Leuze electronic

the sensor people

COMPACT

Safety Light Curtains and Multiple Light Beam Safety Devices

600997 - 2010/08
Subject to change
without prior notice

CONNECTING AND OPERATING INSTRUCTIONS

Original instructions

Notes on the Connecting and Operating Instructions

This connecting and operating instructions manual contains information on the proper use of COMPACT Safety Light Curtains and Multiple Light Beam Safety Devices in accordance with their intended purpose. It is included with delivery.

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

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

Notes regarding safety and warnings are identified with this symbol  .

Notes regarding important pieces of information are identified with the  symbol.

References to the safety of laser devices are identified with the  symbol.

This connecting and operating instructions manual is applicable from device version number P22 and later. The documentation with article number 600980 is applicable for all COMPACT Safety Light Curtains and Multiple Light Beam Safety Devices with an earlier version number.

Leuze electronic GmbH + Co. KG is not liable for damage resulting from improper use of its equipment. Familiarity with these connecting and operating instructions is an element of the knowledge required for proper use.

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1 General

COMPACT Safety Light Curtains and Multiple Light Beam Safety Devices are type 4 Active Opto-electronic Protective Devices (AOPD) in accordance with EN/IEC 61496-1 and prEN/IEC 61496-2.

All versions have start/restart interlock that can be selected and deselected, plus the contactor monitoring function, LED and 7-segment displays for system status diagnostics and a number of additional functions.

The devices are delivered as standard with transistor outputs and cable glands (PG). The system can also be optionally supplