	M4 input/output	Collective malfunction/dirt signal
2	Brown	⇐	Supply voltage	24 V DC
3	Green	⇐	M2 input	EDM, contactor monitoring against 24 V DC
4	Yellow		M5 input/output	free
5	Gray	⇒	OSSD1 output	Transistor output
6	Pink	⇒	OSSD2 output	Transistor output
7	Blue	⇐	Supply voltage	0 V
8	Shield	⇐	Functional earth, shield	FE

Table 7.5-2: Receiver machine interface /T4 connection assignment M12 plug

7.6 Option: Machine interface /R1, MG cable screw M25x1.5

This version of the machine interface is characterized by relay outputs and cable screws on the connection caps in the transmitter and receiver. This has no effect on the option of connecting local control elements or additional sensor equipment to the local interface, as described in Chapter 7.1.

Warning!

It applies with safety-related relay outputs that: The cable for the release circuit must generally be laid with protected installation in a cable duct or with armor in such a way that cross-connections between the cable wires can be safely ruled out.

7.6.1 Transmitter interface /T1

A separate transmitter for devices with relay outputs is not available. The corresponding transmitter /T1 also equipped with cable screw is used (see Chapter 7.2.1).

7.6.2 Receiver machine interface /R1

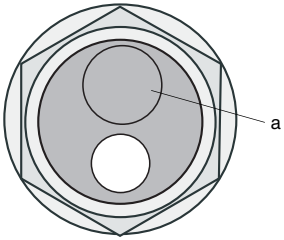
The design type COMPACTplus/R1 has 2 relay outputs (2 potential-free N/O contacts) and is equipped with a cable screw connection for connecting to the machine interface. The seal in the cable screw has an ex-factory lead-in opening. If protective extra low voltages of up to 42 V AC/DC are switched, then **one** cable with up to 12 wires can be pulled through here.

Warning!

The current path via the relay contacts of the AOPD must be compulsorily protected to prevent the contacts welding in the event of an overcurrent. The fuse sizes depend on the load. They are provided in Tab. 12.1-7.

Warning!

*For higher switching voltages of up to 250 V AC, the load circuit must be separated from the voltage supply and the status signals. In this case **two** cables must be routed through the cable screw; the second lead-in opening has already been prepared and must now only be pushed through.*

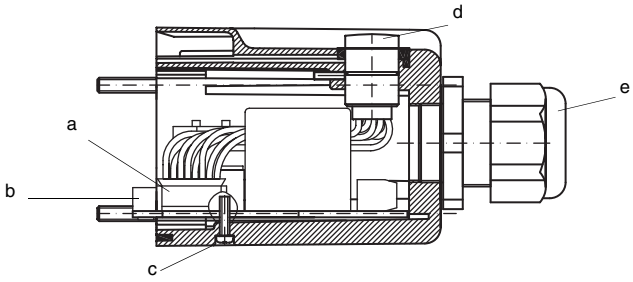


a = Just push opening through when a separate connection cable for the load circuit is to be connected.

Fig. 7.6-1: Cable screw M25x1.5, application prepared for connecting 2 cables

To connect:

- ➢ After you have loosened the 4 fixing screws, pull the connection cap out in as straight a direction as possible.
- ➢ Loosen the fixing screw on the rear side of the connection cap and slightly pull out the connecting circuit board.
- ➢ If required, loosen the plug connection for the cable to the local connection socket.
- ➢ Pull the terminal field out completely, the connecting terminals are free.
- ➢ Use insulated conductor sleeves.



a = Plug connection to local connection socket
b = Connecting circuit board
c = Fixing screw
d = Local connection socket
e = Cable screw M25x1.5

Fig. 7.6-2: Receiver cap /R1, removed

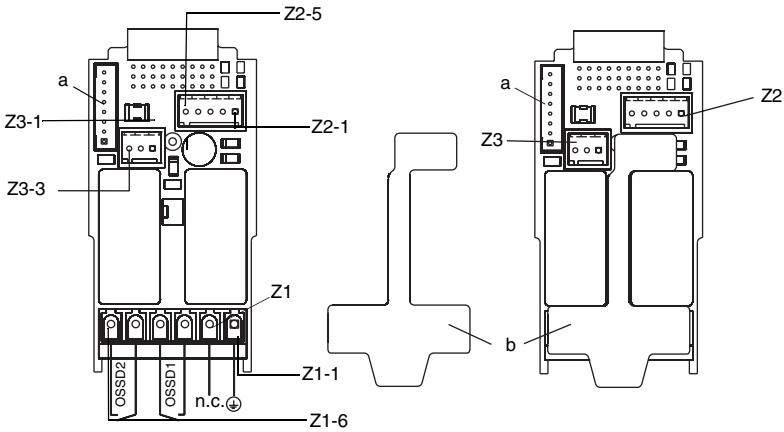
A relay circuit board, to which the load lines (Z1-1 to 6), signal lines (Z2-1 to 5) and power supply lines (Z3-1 to 3) must be connected, is located in the connection cap.

➢ If required, pull plug a, cable to local connection socket.
Remove insulating plate b, connect load lines to Z1.
With switching voltages over 42V, use lead-in with two openings and separate cable for the load line. Connect PE to Z1-1.

➢ Insert insulting plate so that an insulation is provided between load line and the other lines.

➢ Connect signal and power supply line to Z2 and Z3. If PE has to be connected, the FE must not be connected to Z3-3.

➢ If required, re-connect plug for cable to local connection socket again.



a = Plug connection for cable to local connection socket.
b = Insulating plate
Z1= Load circuit connection
Z2= Signal connection
Z3= Supply voltage connection

Fig. 7.6-3: Receiver machine interface /T1, terminal fields (terminal 1 marked accordingly)

The cable(s) is/are connected to the three terminal blocks as follows:

Z1: Load circuit connection:

Warning!
*If voltages U > 42V AC/DC are to be linked up, a **separate cable** must be routed through the second opening of the MG screw intended for this purpose! Instead of the FE connection at Z3-1, PE connection at Z1-1 is required.*

Terminal	Assignment		
Z1-1	⇐	PE, protective earth, shield, to be connected with switching voltages > 42V AC/DC (in this case FE, functional earth connection to Z3-1 must not be connected)	
Z1-2		free	
Z1-3	⇐	OSSD1A, relay 1, terminal A	Potential-free N/O contact Technical data, see Chapter 12.1
Z1-4	⇒	OSSD1B, relay 1, terminal B	
Z1-5	⇐	OSSD2A, relay 2, terminal A	Potential-free N/O contact Technical data, see Chapter 12.1
Z1-6	⇒	OSSD2B, relay 2, terminal B	

Z2: Signal connection:

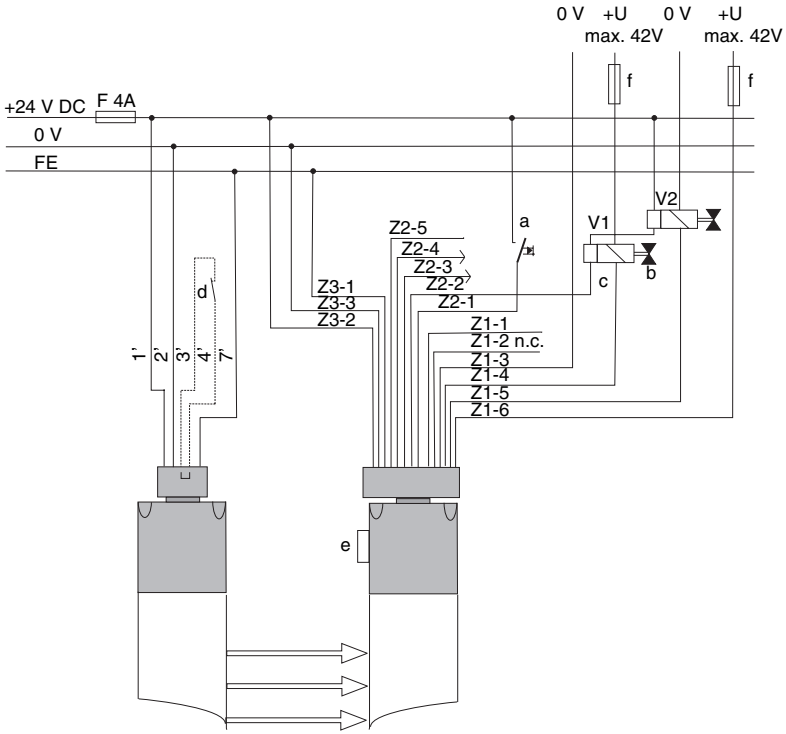
Pin	Assignment		**Inputs/outputs** M1 to M5 (FS), can be differently arranged via SafetyLab
Z2-1	⇐	M1 input	RES_M, machine interface start-/restart button*
Z2-2	⇐	M2 input	EDM, contactor monitoring against +24 V DC
Z2-3	⇔	M3 input/output	Active protective field free/ready for unlocking
Z2-4	⇔	M4 input/output	Collective malfunction/dirt signal
Z2-5	⇔	M5 input/output	free

*) alternative to L5 of the local interface: Start-/restart button on the machine interface M1 has the same effect in FS

Z3: Supply voltage connection:

Pin	Assignment	
Z3-1	⇐	FE, functional earth, shield, to be connected with switching voltages up to 42V AC/DC (in this case PE, protective earth connection to Z1-1 must not be connected)
Z3-2	⇐	Power supply +24 V DC
Z3-3	⇐	Power supply 0 V

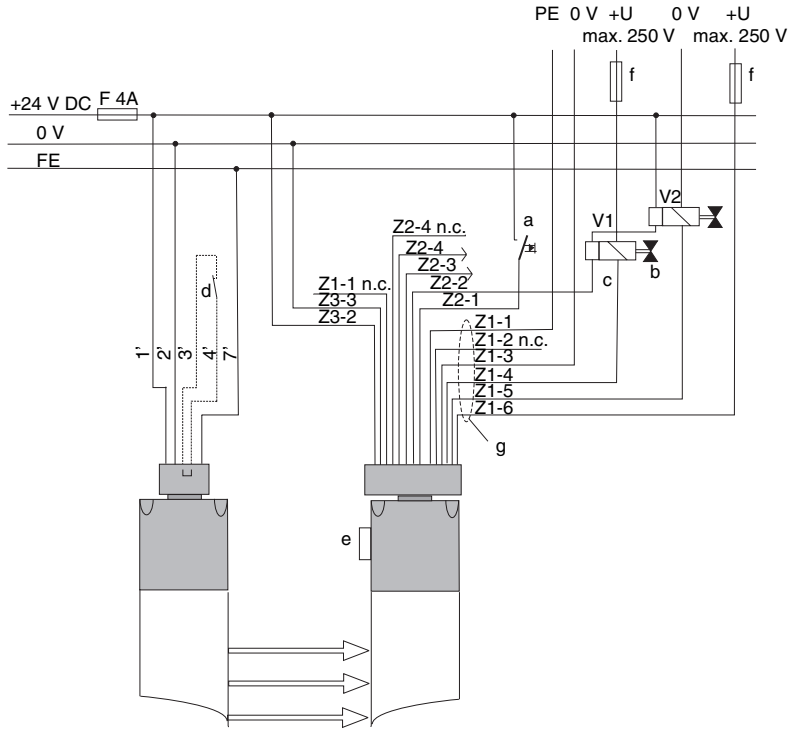
Table 7.6-1: Receiver machine interface /R1, terminal fields connection assignment Z1 to Z3



a = Start-/restart button, alternative to L5
b = Release circuits, safety valves V1 and V2 must be selected in such a way that at ½ Umax they are sure not to pull, and should they be pulled, they are sure to release! Suitable spark extinction elements must be planned parallel to the spooling of V1 and V2.
c = EDM, feedback contacts, valve monitoring
d = Optional: External test, if factory-set jumper is removed
e = Local connection socket
f = Fuse for protecting the normally open contacts, for sizes see technical data Chapter 12.1.7
Z1, Z2 and Z3
= Terminal numbers of the blocks Z1, Z2 and Z3
1' to 4', 7'
= Transmitter terminal numbers

ⓘ The connection cables must be routed in a strong conduit so that mechanical damage is prevented. Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.

Fig. 7.6-4: Connection example machine interface /R1, MG25x1,5, switching voltage up to 42V AC/DC



a = Start-/restart button, alternative to L5
b = Release circuits, safety valves V1 and V2 must be selected in such a way that at ½ Umax they are sure not to pull, and should they be pulled, they are sure to release! Suitable spark extinction elements must be planned parallel to the spooling of V1 and V2.
c = EDM, feedback contacts, valve monitoring
d = Optional: External test, if factory-set jumper is removed
e = Local connection socket
f = Fuse for protecting the normally open contacts, for sizes see technical data, Chapter 12.1.7
g = Separate cable, required with switching voltages > 42V AC/DC
Z1, Z2 and Z3
= Terminal numbers of the blocks Z1, Z2 and Z3
1' to 4', 7'
= Transmitter terminal numbers

ⓘ The connection cables must be routed in a strong conduit so that mechanical damage is prevented. Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.

Fig. 7.6-5: Connection example machine interface /R1, MG25x1,5, switching voltage over 42V AC/DC

7.7 Option: Machine interface /R2, Hirschmann plug, M26 11-pin+FE

The design type COMPACTplus/R2 has 2 relay outputs and is equipped with a Hirschmann plug, M26 11-pin+FE in the connection cap for the connection to the machine interface. This has no effect on the connection of local control elements or additional sensor equipment to the M12x8-pin local interface, as described in Chapter 7.1. The corresponding cable socket in straight or angled version incl. crimp contacts and ready prepared connection cable in varying lengths are available as accessories.

Warning!

It applies with safety-related relay outputs that: The cable for machine control must generally be laid with protected installation in a cable duct or with armor in such a way that cross-connections between the cable wires can be safely ruled out.

7.7.1 Transmitter interface /T2

A separate transmitter for devices with safety-related relay outputs is not available. The corresponding transmitter /T2 also equipped with Hirschmann plug, M26 11-pin+FE is used (see Chapter 7.3.1)

7.7.2 Receiver machine interface /R2

The receiver has safety-related relay outputs.

Warning!

The machine interface /R2 is suitable for switching U max. = 42V AC/DC. Only version /R1 with MG cable screw and separate connection cable is suitable for higher switching voltages. The current path via the relay contacts of the AOPD must be compulsorily protected to prevent the contacts from welding together. The respective fuse size depends on the load. This can be found in the technical data, Table 12.1-7.

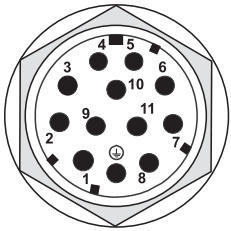


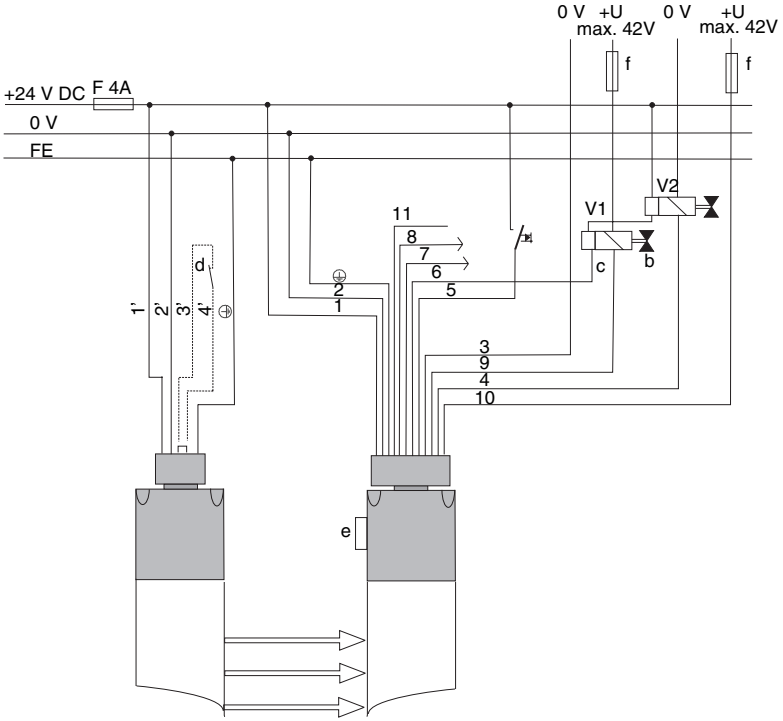
Fig. 7.7-1: Receiver machine interface /R2, Hirschmann plug (view of the pins)

The plug is assigned as follows:

Pin	Wire colors CB-8N-xxxxx-12GF	Assignment		Inputs/outputs M1...M5 (FS), can be differently arranged via SafetyLab
1	Brown	⇐	Supply voltage	+24 V DC
2	Pink	⇐	Supply voltage	0 V
3	Blue	⇐	Relay 1, terminal A max. switching voltage 42 V potential-free normally open contact	OSSD1A
4	Gray	⇐	Relay 2, terminal A max. switching voltage 42 V potential-free normally open contact	OSSD 2A
5	Black	⇐	M1 input	RES_M, machine interface start-/restart button*
6	Orange	⇐	M2 input	EDM, contactor monitoring against +24 V DC
7	Red	⇔	M3 input/output	Active protective field free/ready for unlocking
8	Purple	⇔	M4 input/output	Collective malfunction/dirt signal
9	White	⇒	Relay 1, terminal B	OSSD1B
10	Beige	⇒	Relay 2, terminal B	OSSD2B
11	Clear	⇔	M5 input/output	free
⏚	Green/ yellow	⇐	FE, functional earth, shield	

*) alternative to L5 of the local interface: Start-/restart button on the machine interface M1 has the same effect in FS

Table 7.7-1: Receiver machine interface /R2, Hirschmann cable socket connection assignment



a = Start-/restart button
b = Release circuits, safety valves V1 and V2 must be selected in such a way that at ½ Umax they are sure not to pull, and should they be pulled, they are sure to release! Suitable spark extinction elements must be planned parallel to the spooling of V1 and V2.
c = EDM, feedback contacts, valve monitoring
d = Optional: External test, if factory-set jumper is removed
e = Local connection socket
f = Fuse for protecting the normally open contacts, for sizes see technical data, Chapter 12.1.7
1‘ to 4‘,
= Pin numbers, Hirschmann plug, transmitter
1 to 8,
= Pin numbers, Hirschmann plug, receiver

ⓘ The connection cables must be routed in a strong conduit so that mechanical damage is prevented. Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.

Fig. 7.7-2: Connection example machine interface /R2, Hirschmann plug

7.8 Option: Machine interface /R3, MIN-series plug

The design type COMPACTplus/R3 has 2 relay outputs and is equipped with MIN-series plug in the connection cap for the connection to the machine interface. This has no effect on the option of connecting local control elements or additional sensor equipment to the local interface, as described in Chapter 7.1.

Warning!

It applies with safety-related relay outputs that: The cable for machine control must generally be laid with protected installation in a cable duct or with armor in such a way that cross-connections of the cable wires can be safely ruled out.

7.8.1 Transmitter interface /T3

A separate transmitter for devices with safety-related relay outputs is not available. The corresponding transmitter /T3 with 3-pin MIN-series plug is used (see 7.4.1).

7.8.2 Receiver machine interface /R3

The receiver has safety-related relay outputs.

Warning!

The machine interface /R3 is suitable for switching U max. = 42 V. Only version /R1 with MG cable screw and separate connection cable is suitable for higher switching voltages. The current path via the relay contacts of the AOPD must be compulsorily protected to prevent the contacts from welding together. The respective fuse size depends on the load. This can be found in The Technical Data, table 12.1-7.

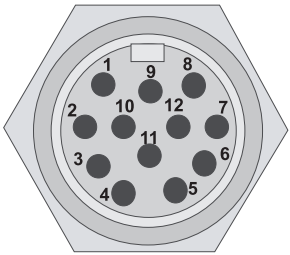


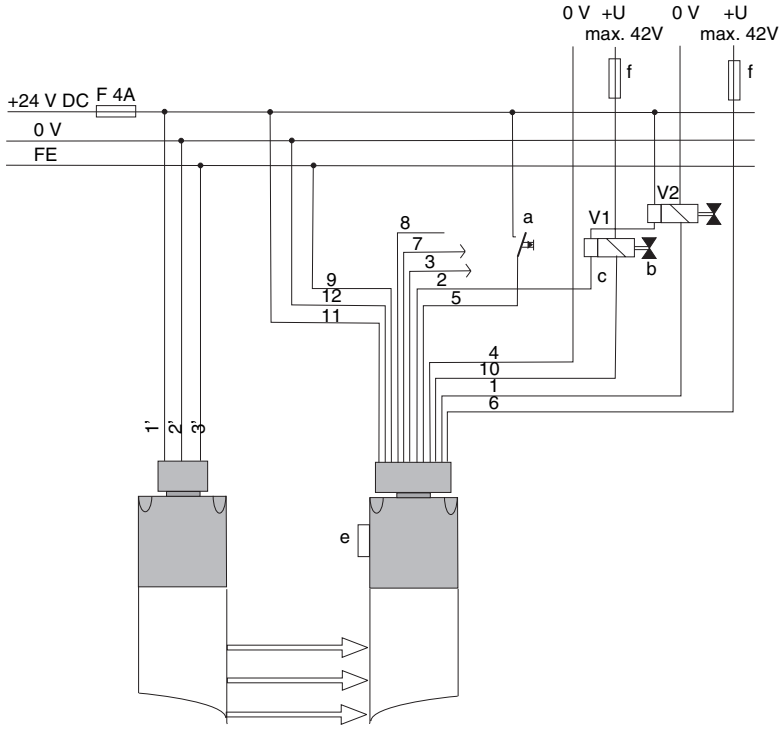
Fig. 7.8-1: Receiver machine interface /R3, MIN-series device plug (view of the pins)

The 12-pin device plug is assigned as follows:

Pin	Wire colors	Assignment		Inputs/outputs M1...M5 (FS), can be differently arranged via SafetyLab
1	Orange	⇐	Relay 2, terminal A max. switching voltage 42 V;	OSSD2A
2	Blue	⇐	M2 input	EDM, contactor monitoring against +24 V DC
3	White/black	⇔	M3 input/output	Active protective field free/ready for unlocking
4	Red/black	⇒	Relay 1, terminal B max. switching voltage 42 V	OSSD1B
5	Green/black	⇐	M1 input	RES_M, machine interface start-/ restart button*
6	Orange/ black	⇒	Relay 2, terminal B	OSSD2B
7	Blue/black	⇔	M4 input/output	Collective malfunction/dirt signal
8	Black/white	⇔	M5 input/output	free
9	Green/ yellow	⇐	Functional earth, shield	FE
10	Red	⇐	Relay 1, terminal A	OSSD1A
11	White	⇐	Supply voltage	+24 V DC
12	Black	⇐	Supply voltage	0 V

*) alternative to L5 of the local interface: Start-/restart button on the machine interface M1 has the same effect in FS

Table 7.8-1: Receiver machine interface /R3, 12-pin MIN-series cable socket connection assignment



a = Start button
b = Release circuits, safety valves V1 and V2 must be selected in such a way that at ½ Umax they are sure not to pull, and should they be pulled, they are sure to release!
c = EDM, feedback contacts, valve monitoring
e = Local connection socket
f = Fuse for protecting the normally open contacts, for sizes see technical data, Chapter 12.1.7
1‘ to 3‘
= Pin numbers, 3-pin MIN-series plug, transmitter
1 to 12
= Pin numbers, 12-pin MIN-series plug, receiver

ⓘ Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.

Fig. 7.8-2: Connection example machine interface /R3, MIN-series plug

7.9 Option: Machine interface /A1, AS-i Safety at Work

The COMPACT*plus-s*/A1 design type is equipped to connect the transmitter and the receiver/transceiver machine interface on the AS-I bus system with a 5-pin M12 plug in the connection cap.

7.9.1 Transmitter interface /AP

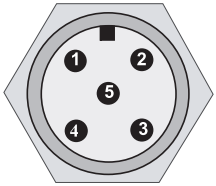
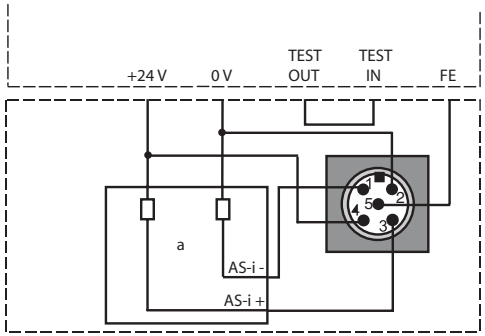


Fig. 7.9-1: Transmitter interface /AP, device plug M12 5-pin (view of the pins)

Pin	Assignment
1	AS-i +
2	0 V auxiliary supply
3	AS-i –
4	+24 V DC auxiliary supply
5	FE

Table 7.9-1: Transmitter interface /AP, 5-pin M12 plug signal assignment



a = Decoupling electronics

Fig. 7.9-2: Transmitter interface /AP, schematic structure

Note!

The transmitter can be supplied either from the yellow AS-i cable or by a separate 24V power supply line. Concurrent connection of all lines is not allowed. If power supply from the AS-i cable is used, grounding has to be done over a sliding nut and the housing. If power supply via pin 2 and 4 is used, use pin 5 for grounding.

7.9.2 Receiver machine interface /A1

It must be ensured that the supply voltage for the receiver cannot be taken from the standard AS-i line. 24 V DC must be fed via pins 2 and 4 for the receiver. A suitable AS-i adapter for bus connection and 24V voltage supply, AC-PDA1/A, is available as an accessory, which feeds the separately laid AS-i data and power supply line to an M12 socket so that the receiver can be connected via a standard M12 extension cable with 1:1 connection.

Fig. 7.9-3: Machine interface /A1, 5-pin M12 plug signal assignment (view of the pins)

Pin	Assignment
1	AS-i +
2	0 V auxiliary supply
3	AS-i –
4	+24 V DC auxiliary supply
5	FE, optional connection

Table 7.9-2: Machine interface /A1, 5-pin cable socket connection assignment

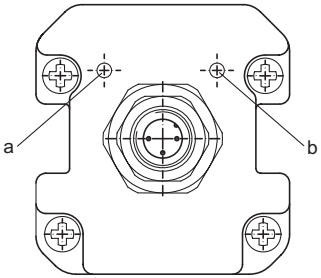


Fig. 7.9-4: Receiver connection cap, switch positions

LED green „PWR“	LED red „Fault“	Meaning	Activity
On	Off	AS-i communication without faults	None
Flashing	On	Receiver has AS-i address 0	Assign valid address
On	On	No communication with AS-i master, because: - Master not connected with AS-i - Device has wrong AS-i address - Wrong slave profile expected in the AS-i master	- Ensure AS-i master connection with AS-i - Correct device's AS-i address - Set AS-i profile in the master again
On	Flashing	Device fault, AS-i connection defective	Replace device
Off	*	No AS-i power on yellow AS-i cable	Ensure connection of the AS-i power supply and the device to the AS-i cable

Table 7.9-3: Maschine interface /A1, meaning of LEDs

The machine interface /A1 delivers the AS-i Safety at Work-specific code sequence, which the AS-i safety monitor learns and permanently monitors. Additionally, the bus master has the option via the parameter port of reading the outputs M3 and M4 diagnostic data and of writing control data via the cyclic output data to the inputs M1, M2 and M5. The meaning of the signals can be changed via the Diagnostics and Parameterization Software, SafetyLab. Set ex-factory is:

Assignment		Bit	Factory setting of the signal assignment
⇐	M1 input	D0	"Start button" input in all function packages, however may not be used via AS-i for safety reasons, and therefore is ignored in this function by the device. This signal input can otherwise be assigned by SafetyLab.
⇐	M2 input	D1	"Contactor monitoring" input in all function packages. This function is usually implemented in the safety monitor. This signal input can otherwise be assigned by SafetyLab.
⇐	M5 input	D2	n.c.
⇒	M3 output	P0	Active protective field free / ready for unlocking
⇒	M4 output	P1	Fault, dirt or failure

Table 7.9-4: Receiver/transceiver machine interface /A1, status signal assignment factory setting

The machine interface /A1 has the following internal schematic structure. The data port and the parameter port of the AS-i IC are both shown.

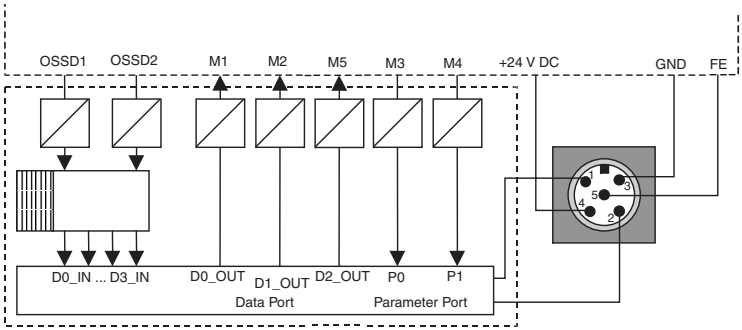


Fig. 7.9-5: Machine interface /A1, schematic structure

The potential separated OSSD outputs control the generator for the code sequence, which supplies the cyclically changing 4 output data bits as long as both OSSD = 1. These input data bits are evaluated by the safety monitor, generally, however, not by the bus master. The output data bits D0, D1 and D2 can be used by the AS-i bus master (for example in a standard PLC) to transfer control signals. Because the factory set expected signals are normally not very useful in AS-i applications, the signal assigment of M1 (= D0), M2 (=D1) and M5 (=D2) has to be changed by SafetyLab. This can be:

- a muting signal at M5, when in the function package "Muting" the basic IO-configuration "2 sensor parallel muting (L1, M5) has been selected
- an additional muting enable signal
- a control signal for the muting timer
- an enable signal for blanking in the protective field (function package „blanking“)
- a Clear signal of a cycle control (single break / double break) (function package „cicle control“)

Warning!

None of these signals must be used for safety critical purposes.

The parameter port can only be operated by the bus master. The diagnostic information supplied to M3 and M4 by the receiver is available in P0 and P1. All parameter bits are inverted, that means, in order to read M3 and M4, the master must first write 1 in P0 and P1. COMPACT*plus* overwrites this value where necessary. If 1 is still in these bits after reading back by the master, then a 0-signal is present at M3 or M4. If 0 is in P0 and P1, then a logical “1” (=24VDC) is present in M3 or M4.

Note!

From firmware/hardware version V13 (see type plate) the AS-i profile must be changed to "S-7.B.1". If you replace a device from version V13 onwards with LEDs in the cap with an older device without LEDs in the cap, it will no longer be detected by the AS-i master and will not be automatically accepted by AS-i. To integrate such a device into an existing AS-i network you must:

-Set the AS-i address with the programming device manually.

-Set the AS-i master to the new slave profile.

You will find details on this in the manual of the respective master manufacturer; they are not part of this device documentation.

7.9.3 Initial operation of COMPACT*plus*/AS-i, interface for the AS-i master

Installation in AS interface/functions control:

See also connecting and operating instructions of the AS-i safety monitor, Chapter 7 (function and initial operation).

Continue as follows:

1	**Address the AS-i slave** The addressing of the receiver is performed via the M12 device connection plug, with standard AS-i addressing devices. Each address may only be used once in an AS-i network (possible bus addresses: 1…31). The transmitter does not receive a bus address.
2	**Install the AS-i slave in the AS interface** Connection of the COMPACT*plus*/AS-i transmitter is made via an M12 bus terminal; the COMPACT*plus*/AS-i receiver is connected via the AS-i adapter for bus connection and 24V voltage supply, AC-PDA1/A.
3	**Check the supply voltage of the sensor via the AS interface** The 7-segment displays and the red LED1 light up on the COMPACT*plus*/AS-i receiver and transmitter.
4	**Check the communication between COMPACT*plus*/AS-i Transmitter and Receiver** The 7-segment displays on the transmitter and receiver light up and, where required, LED1 switches with free protective field after unlocking of the internal start/restart interlock of the COMPACT*plus* /A1, from red to green. ⓘ COMPACT*plus* /AS-i may not be interrupted for the system integration, that is, with the teaching-in of the code table of the AS-i slave by the AS-i safety monitor. The OSSDs must be in the ON-state.
5	**The initial operation and configuration of the safe AS-i slave is now carried out with the "asimon configuration and diagnosis software" of the AS-i safety monitor (see the user manual for "asimon configuration and diagnosis software").**

Notes for error and fault clearance:

See Chapter 11, and connecting and operating instructions of the AS-i safety monitor, Chapter 9 (status report, error and fault clearance).

7.9.4 COMPACT*plus*/AS-i maintenance, interface for AS-i master

Swapping out a safety-set AS-i slave:

If a safety-set AS-i slave is defective, its replacement is also possible without PC and reconfiguration of the AS-i safety monitor using the SERVICE button on the AS-i safety monitor. See also connecting and operating instructions of the AS-i safety monitor, Chapter 9.4 (replacing a defective safety-set AS-i slave).

Continue as follows:

1	**Separate the defective AS-i slave from the AS-i line** The AS-i safety monitor stops the system.
2	**Press the SERVICE button on the AS-i safety monitor**
3	**Install the new AS-i slave** The AS-i slaves have the bus address "0" in the factory setting status. With the swap-out, the AS-i master automatically programs the replacement device with the previous bus address of the defective device. A readdressing of this replacement device to the bus address of the defective device is therefore not necessary.
4	**Check the supply voltage of the sensor via the AS interface** The 7-segment displays and the red LED light up on the COMPACT*plus*/AS-i receiver and transmitter.
5	**Check the protective field function between COMPACT*plus*/AS-i transmitter and receiver:** The 7-segment displays on the transmitter and receiver light up and, where required, LED1 switches with free protective field after unlocking of the internal start/restart interlock, from red to green. ⓘ COMPACT*plus*/AS-i may not be interrupted for the system integration, that is, with the teaching-in of the code table of the AS-i slave by the AS-i safety monitor. The OSSDs must be in the ON-state.
6	**Press the SERVICE button on the AS-i safety monitor**
7	**Press the start signal to restart the AS-i system** The system restart is made according to the AS-i-side configuration of a restart interlock or an automatic restart in the AS-i safety monitor (see the user manual for "asimon configuration and diagnosis software" for AS-i safetymonitor).

Warning!

It is determined with the first pressing of the SERVICE button if an AS-i slave is missing. This is noted in the error memory of the AS-i safety monitor. The AS-i safety monitor changes to configuration mode. With the second pressing of the SERVICE button, the code sequence of the new AS-i slave is saved and tested to ensure correctness. If this is okay, the AS-i safety monitor changes back to the protective mode.

After the swap-out of a defective safety-set AS-i slave, be sure to check the correct functioning of the new AS-i slave.

Checking for safe switching-off:

The fault-free functioning of the safe AS-i system, that is, the safe switching-off of the AS-i safety monitor with activation of an assigned safety-set sensor (e.g. COMPACT*plus*/AS-i) must be checked by a specialist and authorized person on a yearly basis.

To facilitate this, the COMPACT*plus*/AS-i Slave must be activated once a year and the switching behavior must be checked by observing the safety outputs of the AS-i safety monitor.

8 Parameterization

8.1 Factory settings

When delivered, the CPT transmitter is set and ready for operation on

- transmission channel 1

with switch S2 in the connection cap in the L (left) position.

The receiver is also ready for operation and its switches S1 to S6 are set on L (left), which means:

- No contactor monitoring (EDM)
- Transmission channel 1
- Without start/restart interlock
- No floating blanking
- No reduced resolution
- No contact-based additional safety sensor connected

You have the option of setting parameters for individual functions with the internal switches as described below.

8.2 Transmitter parameterization

To switch the transmission channel to channel 2

➢ Turn the device power off

➢ Loosen the 4 screws and remove the connection cap of transmitter's CPT

➢ Turn switch S 2 to the right setting R

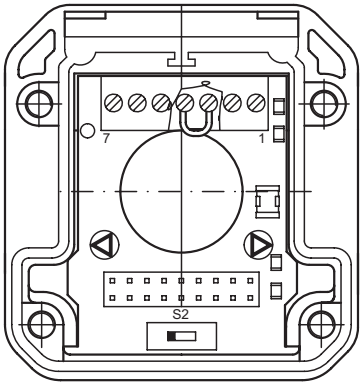


Fig. 8.2-1: Transmitter connection cap

Switch	Function	Pos.	Transmitter functions, can be set using switch	Factory setting
S2	Transmission channel	L	Transmission channel 1	L
		R	Transmission channel 2	

Table 8.2-1: Transmitter function depending on switch setting

➢ When replacing the connection cap, ensure that none of the plug pins extending out of the profile are bent.
➢ Check the CPT transmitter display after the change has been made and it has been turned back on. After self-testing, it permanently displays the selected transmission channel.
ⓘ A change in the transmitter transmission channel also requires the transmission channel of the corresponding receiver to be changed.

8.3 Receiver parameterization

Five switches on the front and one switch on the back of the removable display and parameter module in the receiver are used for switching the receiver functions. To do this:

➢ Turn off the receiver power,
➢ with devices with relay outputs, also separate the feed of the release circuit if required,
➢ loosen the 4 screws on the connection cap and
➢ pull the connection cap straight off.

The operating elements are now exposed.

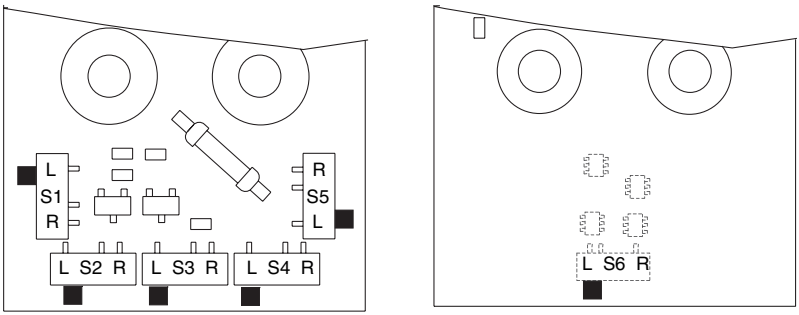


Fig. 8.3-1: Display and parameter module, front and rear side (from the front)

The following table summarizes the functions of the receiver, which can be selected using switches S1 to S6. Plan the required settings carefully and always observe the **safety notes** for each of the individual functions in Chapters 2 and 4. The factory setting for all switches is position L. It is only in this position that the value written to the receiver by the SafetyLab Diagnostics an Parameterization Software becomes effective.

The module that has already been parameterized with SafetyLab can no longer be changed with switches. If one or more switches are changed to the switch setting R, the error indication E 17 appears after turning on the receiver. If, on the other hand, the switch is set back to the factory setting L, the value of this display and parameterization module set using SafetyLab is valid.

If the setting of a module with switches parameterized with SafetyLab is required, the module must first be reset with SafetyLab and password to the basic setting. Only then can the switches S1 to S6 become effective again with their functions shown below.

ⓘ Please note that changes or additions to the purpose of the switches S1 to S6 described below, as well as changes to the factory-set parameters as part of a customer-specific parametering at the factory (see chapter 8.1 Factory settings) are documented as required in an accompanying datasheet or additional operating instructions.

Switch	Function	Pos.	"Blanking" function package, functions can be set by switch	Factory setting
S1	Contactor monitoring	L	SW: Default = No contactor monitoring EDM	L
		R	With dynamic contactor monitoring, feedback signal to M2	
S2	Transmissio nchannel	L	SW: Default = Transmission channel 1	L
		R	Transmission channel 2	
S3	Start/restart interlock	L	SW:Default = automatic startup, (delay T_D= 100 ms)	L
		R	With start/restart interlock, start-/restart button required on L5 or M1	
S4/S5	Floating blanking and reduced resolution	L / L	SW: Default = No floating blanking permitted and no reduced resolution set	L/L
		R / L	Multiple objects with floating blanking can be taught in in the entire protective field, except for the first beam	
		L / R	1-Beam reduced resolution in complete protective field	
		R / R	2-Beam reduced resolution in complete protective field	
S6	Optional safety circuit	L	SW: Default = No additional safety circuit activated	L
		R	2-Channel safety circuit L3/L4 expected, response time = 40 ms + allowance interface, simultaneity with closing: 0.5 s	

Table 8.3-1: Receiver functions depending on switch settings

Warning!

After every safety-relevant function change, check the optical protective device for proper effectiveness. Instructions can be found in Chapters 10 and 13.

The parameterization options of the receiver are described below, which are possible by changing switches S1 to S6 without the "SafetyLab" software.

The settings described below can also be made using SafetyLab, without any adjustment of the switches. For parameterization with PC, this is connected via the optical interface between connection cap and 7-segment display on the receiver. All switches S1 to S6 must be set in the factory setting to position L so that changes made with SafetyLab can be made effective. For other significant settings see the SafetyLab user manual.

8.3.1 S1 – contactor monitoring (EDM)

Place switch S1 to the R setting to activate the dynamic contactor monitoring function. As illustrated in the wiring diagram examples in chapter 7, the receiver expects the reply from the positive-guided normally closed contacts within 300 ms (FS) after the OSSDs are turned on or off by a 24 V DC signal at M2.

If this reply is not received, the receiver/transceiver will show the E31 error message and go to the error locking state, from which it can only be returned to normal operation by switching the supply voltage off and back on again.

8.3.2 S2 – Transmission channel

In factory setting L, the receiver expects a transmitter set to transmission channel 1. After switch S2 has been changed to the R setting, the receiver expects signals from a transmitter that has also been changed to transmission channel 2.

8.3.3 S3 – Start/restart interlock

The receiver leaves the factory with the S3 switch in the L setting, therefore with automatic start/restart. You can select internal start/restart interlock by moving switch S3 to the R setting if no downstream machine interface takes over this function.

Internal start/restart interlock requires a start-/restart button to be connected against 24 V either on the machine interface input M1 or optionally on pin L5 of the local interface.

Release can be achieved by pressing and releasing the start-/restart button within 100 ms <= t <= 4 s, which requires the active protective field to be free.

If activated, the optional safety circuit at L3, L4 must be closed.

The start-/restart button can be alternatively connected on the local interface L5 or on the machine interface M1; it has the same effect in FS.

8.3.4 S4/S5 – Floating blanking

When switches S4/S5 are moved to R/L, teaching in is enabled in the entire protective field for any amount of zones of any size with floating blanking in the teaching-in process, which therefore includes any guests that are connected. The teaching-in of any number and any size of float zones is possible, e.g. as described in chapter 4.3.1, any number of taught-in floating objects can move independently through the protective field, without the receiver switching off, if the following conditions are met:

- Each object only moves in its own taught-in beam zone.
- During teaching-in, the beam zone for floating blanking of an object (beams that are interrupted by the object during its movement) may not overlap with beam zones of other objects.
- With objects of the same size, the number of beams may only change by one beam (FS) with the teaching-in and during the operation. The display that shows the number of interrupted beams is provided to observe this during the teaching-in procedure.

The floating blanking function is connected with a reduction of the resolution at the marginal area at the top and bottom of the floating object and, where applicable, the locking devices (see table 4.3-1). The effective resolution given here is displayed in the factory setting of the permanent display on the 7-segment display and must be used for calculating the safety distance, and therefore the mounting distance between the protective field and danger point.

It is important that the objects to be blanked out do not have any shiny or reflective surfaces. Only matted surfaces are permitted! (See Chapter 4.3.1).

8.3.5 S4/S5 – Reduced resolution

If switches S4/S5 are moved to L/R, the resolution of the complete protective field is reduced by one beam. In position R/R, the effective resolution is reduced by 2 beams. In contrast to a lower physical resolution, the safety light curtain accepts the interruption of any number of beams within the entire protective field (position L/R), or even any amount of zones from adjacent beams, position R/R), thereby including any guests as long as the two adjacent beams are not interrupted.

When reduced resolution is activated, the safety distance must be recalculated and the mounting distance between the protective field and the danger point must be increased. The 7-segment display in the factory setting "Effective resolution" provides help with the selection of the appropriate test rod. **Please observe the safety instructions in Chapter 4.3-2.**

8.3.6 S6 – Additional contact-based safety circuit

When switch S6 is moved to the right position, an additional safety switch with two contacts like a door switch, Section Emergency STOP button or another Active Opto-electronic Protective Device with two normally open contacts can be connected to this safety circuit. The "Notes on Safety for Section Emergency STOP" can be found in Chapter 4.2.4.

This function also allows a position monitoring of fixed or floating objects with the advantage that their presence can be monitored (short cable with coded plugs or safety switches with separate actuators).

If switch S6 is changed to position R, the receiver expects a connection on L3 and L4 of the local interfaces exclusive signal level, e.g. on L3 a connection to 0V, on L4 to +24 V. Otherwise the safety switching outputs will not release even with free protective field and, where applicable, after pressing and releasing the start-/restart button. In this case, the 7-segment display of the receiver shows "U1" alternating with the permanent display, "Effective resolution" (FS). The tri-state inputs L3 and L4 are monitored at cross circuit; short circuit against 0 and +24 VDC and simultaneous closing of both contacts within 0.5 s. The response time for this additional safety circuit is 40 ms and an additional time, which depends on the type of safety output (Chapter 4.2.4).

8.3.7 Teach-in Override

Teach-in Override, the optional bridging of the protective field state is already enabled ex-factory and expects a signal change on L3 from 0 V to 24 V DC together with a signal change on L4 from 24V to 0 V within 0.5 s. The override function can only be activated during teach-in and is limited to 60 s (FS). A 24 V DC signal is given on L5 so that an unmonitored lamp connected here is switched on. As the override function in FS also uses the inputs L3 and L4, it cannot be used simultaneously with the contact-based safety circuit.

Safety notes for connecting an override switch can be found in Chapter 4.2.5.

8.4 Teaching-in procedure for teaching in fixed and floating blanking zones

Warning!

Please observe the notes on fixed and floating blanking in Chapter 4. The teaching-in procedure must be performed by experienced personnel.

In addition to the parameterization of the protective field with SafetyLab, two procedures for teaching-in fixed blanking zones can be used without PC:

- Teaching-in with SafetyKey
- Teaching-in using a 2-pin key lock

After every teaching-in, the beam zones above and below the respective blanked zones must be checked with a test rod. Test instructions can be found in Chapter 10.3.

Information on teaching-in of fixed blanking zones:

No internal switch must be changed to be able to teach-in fixed blanking zones. As described below, the teaching-in can be done either with the SafetyKey or optionally with a 2-pin changeover switch. It is important that neither the size nor the position changes, neither during teaching-in nor later during operation. It therefore helps to watch the receiver 7-segment display that indicates the number of interrupted beams during the teaching-in procedure. The value it shows must not change while teaching in.

If the object's position changes in the protective field, the object should be taught-in using the floating blanking function.

Information on teaching in floating blanking zones:

Floating blanking zones can be taught in if the zones of the protective field intended have been parameterized with SafetyLab or if the switches S4/S5 have been set to position R/L. An object of constant size may then change its position during the teaching-in procedure within its end positions. The beam zone in which the object may move during operation is consequently defined. If big objects shall be taught in, that can not be moved manually, the integrated Override function can be used to trigger off a working cycle of the machine to teach the object's size and movement range. It is recommended that you observe the number of interrupted beams on the 7-segment display during teaching-in procedure. Contrary to fixed blanking it can change by 1 beam (FS, can be changed to 2 beams with SafetyLab).

8.4.1 Teaching-in with SafetyKey

The SafetyKey is included in delivery. It must only be made available to the specialist, authorized machine setter and must be kept where it is protected from unauthorized access. The following is a description of the teaching-in procedure:

➢ Ensure that the transmitter and receiver are aligned with each other. If the blue LED4 is continuously lit, a special function such as „fixed“ or „floating blanking“ or „reduced resolution“ has already been selected. Check to see if a reset is required. Performing a teaching-in procedure again will overwrite any fixed and/or floating blanking procedure that has been programmed earlier!

Warning!

Reduced resolution is, however, not reset as a result! To switch off reduced resolution, bring S4/S5 into another position than L/R or R/R.

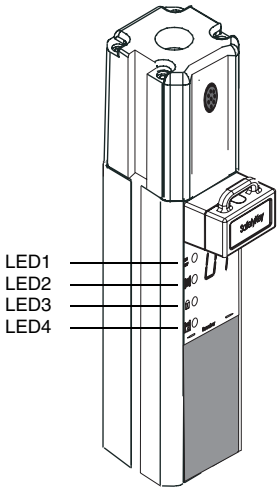
➢ Turn off the power supply.
➢ Put the object or objects for fixed and floating blanking into their position and secure them in place using a tool.
➢ Keep in mind that nobody should be able to reach into the protective field beside the object, using, for example, mechanical barriers of the same size.
➢ Make sure that the barriers are firmly connected to the objects they surround or, as described in Chapter 8.3.6 for switch S6, connected electrically with the receiver.
➢ Now switch the power supply back on.

The receiver LEDs display as follows, depending on whether the start/restart function is activated internally or set in the downstream machine control safety interface:

		With internal start/restart function		Without internal start/restart function	
LED	**Color**	Status	Meaning	Status	Meaning
LED1	**Red**	ON	OSSDs turned off	ON	OSSDs turned off
LED2	**Orange**	OFF	Protective field not free	OFF	No weak beam
LED3	**Yellow**	ON	Start/restart interlock locked	OFF	No internal start/restart interlock
LED4	**Blue**	OFF	No special function	OFF	No special function
		ON	Special function active	ON	Special function active

Table 8.4-1: Display of LEDs after putting in objects before teaching-in procedure

Place the SafetyKey at the intended position over the receiver display panel. The 7-segment display positioned beneath indicates the number of interrupted beams. The blue LED4 blinks slowly during the teaching-in procedure.



LED1 = red/green; LED2 = orange; LED3 = yellow; LED4 = blue

Fig. 8.4-1: Setting the SafetyKey in place; the 7-segment display shows the number of interrupted beams.

The receiver stores the position and the number of interrupted beams per blanking zone during the teaching-in procedure.

➢ Fixed blanked objects must not change their position during teaching-in. If you have to assume that blanking objects may vibrate, you should activate floating blanking.

➢ "Floating blanking objects must be moved slowly between their end positions during the teaching-in procedure to teach the beam zone where the object may move during normal operation.

Warning!

Ensure that nobody is reaching any part of their body into the protective field during the teaching-in procedure! ***This causes a risk to life and limb because those parts of the body are blanked out as well!*** *With automatic start, the receiver's OSSDs immediately switch to the ON state after the SafetyKey is removed!*

➢ Ensure that nobody is reaching into the protective field during the teaching-in procedure.

➢ Remove the SafetyKey. The teaching-in procedure is completed when the SafetyKey is removed.

Note!

Problems recognized during the teaching-in procedure, because, for example,

- the object changes its position without floating blanking being activated with S4/S5,
- the object changes its size,
- a new object enters or an object leaves the protective field during the teaching-in procedure,

creates an error message and the blue LED4 flashes rapidly. In this case, remove the SafetyKey and repeat the teaching-in procedure. Please also observe the notes in Chapters 11.2 and 11.3.

Depending on whether the start/restart function is internally activated or set in the downstream machine control safety interface, after the successful teaching-in procedure, the receiver LEDs display:

		With internal start/restart function		**Without internal start/restart function**	
LED	**Color**	Status	Meaning	Status	Meaning
LED1	**Red**	ON	OSSDs turned off	OFF	OSSDs turned on
LED2	**Orange**	ON	Active protective field free	OFF ON	No start/restart interlock Weak signal/beam with partial beam covering
LED3	**Yellow**	ON	Start/restart interlock locked	OFF	No start/restart interlock
LED4	**Blue**	ON	Special function active	ON	Special function active
		The OSSDs turn ON after the start-/restart button has been pushed and released.		The OSSDs immediately turn ON after the SafetyKey has been removed!	

Table 8.4-2: Display of LEDs after teaching-in procedure

➢ Use suitable test rods to test whether the remaining protective field is effective at every point above and below the blanked out areas. As long as the test rod, the diameter of which is determined by the resolution required, is moved through the protective field, the orange LED2 may not light up, if the internal start/restart interlock is activated (see Chapter 10.3). If COMPACT*plus* is operated without internal start/restart interlock, the following applies: When checking the remaining protective field, LED1 must not turn to green at any point.

ⓘ If the blue LED4 of the receiver is flashing rapidly during the teaching-in procedure or for several seconds after removing the SafetyKey, the values have not been accepted. In this case, none of the blanking features, fixed and floating, are valid any longer.

8.4.2 Option: Teaching-in using 2-pin key switch

Authorized persons can also perform the teaching-in procedure using a key lock with two neutral changeover contacts via a local interface. The teaching-in procedure is exactly the same as described in the SafetyKey instructions. The teaching-in procedure has been completed when the switch that was actuated for teaching-in has been reset.

Warning!

The same SafetyKey teaching-in procedure notes on safety apply for the teaching-in procedure. The key must be kept protected from unauthorized access. It is also extremely important that, when using this method, the rest of the remaining protective field should be checked for its effectiveness after an object has been taught-in.

8.4.3 Deleting taught-in protective field parameters

If taught-in objects have been moved and/or the transmitter has been changed, or the receiver is to be used in a new application, it is useful to clear the taught-in protective field parameters (objects with fixed and floating blanking). This makes the alignment between transmitter and receiver with a free protective field significantly easier. Objects to be blanked out can then be positioned and taught-in. The receiver "forgets" the taught-in beam zones if:

- The SafetyKey is set on the interface and then the power supply is switched off or
- the teaching-in key lock is in the "teach-in" position and the power is switched off
- the teaching-in procedure is intentionally disturbed, e.g. by removing or introducing an object to or from the protective field during the teaching-in
- a protective field in the receiver is parameterized with SafetyLab.

If transmitter and receiver are aligned with one another, then the blue LED4 blinks. It does not blink if there is no alignment. Deletion of taught-in blanking zones is made in all cases.

9 Setting the device into service

Warning!

Before being put into operation for the first time on a power-driven production machine, an experienced and commissioned person with suitable training must check the entire setup and the integration of the opto-electronic protective device into the machine control system.

Before connecting the supply voltage for the first time and while the transmitters and receivers are being aligned, it must also be ensured that the outputs of the optical protective device do not have any effect on the machine. The switching elements that finally set the dangerous machine in motion must be safely switched off and secured against restarting.

The same precautionary measures apply after each change in parameter-based functions of the optical protective device, after repairs or during maintenance work.

Only after it has been determined that the optical protective device functions are correct it can be integrated into the machine's control circuit!

9.1 Switching on the device

Ensure that transmitter and receiver are protected against overcurrent (see Tab 12.1-3). There are special requirements for the supply voltage: The power supply unit must have a load current reserve of at least 2 A and, with use of receivers/transceivers with safety-related transistor outputs, the ability to bridge a power outage for at least 20 ms, and it must guarantee secure supply isolation.

9.1.1 Display sequence with CPT transmitter

After the device is turned on, "8." appears briefly on the transmitter display and then an "S" for about 1 sec. for the self test. The display then switches and permanently shows the selected transmission channel, "1" or "2".

ⓘ A "." next to the number indicates when the test input is open. As long as the test input is open, the transmitter diodes do not deliver any valid light pulses. With test signals longer than 3 seconds the receiver fails and shows „E18“.

Warning!

If an error is shown on the transmitter (permanent display of "8" or "F" for a fault code), then the 24V DC connection voltage and wiring should be checked. If the error remains after it is turned on again, abort the setup process immediately and send in the malfunctioning transmitter to be checked.

9.1.2 Display sequence for the CPR-b receiver

After the receiver is turned on or restarted, the following will appear in the factory setting:

- 88: = Self test
- 2y xx: 2 = "Blanking" function package; y.xx = Firmware version
- Hx: H = MultiScan factor; x = number of scans (FS = 1)
- tx xx: t = Response time of the AOPD; x xx = Value in milliseconds
- Cx: C = Transmission channel; x = Number of the channel (FS = 1)
- r r: Effective resolution in the protective field (only of the hosts with cascading devices)

Warning!

In case of an error or failure, the display will show "Ex xx" or "Fx xx". Using the error number, Chapter 11 "Troubleshooting" will provide information on whether it is an error "E" in external wiring or an internal fault "F". For internal faults "F", immediately interrupt the installation and send in the malfunctioning receiver to be checked.

However, if errors are found and cleared in the external wiring, the receiver will be restored to normal mode and startup can be continued.

If the internal **start/restart interlock function is not activated** (FS), because, for example this function is executed by a downstream safety interface, the receiver's LEDs display after startup:

Warning!

The receiver switches to the ON state as soon as it receives all beams that have not been blanked out and all blanked out beams have been interrupted.

LED	***No* start/restart interlock, transmitter/receiver not aligned or protective field *not free***		***No* start/restart interlock, transmitter/receiver aligned and protective field *free***	
Red/ green	Red ON =	OFF state of the OSSDs	Green ON =	ON state of the OSSDs
Orange	OFF =	Protective field interrupted or transmitter/receiver alignment error	ON =	Weak beam indication with free active protective field
Yellow	OFF =	Start-/Restart interlock not locked	OFF =	Start-/Restart interlock not locked
Blue	OFF =	No blanking, no reduction of resolution active	OFF =	No blanking, no reduction of resolution active
	ON =	Blanking and/or reduction of resolution active	ON =	Blanking and/or reduction of resolution active

Table 9.1-1: Receiver display sequence without internal start/restart interlock

If the internal start/restart interlock function **is activated** (activation, see Chapters 4.2.2 and 8.3.3) after startup, the LEDs of the receivers display:

LED	***With*** **start/restart interlock** ***before*** **unlocking with the start/ restart button**		***With*** **start/restart interlock** ***after*** **unlocking with the start/ restart button with free protective field**	
Red/ green	Red ON =	OFF state of the OSSDs	Green ON =	ON state of the OSSDs
Orange	OFF =	Protective field interrupted or transmitter/receiver alignment error	ON =	Weak beam indication with free active protective field
	ON =	Active protective field free		
Yellow	ON =	Start/restart interlock locked	OFF =	OFF = start/restart interlock unlocked
Blue	OFF =	No blanking, no reduction of resolution active	OFF =	No blanking, no reduction of resolution active
	ON =	Blanking and/or reduction of resolution active	ON =	Blanking and/or reduction of resolution active

Table 9.1-2: Receiver display sequence with internal start/restart interlock

9.2 Aligning transmitter and receiver

Transmitter and receiver must be at the same height or, if installed in a horizontal position, be at the same distance from the reference surface and slightly fastened at first. The small specified angle of beam spread of ± 2° requires increased precision in aligning the two components with each other before the devices are screwed firmly into place.

ⓘ If cascaded AOPDs are aligned with each other, it must always be in the order of host first, then guest.

9.2.1 Aligning with the 7-segment display of the receiver

If the SafetyKey is placed on the position in the display field reserved for this purpose, briefly removed and then replaced within approx. 2 seconds, the 7-segment display switches from the permanent display to alignment mode.

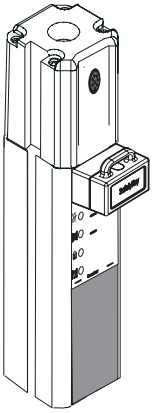


Abb. 9.2-1: Setting the SafetyKey on a light curtain's receiver

Individual device alignment	Switch the receiver display to service mode with SafetyKey:  The first beam next to the display (synchronization beam) meets the first receiver diode →, the top horizontal beam in the left display lights up:  The last beam also hits the corresponding diode in the receiver →, the lowest horizontal beam in the left display lights up: 
Align host/ guest combina-tion	First align the host as an individual device (see above):  The top and bottom horizontal beams of the right 7-segment display light up if both transmitter and receiver of the guest(s) are aligned with one another. With two guests, the above right beam represents the first beam of the first guest and the bottom right beam represents the last beam of the second guest. 

Table 9.2-1: Aligning with the aid of the 7-segment displays

- With internal start/restart interlock: The orange LED2 of the receiver is lit constantly, → rotate transmitter and receiver to each other optimally and fix them in place.
- Without internal start/restart interlock: The LED1 of the receiver is constantly lit green, → rotate transmitter and receiver to each other optimally and fix them in place.

When the SafetyKey is removed, the 7-segment display of the receiver switches back into permanent display mode.

9.2.2 Optimizing alignment by turning the transmitter and receiver

Using standard brackets for fastening requires level, precisely aligned mounting surfaces so that, for example, if mounted vertically using adjustable sliding nuts, then only the precise heights of the transmitter and receiver have to be set.

If this requirement is not met, swiveling mounting brackets (accessories) can be used as described in Chapter 6.3.2.

Alignment with internal start/restart interlock

If the protective field is clear, the alignment can be optimized by observing the orange LED2 on the receiver (protective field free). Precondition here is that the pre-alignment work has been completed to such an extent that the orange LED2 is already constantly lit.

➢ Unscrew the locking screws on the transmitter's swivelling mounting brackets so that you can just move it. Move the transmitter until the orange LED2 switches off. Note this position. Move the transmitter back until the orange LED2 is constantly lit again and then continue until it goes off again. Now move the transmitter back to the center of the two positions found and fix the swiveling mounting brackets so that it cannot be moved.

➢ Now do exactly the same with the receiver and move it to the center between the two positions where LED2 goes off. Fix the receiver into place. The optimum setting is consequently achieved.

➢ For cascaded systems, the procedure can be performed for all transmitters and receivers one after the other, beginning with the host. A precise preliminary adjustment of all components is also required in this case.

Alignment without internal start/restart interlock

➢ The procedure is the same as described above. Instead of the orange LED2, observe LED1 of the receiver. The transition point is where LED1 switches from green to red. LED2 can be lit at the transition points during the setup procedure (weak beam indication).

10 Testing

10.1 Testing before putting the equipment in service the first time

Testing by an experienced technician before initial startup must ensure that the optical safety device and any other safety components that might be present have been selected in accordance with local regulations and if applicable the European Directives especially the European Machine and Machine Utilization Directive and that they provide the required protection when properly operated.

- ➢ Use the regulations listed above, where required, with the help of the checklists provided in the Appendix of these instructions, to check that the protective devices are properly installed, that they are properly wired into the controls and that they work in all machine modes.
- ➢ The same testing requirements apply if the machine in question has not been operated for a longer period of time and after major modifications or repairs if this could affect the safety of the machine.
- ➢ Observe the specifications regarding the provision of instruction to operating personnel by experienced technicians before work is started. Instruction of personnel is the responsibility of the machine owner.

Leuze provides a specialist service in Germany, which undertakes the required testing and monitoring tasks (www.leuze.de). The results of the test are documented for the machine owner in accordance with ISO 9000 ff.

10.2 Regular inspections

Regular inspections are also carried out in accordance with local regulations. They are designed to discover changes (e.g. in machine stopping time) or manipulations to the machine or protective device.

- ➢ You must have the effectiveness of the protective device checked by an experienced technician at the required intervals, but at least once per year.
- ➢ The applicable checklist in the Appendix may also be used during regular testing.

Leuze also provides a specialist service for regular tests.

10.3 Daily testing with the test rod

COMPACT*plus* are self-monitoring safety light curtains. Nevertheless it is very important to check the protective field for its effectiveness daily to be sure that the protection also stays effective at every point after a parameter or tool change.

Warning!

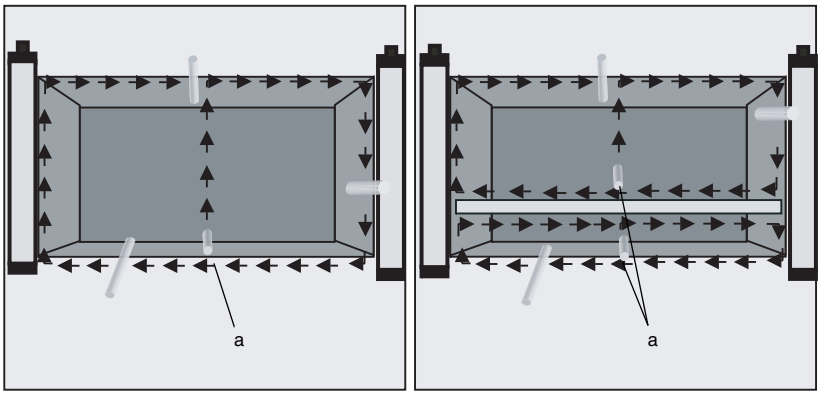
*Work authorities in Germany require **daily testing** with the test rod in accordance with ZH1/281 for presses with hand feed in metal industries.*

The test is also required with all machine types including the presses mentioned **after every change of the machine modes**: fixed blanking, floating blanking or reduced resolution as well as after a tool change!

Warning!

Never use your fingers, hand or arm for checking the system!

- ➢ When selecting the test rod, use the nameplate on the receiver or on the additional nameplate indicating the effective resolution as a guideline.
- ➢ If internal start/restart interlock is selected and the AOPD is released, LED1 lights up green. When the test rod is inserted, LED1 switches to red and LED3 lights up yellow and therefore signals that the start/restart interlock is locked. During the testing procedure, LED2 must not light up orange at any point.
- ➢ If the AOPD is being operated without the internal start/restart interlock, it is sufficient to watch LED1 on the receiver during the testing procedure. When the test rod is inserted into the protective field, this LED1 must switch from "green" to "red" and must not switch back to "green" at any point during the test.



a = Beginning of test

Fig. 10.3-1: Testing with the test rod, with blanking functions test of all partial areas

Warning!

If the test does not provide the desired result, the cause could, for example, be a protective field height that is too low or reflections from shiny metals or tools placed in the area. In this case the installation of the safety light curtain must be checked by a specialist. If the cause cannot be clearly defined and remedied, the machine or system may not be used!

10.4 Cleaning the front screens

The front screens on the transmitters and receivers must be cleaned regularly depending on how dirty they are. If the orange LED2 on the receiver is on with free protective field (LED1 is green) a "weak signal reception" is indicated. The collective "malfunction/dirt" signal is provided on M4 in the factory setting. The dirt signal is generated with time filtering (10 min) from the internal weak beam signal. If this signal is activated (LOW signal on M4), then cleaning of the front screen may be required with free protective field and switched LED2. If cleaning the screens does not improve this, then the detection range and alignment must be checked.

We recommend using a mild cleanser for cleaning the front screens. The screens are resistant to thinned acids or alkalis and resistant to organic solvents within limits.

11 Troubleshooting

The following information is used for rapid troubleshooting in the event of a malfunction.

11.1 What should I do if an error occurs?

If the AOPD shows an error on the display, the machine must be stopped immediately and checked by an experienced technician. If it is found that the error cannot be clearly defined and remedied, your local Leuze office and or the Leuze hotline can assist.

11.2 Quick diagnostic using the 7-segment displays

Operational malfunctions often have simple causes that you can remedy yourself. The following tables will help you do this.

11.2.1 Transmitter diagnostic

Symptom	Measures to clear errors
7-Segment display does not light up	Check +24 V supply voltage (also check for polarity) Check the connection cable Replace the transmitter if required
8. is constantly lit	Hardware error, replace transmitter
F. is constantly lit and briefly interrupted by an error number	Internal error, replace transmitter
Decimal point in the 7-segment display is lit	Jumper 3-4 is missing in the transmitter's connection cap or external circuit is not closed Insert jumper

Table 11.2-1: Transmitter diagnostic

11.2.2 Receiver diagnostic

The receiver distinguishes between error codes (Ex xx) and fault codes (Fx xx). Only error codes provide you with information about events or conditions that you can eliminate. If the receiver shows a fault code F, it must be replaced (see Chapter 11.4). For this reason, only error codes E are listed below:

Code	Cause/Meaning	Measures to clear errors
	LEDs and 7-segment displays do not light up	+24V supply voltage (also check for polarity and connection cable), replace the receiver if necessary
8 : 8	is constantly lit $\rightarrow$ Hardware fault	Replace receiver
F x(x)	Internal hardware fault	Replace receiver/transceiver

E 1	Cross connection between OSSD1 and OSSD 2	Remove connection
E 2	Overload on OSSD1	Use correct load
E 3	Overload on OSSD2	Use correct load
E 4	Overvoltage on OSSD1	Use correct power supply
E 5	Overvoltage on OSSD2	Use correct power supply
E 6	Circuit against 0 V on OSSD1	Remove connection
E 7	Circuit against 24V on OSSD1	Remove connection
E 8	Circuit against 0 V on OSSD2	Remove connection
E 9	Circuit against 24V on OSSD2	Remove connection
E 10	Switch S1 - S6 not correctly positioned	Correct switch positions
E 11	Current and configured beam count differ	Correct beam parameters with PC and SafetyLab
E 12	Guest lit during operation, device too long	Connect correct guest(s) before power-on
E 13	Guest removed during operation, device too short	Connect correct guest(s)
E 14	Undervoltage on the power supply	Check/change power supply or load
E 15	Reflection errors at PC interface	Protect interface optically
E 16	Error at input/output	Switch signal line on correctly
E 17	Fault in the parameterization or wrong switch setting S1 to S6	Reset to basic setting with PC and SafetyLab or All switches S1 to S6 to position L
E 18	Transmitter test signal received for longer than 3 seconds	Close jumper between terminal 3 and 4 in the transmitter connection cap
E 20 E 21	Electromagnetic interference	Suppression of electromagnetic interference and/or signal lines
E 22	Overvoltage	Check/change power supply
E 30	Feedback contact of contactor monitoring not opening	Replace contactor, check wiring
E 31	Feedback contact of contactor monitoring not closing	Replace contactor, check wiring
E 32	Feedback contact of contactor monitoring is not closed	Replace contactor, check wiring
E 39	Start button pressed too long or short-circuited	Remove block or short against 24 V

E 40	Safety circuit on L3 / L4 has short cut to 0 V	Remove connection
E 41	Safety circuit on L3 / L4 has short cut to 24V	Remove connection
E 42	Safety circuit on L3 / L4: Simultaneity fault	Replace sensor
E 43	Override circuit on L3 / L4 has short cut to 0 V	Remove connection
E 44	Override circuit on L3 / L4 has short cut to 24V	Remove connection
E 45	Override circuit on L3 / L4 not connected	Connect override key lock.
E 46	Override circuit on L3 / L4: Simultaneity fault	Replace button
E 54	Override time limit exceeded	After AutoReset, device switches back to normal operation.
E 70	Display module incompatible with the receiver's hardware	Set original display and load correct parameter set
E 71	Display module incompatible with the receiver's hardware	Set original display and load correct parameter set
E 72	SafetyLab incompatible with the receiver's firmware version	Use current SafetyLab version
E 95	Fault in the beam parameterization	Correct beam parameterization with SafetyLab

Tab. 11.2-2: Receiver diagnosis

11.3 AutoReset

After an error or a fault has been detected and indicated, with the exception of the locking error/fault, a restart follows automatically in the

- transmitter after about 2 seconds and
- in the receiver after about 10 seconds

in the respective device. If an error is therefore no longer present, the machine/application can be restarted, but the temporary error code is then lost.

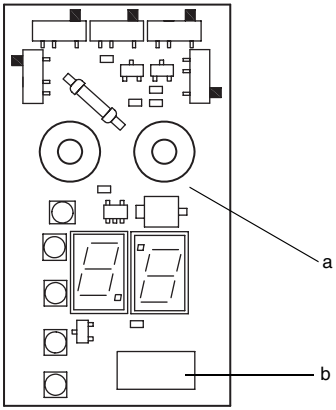
If these kinds of errors happen frequently and you want to find out the cause, keep the error signal until the reset is carried out by a maintenance technician. You can do this with the receiver by inversely setting the SafetyKey to the corresponding position of the receiver display (fig. 9.2-1), so that the "handle" points away from the connection cap. This prevents a teach-in procedure from being activated and therefore the OSSD from switching off.

The receiver will no longer reset automatically after approx. 10 seconds. It will now permanently display the last error code. Only after taking away the key and waiting another 10 seconds does the AutoReset procedure take place again.

The receiver is not automatically reset after 10 seconds with locking errors (e.g. E30, E31, E32). The receiver goes instead to the error locking state, which it can only leave by pressing the start/restart button or by switching the supply voltage off and back on again.

11.4 Maintaining the parameterization when replacing the receiver

All setting values are stored on the display and parameterization module, where switches S1 to S6 are also located. When replacing a device, all parameter settings can be transferred by a specialist and authorized person into the new **same-model** receiver/ transceiver by transferring a correctly parameterized module.



a = Display and parameter module
b = Plug connection

Fig. 11.4-1: Display and parameter module

Warning!

*When replacing a device it must be assured that an **identical exchange device** is used. This is the only way that the correct functionality is reached for the **same installation point** if the correctly parameterized display and parameterization module is transferred into the exchange device.*

Even when exchanging the display and parameterization module, it is an unavoidable necessity to carefully recheck all safety-related functions of the optical protective device before placing it in service again. Non-observance can cause impairments of the protective function.

12 Technical data

12.1 General data

12.1.1 Beam/protective field data

Safety Light Curtain	Physical resolution	Detection range		Height of protective field	
		Min.	Max.	Min.	Max.
CP14-	14 mm	0 m	6 m	150 mm	1800 mm
CP30-	30 mm	0 m	18 m	150 mm	1800 mm
CP50-	50 mm	0 m	18 m	450 mm	3000 mm

Table 12.1-1: Beam/protective field data

12.1.2 Safety-relevant technical data

Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
SILCL in accordance with IEC/EN 62061	SILCL 3
Performance Level (PL) in accordance with EN ISO 13849-1: 2008	PL e
Category in accordance with ISO 13849	Cat. 4
Average probability of a failure to danger per hour (PFH_d) For protective field heights up to 900 mm, all resolutions For protective field heights up to 1800 mm, all resolutions For protective field heights up to 3000 mm, all resolutions	 $2.26 \times 10^{-8}\ ^1/_h$ $2.67 \times 10^{-8}\ ^1/_h$ On request
Service life (T_M)	20 years
Number of cycles until 10 % of the components have a failure to danger (B_{10d}) Version /R with relay output, DC13 (5 A, 24 V, inductive load) Version /R with relay output, AC15 (3 A, 230 V, inductive load)	 630,000 1,480,000

Table 12.1-2: Safety-relevant technical data

12.1.3 System data

Safety category	Type 4 in accordance with IEC/EN 61496 SIL 3 in acc. with IEC/EN 61508
Supply voltage Uv Transmitter and receiver	+24 V DC, ± 20 %, external power supply with secure mains supply isolation and equalization with a 20 ms voltage dip where required (Chap. 7), current reserve of at least 2 A
Residual ripple of supply voltage	± 5 % within Uv limits
Transmitter power consumption	75 mA
Receiver power consumption	160 mA without external load and additional sensor equipment
Shared value for external fuse in the feed line for transmitter and receiver	4 A
Transmitter: Class: Wavelengths: Pulse duration Pulse pause Power:	Light-emitting diodes in accordance with EN 60825-1:1994+ A1:2002+A2:2001 1 880 nm 7 µs 3,12 ms 8,73 µW
Synchronization	Optical between transmitter and receiver
Safety class (VDE 106): Exception: Receiver with Machine interface /R1 with separate cable for switch outputs Safety class:	III PE connection to Z1-1 instead of FE to Z3-3 (see connection example, Fig. 7.6-5) I
Type of protection	IP65*
Ambient temperature, operation	0 ... 50 °C
Ambient temperature, storage	-25 ... 70 °C
Relative humidity	15 ... 95 %
Vibration fatigue limit	5 g, 10 - 55 Hz in accordance with IEC/EN 60068-2-6
Resistance to shocks	10 g, 16 ms in accordance with EN/IEC 60068-2-29
Dimensions	See dimensional drawings and tables
Weight	See table

*) Without additional measures the devices are not suited for outdoor use.

Table 12.1-3: General system data

12.1.4 Receiver, local interface, status and control signals

Voltage output, only for command devices or safety sensor equipment	24 V DC ± 20% max. 0.5 A	
L1: Signal input	Input:	Contact or transistor against +24 V DC current load: 20 mA max.
L2: Signal input/output	Input: Output:	Contact or transistor against +24 V DC current load: 20 mA max. pnp, +24VDC-switching, 60mA max.
L3, L4: TriState signal input for potential-free safety circuit	Input:	Contact or transistor against +24 V DC or against 0 V current load: 20 mA max., typical 10mA
L5: Signal input/output	Input: Output:	Contact or transistor against +24 V DC current load: 20 mA max. pnp, +24VDC-switching, 500mA max.

Table 12.1-4: Receiver, local interface, status and control signals

12.1.5 Receiver, machine interface, status and control signals

M1, M2: Signal input	Input:	Contact or transistor against +24 V DC current load: 20 mA max.
M3, M4: Signal input/output	Input: Output:	Contact or transistor against +24 V DC current load: 20 mA max. pnp: +24VDC-switching, 60mA max.
M5: Signal input/output	Input: Output:	Contact or transistor against +24 V DC (external pullup required) current load: 20 mA max. npn: 0 V switching, 1A max.

Table 12.1-5: Receiver, machine interface, status and control signals

12.1.6 Receiver, machine interface, safety-related transistor outputs

OSSDs safety switch outputs	2 Safety-related pnp semiconductor outputs, cross circuit monitored, resistant to short circuits		
	Min.	typical	Max.
Switching voltage high active (Uv – 1V) Switching voltage, low Switched current Leakage current Load capacity Load inductivity	+18.2 V 0 V 2 mA	+23 V 0 V 500 mA < 2 µA	+28.8 V +2.5 V 650 mA 200 µA *) 3.3 µF 2.2 H
Permissible wire resistance for load	-	-	< 1 kΩ **)
Permissible wire gauge	1 mm² with conductor sleeve		1.5 mm²
Permissible wire length between receiver and load (at 1 mm²)	-	-	100 m
Test pulse width	-	-	250 µs
Test pulse distance	-	-	22 ms
OSSD restart time after beam interruption	-	100 ms	-
OSSD response time	Dependent on number of beams and MultiScan factor H, see tables in Chapter 12.2		

*) In case of a failure (disconnection of 0 V wire) the outputs emulate a 120 kΩ resistor in line with Uv. A subsequent Safety PLC, must not recognize this as a logical "1".
**) Be aware of other restrictions due to cable length and load current

Table 12.1-6: Receiver, machine interface, safety-related transistor outputs

ⓘ The output transistors carry out the spark extinction. With transistor outputs, it is therefore not necessary to use the spark extinction elements recommended by contactor/valve manufacturers etc. (RC modules, varistors or recovery diodes). These extend the delay times of inductive switching elements.

12.1.7 Receiver, machine interface, safety-related relay outputs

OSSD Relay outputs		2 Potential-free relay outputs		
		Min.	typical	Max.
/R1	Cable screw M25x1,5 when using only **one** connection cable:			
/R2 /R3	Hirschmann plug (typical 0.5 mm²) MIN-series plug (AWG 16 = 0.75 mm²)			
	⚠ The protective extra low voltage, 42V AC/DC may under no circumstances be exceeded.			
	With switching voltage 24 V DC	**15 V DC**	**24 V DC**	**30 V DC**
	Switching current inductive load*			1.5 A
	[τ=L/R=40 ms] Assigned cable length, A = 0.75 mm² Fuse: max. 2 A slow			26 m
	Switching current inductive load*			1.5 A
	[τ=L/R=40 ms] Assigned cable length, A = 0.5 mm² Fuse: max. 2 A slow			9 m
	Switching current ohmic load		up to 0.4 A 100 m	3.0 A
	Assigned cable length, A = 0.75 mm² Fuse: max. 3.15 A slow			13 m
	Switching current ohmic load		up to 0.4 A 60 m	2.0 A
	Assigned cable length, A = 0.5 mm² Fuse: max. 2.5 A slow			13 m
/R1	Cable screw M25x1,5, 2 cables When using an **additional** cable for the OSSD switching contacts: 4 x 0.75 mm² + PE safety class I			
	⚠ Insulating plate is compulsory in the connection cap (see Fig. 7.6-3)			
	With switching voltage 115V AC		**115 V AC**	**127 V AC**
	Switching current, inductive load* (cosφ = 0.8) e.g. contactors, valves, etc.		0.6 A	2.0 A
	Assigned cable length, A = 0.75 mm² (AWG 16); fuse: max. 2.5 A slow		100 m	30 m
	Switching current, ohmic load Assigned cable length, A = 0.75 mm² (AWG 16); fuse: max. 3.15 A slow		0.5 A 100 m	3.0 A 16 m

Table 12.1-7: Receiver, machine interface, safety-related relay outputs

OSSD Relay outputs		2 Potential-free relay outputs		
		Min.	typical	Max.
/R1	MG 25 cable screw, 2 cables When using an **additional** cable for the OSSD switching contacts: 4 x 0.75 mm² + PE safety class I ⚠ Insulating plate is compulsory in the connection cap (see Fig. 7.6-3)			
	With switching voltage 230 V AC		**230 V AC**	**250 V AC**
	Switching current, inductive load* ($\cos\varphi$ = 0.8) e.g. contactors, valves, etc. Assigned cable length, A = 0.75mm² Fuse: max. 2.5 A slow		1.2 A 100 m	2.0 A 60 m
	Switching current, ohmic load Assigned cable length, A = 0.75mm² Fuse: max. 3.15 A slow		1 A 100 m	3.0 A 32 m
Transmitter test input response time		18 ms	-	66 ms
Restart time after beam interruption		-	115 ms	-
OSSD response time		Depends on number of beams, MultiScan factor H and type of machine interface, see tables in Chapter 12.2		

⚠ It applies with safety-related relay outputs that: The cable or cables for machine control must generally be laid with protected installation in a cable duct or with armor in such a way that cross-connections of the cable wires can be safely ruled out.

*) With relay outputs, the spark extinction elements recommended by the manufacturers of contactors/valves etc. must be used (RC modules, varistors, etc.). With DC voltages, no recovery diodes should be used. These extend the delay times of inductive switching elements.

Table 12.1-7: Receiver, machine interface, safety-related relay outputs

12.1.8 Receiver machine interface, AS-i Safety at Work

OSSDs safety related switching outputs	4-Bit AS-i data		
	Min.	typical	Max.
Permissible wire length	-	-	100 m
Restart time after beam interruption		140 ms	
Slave address range	1	-	31
Slave address (FS)	0 (ex-factory)		
Transmitter ID-code/IO-code	-		
ID-code, receiver	B		
IO-code, receiver	7		
AS-i profile	Safe slave		
Cycle time in accordance with AS-i specifications	5 ms		
OSSD response time	See tables in Chapter 12.2		
Current consumption	35 mA		
Additional response time of the AS-i system	40 ms		

Table 12.1-8: Receiver machine interface, AS-i Safety at Work

12.2 Dimensions, weights, response times

12.2.1 Safety light curtains with transistor outputs, relay outputs or AS-i Bus connection

Dim. A [mm]	Dim. B [mm]	Earth [kg]	tH1 = Response time of the AOPD in ms with MultiScan factor H=1 (FS) /T = Transistor outputs; /R = Relay outputs; /A = AS-i bus connection n = Number of beams											
			CP14-xxxx				CP30-xxxx				CP50-xxxx			
			n	/T	/R	/A	n	/T	/R	/A	n	/T	/R	/A
				tH1 [ms]	tH1 [ms]	tH1 [ms]		tH1 [ms]	tH1 [ms]	tH1 [ms]		tH1 [ms]	tH1 [ms]	tH1 [ms]
150	284	0.7	16	**5**	**20**	**10**	8	**5**	**20**	**10**				
225	359	0.9	24	**7**	**22**	**12**	12	**7**	**22**	**12**				
300	434	1.1	32	**9**	**24**	**14**	16	**5**	**20**	**10**				
450	584	1.5	48	**12**	**27**	**17**	24	**7**	**22**	**12**	12	**7**	**22**	**12**
600	734	1.9	64	**15**	**30**	**20**	32	**9**	**24**	**14**	16	**5**	**20**	**10**
750	884	2.3	80	**18**	**33**	**23**	40	**10**	**25**	**15**	20	**6**	**21**	**11**
900	1034	2.7	96	**22**	**37**	**27**	48	**12**	**27**	**17**	24	**7**	**22**	**12**
1050	1184	3.1	112	**25**	**40**	**30**	56	**13**	**28**	**18**	28	**8**	**23**	**13**
1200	1334	3.5	128	**28**	**43**	**33**	64	**15**	**30**	**20**	32	**9**	**24**	**14**
1350	1484	3.9	144	**31**	**46**	**36**	72	**17**	**32**	**22**	36	**9**	**24**	**14**
1500	1634	4.3	160	**35**	**50**	**40**	80	**18**	**33**	**23**	40	**10**	**25**	**15**
1650	1784	4.7	176	**38**	**53**	**43**	88	**20**	**35**	**25**	44	**11**	**26**	**16**
1800	1934	5.1	192	**41**	**56**	**46**	96	**22**	**37**	**27**	48	**12**	**27**	**17**
2100	2234	5.9									56	**13**	**28**	**18**
2400	2534	6.7									64	**15**	**30**	**20**
2700	2834	7.5									72	**17**	**32**	**22**
3000	3134	8.3									80	**18**	**33**	**23**

Table 12.2-1: Safety light curtains, dimensions and response times with AutoScan (FS: H=1)

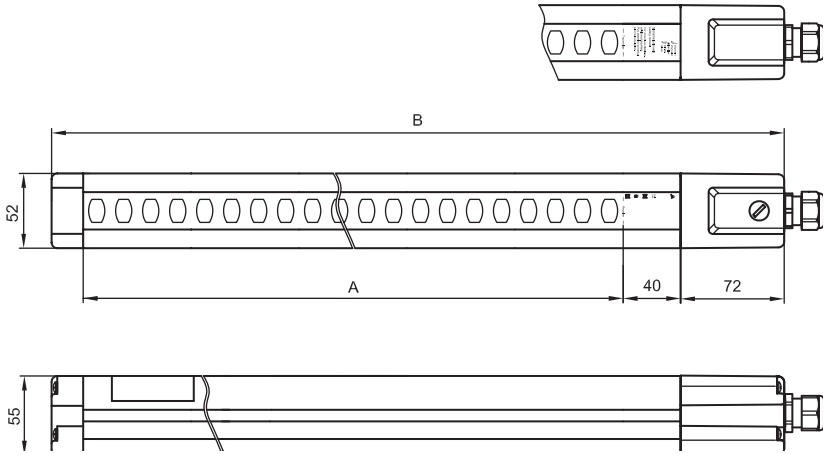


Fig. 12.2-1: Dimensions Safety Light Curtains

12.2.2 COMPACT Guests series

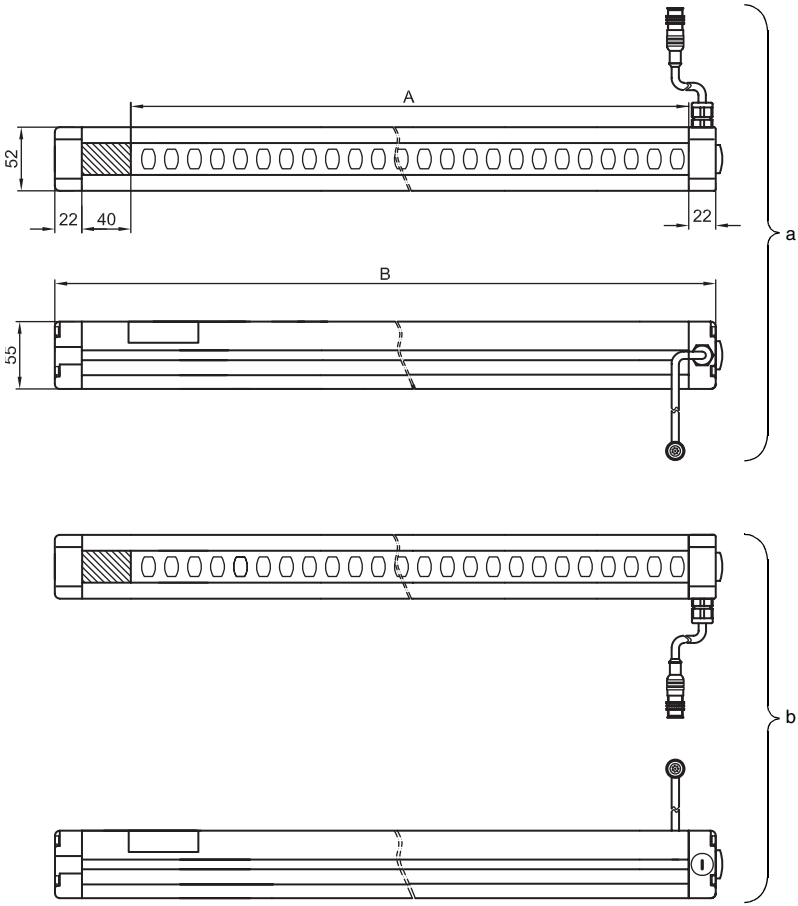
Dim. A [mm]	Dim. B [mm]	Weight CT-..S, CR-..S [kg]	tS = Guest response time; n = Number of beams							
			Example:		C14-300S with H = 1: tS = 13 ms					
			C14-xxxxS		C30-xxxxS		C50-xxxxS		C90-xxxxS	
			n	tS [ms] H = 1	n	tS [ms] H = 1	n	tS [ms] H = 1	n	tS [ms] H = 1
300	434	1,1	32	13	16	7				
450	584	1,5	48	10	24	10	12	10		
600	734	1,9	64	13	32	13	16	7		
750	884	2,3	80	17	40	9	20	9	10	9
900	1034	2,7	96	20	48	10	24	10	12	10
1050	1184	3,1	112	23	56	12	28	12	14	6
1200	1334	3,5	128	26	64	13	32	13	16	7
1350	1484	3,9	144	30	72	15	36	8	18	8
1500	1634	4,3	160	33	80	17	40	9	20	9
1650	1784	4,7	176	36	88	18	44	9	22	9
1800	1934	5,1	192	39	96	20	48	10	24	10
2100	2184	5,9					56	12	28	12
2400	2484	6,7					64	13	32	13
2700	2784	7,5					72	15	36	8
3000	3084	8,3					80	17	40	9

Table 12.2-2: COMPACT Guests series dimensions and response times

Warning!

An increase of the MultiScan factor H using PC and SafetyLab extends the response time! The recalculation and adjusting of the safety distance in accordance with Chapter 6.1.1 is compulsory.

The total response time of the protective device tAOPD is calculated by adding the host response time to the guest response time.



a = Receiver, Guest
b = Transmitter, Guest

Fig. 12.2-2: Guest series dimensions

12.2.3 Mounting bracket dimensions

Dimensions in mm

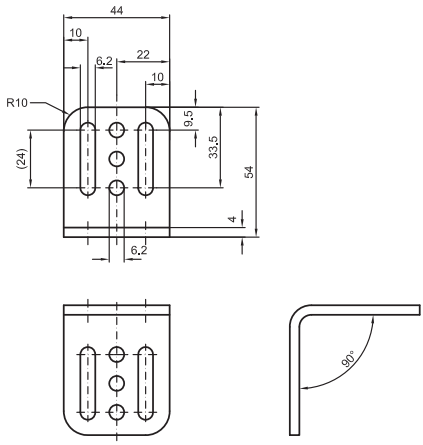
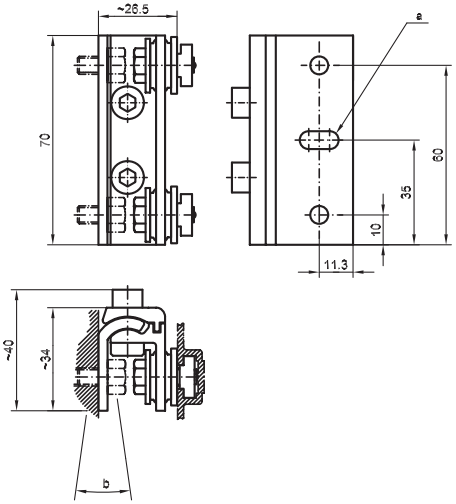


Fig. 12.2-3: Standard mounting bracket

12.2.4 Swiveling mounting bracket dimensions

Dimensions in mm



a = Slot 13 x 6
b = Swiveling angle ± 8°

Fig. 12.2-4: Option: Swiveling mounting bracket with shock absorber

13 Appendix

13.1 Delivery

Safety Light Curtains are delivered with:

- 1 Transmitter
- 1 Receiver
- 4 Sliding nuts with screws M6x10
- 4 Standard mounting brackets
- 1 SafetyKey
- 1 Connecting and operating instructions
- 1 Self-adhesive information plate

Additionally included in delivery for:

- Safety Light Curtains with 14 mm resolution:
  Test rod set consisting of test rods 14, 19, 24, 29, 33 mm
- Safety Light Curtains with 30 mm resolution
  Test rod set consisting of test rods 14/30 und 38 mm

13.2 Accessories

Art.-No	Article	Description
560030	LA78UDC	External laser alignment aid for column mounting
150704	CB-M12-3000-8W/M	Cable for local connection with angled M12x8 plug, 3 m
150699	CB-M12-10000-8W/M	Cable for local connection with angled M12x8 plug, 10 m
426045	AC-LDH-12GF	Hirschmann cable socket, angled, incl. crimp contacts
426046	AC-LDH-12GF	Hirschmann cable socket, straight, incl. crimp contacts
426042	CB-8N-10000-12GW	Cable for /T2 – machine interface 10 m, straight socket
426044	CB-8N-25000-12GW	Cable for /T2 – machine interface 25 m, straight socket
426043	CB-8N-50000-12GW	Cable for /T2 – machine interface 50 m, straight socket
429071	CB-M12-5000S-5GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 5-poles, 5 m, straight / open end
429073	CB-M12-10000S-5GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 5-poles, 10 m, straight / open end
429075	CB-M12-15000S-5GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 5-poles, 15 m, straight / open end

Table 13.2-1: COMPACT*plus*-b Accessories

429081	CB-M12-5000S-8GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 8-poles, 5 m, straight / open end
429083	CB-M12-10000S-8GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 8-poles, 10 m, straight / open end
429085	CB-M12-15000S-8GF	Connection cable /T4 Transmitter, shielded with M12-coupling, 8-poles, 15 m, straight / open end
580004	AC-PDA1/A	AS-i, adapter for bus connection and 24V supply voltage
500243 46	AM 06	AS-i adapter, M12 bus terminal for AS-i flat cable
500247 50	AKB 01	AS-i flat cable, yellow
548361	CB-M12-1000-5GF/GM	AS-i cable adapter, 5-wire, 1 m
548362	CB-M12-2000-5GF/GMF	AS-i cable adapter, 5-wire, 2 m
520065	AC-SCM1	Local connection box, external with 6 M12 connection sockets, cable 0.5 m
520068	AC-SCM1-BT	Local connection box with mounting plate
520066	AC-SCC2	Sensor cable splitter for PRK series … (Pin 2 active)
529603	UM 60-300	Deflecting Mirror, length 300 mm
529604	UM 60-450	Deflecting Mirror, length 450 mm
529606	UM 60-600	Deflecting Mirror, length 600 mm
529607	UM 60-750	Deflecting Mirror, length 750 mm
529609	UM 60-900	Deflecting Mirror, length 900 mm
529610	UM 60-1050	Deflecting Mirror, length 1050 mm
520073	SLAB-SWC	SafetyLab parameterization and diagnostic software incl. PC-cable, RS232 - IR
520072	CB-PCO-3000	PC-cable, RS232 - IR-adapter
346503	PS-C-CP-300	Protective screen 300 mm
346504	PS-C-CP-450	Protective screen 450 mm
346506	PS-C-CP-600	Protective screen 600 mm
346507	PS-C-CP-750	Protective screen 750 mm
346509	PS-C-CP-900	Protective screen 900 mm
346510	PS-C-CP-1050	Protective screen 1050 mm
346512	PS-C-CP-1200	Protective screen 1200 mm
346513	PS-C-CP-1350	Protective screen 1350 mm
346515	PS-C-CP-1500	Protective screen 1500 mm
346506	PS-C-CP-1650	Protective screen 1650 mm
346518	PS-C-CP-1800	Protective screen 1800 mm

Table 13.2-1: COMPACT*plus*-b Accessories

560300	BT-SSD	Swiveling mounting bracket with shock absorber
549940	SITOP power	Power supply 115 V 50/60 Hz => 24 V/5 A
549908	LOGO! power	Power supply 230 V 50/60 Hz => 24 V/1.3 A

Table 13.2-1: COMPACT*plus*-b Accessories

13.3 Checklists

The inspection before the initial operation determines the safety related integration of the active opto-electronic protective device (AOPD) into the machine and its control. The results of the inspection must be written down and kept with the machine documents. They can then be used as a reference during the subsequent regular inspections.

13.3.1 Checklist for safeguarding danger points

Safety Light Curtain (effective resolution 14 to 40 mm), approaching direction normal to the protective field

ⓘ This checklist represents a help tool. It supports but does not serve for the inspection before the initial operation or the regular inspections by an expert.

The following part of the checklist applies when fixed or floating blanking have been chosen:

- If fixed or floating blanking were taught in, do the inserted object(s) or mechanical barriers occupy the entire protective field width in order to prevent reaching into the protective field beside the object(s)? yes no
- Are built-in mechanical barriers firmly combined with the inserted objects so that they form a unit? yes no
- Can the fixed or floating objects including mechanical barriers only be removed by using a tool? yes no
- Has it been ensured that the surfaces of the inserted objects and, where applicable, of the mechanical barriers are matt so that reflection is prevented? yes no
- Is the complete protective effect of the residual protective fields found with the suitable test rod in accordance with the effective resolution? yes no

This part of the checklist applies when the receiver with floating blanking or reduced resolution have been chosen:

- Is the **effective** resolution of the AOPD legibly marked onto the supplementary nameplate? yes no

This part of the checklist always applies:

- Is the safety distance calculated in accordance with the valid formulas for safeguarding danger points, while taking the effective resolution and the response time of the AOPD, the response time of a possibly used safety interface and the stopping time of the machine into consideration, and has this minimum distance between the protective field and danger point been observed? yes no
- Is access to the danger point only possible through the protective field of the AOPD and are other possible accesses protected by suitable safety components? yes no
- Is the protective field effective at each position and checked in accordance with Chapter 10.3? yes no
- Is reaching-over, reaching-under or reaching-around the protective field effectively prevented, e.g. by mechanical measures (welded or screwed)? yes no
- Is the external condition of the protective device and the control devices in good condition with no faults? yes no
- Are transmitter and receiver fixed against displacement/turning after the alignment? yes no
- Is unprotected presence between the protective field and danger point safely excluded with a maximum distance of 75 mm between protective field and machine table, e.g. through fixed mechanical measures or through the control of monitored mechanical components or cascading of the COMPACTplus? yes no
- Are all connectors and connection cables in fault-free conditions? yes no
- Is the start/restart button for resetting the AOPD positioned outside the danger zone in line with specifications and at a position from which the entire danger point is fully visible? yes no
- Are the safety outputs (OSSDs), linked into the downstream machine control in accordance with the required safety category? yes no
- Are the subsequent circuit elements controlled by the AOPD monitored by the feedback circuit (EDM), e.g. contactors with positive-guided contacts or safety valves? yes no
- Does the actual integration of the AOPD into the machine control unit match the circuit diagrams? yes no
- Is the AOPD effective during the entire dangerous movement of the machine? yes no
- Is a possibly connected Section Emergency STOP button effective and after its resetting, is pressing and releasing of the start/restart button required to start the machine again? yes no
- Is a possibly connected Safety Door Switch effective and after its resetting is, pressing and releasing of the start/restart button required to start the machine again? yes no

- Is the dangerous movement stopped immediately if the power supply voltage of the AOPD is interrupted and is the start/restart button required to start the machine again after power returns? yes no
- Is the plate with information about the daily check of the AOPD provided so that it can be seen easily by operating personnel? yes no

13.3.2 Checklist for safeguarding danger areas

Safety Light Curtain (effective resolution 40 to 116 mm), approaching direction parallel to the protective field

ⓘ This checklist represents a help tool. It supports but does not serve for the inspection before the initial operation or the regular inspections by an expert.

Comment:

The fixed and floating blanking functions may not be applied for applications with parallel approach. Introduced and blanked out objects can form bridges in the protective field from which the necessary safety distance to the danger area would not be sufficient!

This part of the checklist applies when the receiver with reduced resolution is chosen:

- Is the **effective** resolution of the AOPD legibly marked onto the supplementary nameplate? yes no

This part of the checklist always applies:

- The minimum height of the protective field above the reference plane relates to the resolution of the AOPD. Was the effektive resolution used during the calculation of the minimum height and is this height not fallen below? yes no
- Is the safety distance calculated in accordance with the valid formulas for safeguarding danger areas and is this minimum distance between the most distant beam and the danger point observed? yes no
- During risk assessment, has it been considered that only protective field heights less than 300 mm above the floor are regarded as low enough not to be crawled under (EN 999)? yes no
- Is the access to the danger point only possible through the protective field of the AOPD and are other access possibilities especially from the sides protected by suitable hard guards or other means? yes no
- Is the external condition of the protective device and the control devices in good condition with no faults? yes no
- Are transmitter and receiver fixed against displacement/turning after the alignment? yes no
- Is unprotected presence between the next beam and the danger point definitively excluded? yes no
- Are all connectors and connection cables in fault-free conditions? yes no
- Is the start/restart button for resetting the AOPD positioned outside the danger zone in line with specifications and at a position from which the entire danger point is fully visible? yes no

- Are the safety outputs (OSSDs), linked into the downstream machine control in accordance with the required safety category? yes no
- Are the downstream circuit elements controlled by the AOPD, e.g. contactors with positive-guided contacts or safety valves, monitored by the feedback circuit (EDM)? yes no
- Does the actual integration of the AOPD into the machine control unit match the circuit diagrams? yes no
- Is the AOPD effective during the entire dangerous movement of the machine? yes no
- Is a possibly connected Section Emergency STOP button effective and after its resetting, is pressing and releasing of the start/restart button required to start the machine again? yes no
- Is a possibly connected Safety Door Switch effective and after its resetting is pressing and releasing of the start/restart button required to start the machine again? yes no
- Is the dangerous movement stopped immediately if the power supply voltage of the AOPD is interrupted and is the start/restart button required to start the machine again after power returns? yes no

13.4 Declaration of Conformity

Leuze electronic GmbH + Co. KG
In der Braike 1
73277 Owen - Teck / German

The signatory declares that the safety components of series **COMPACT*plus*** in the form in which they are marketed by us conform with the relevant, basic safety and health requirements of the EC directives*, and that the standards* were used in their design and construction.

Owen, 31.01.09

Dr. Harald Grübel
General Manager

* You can also download this EC Declaration of Conformity from the Internet under: http://www.leuze.com/compactplus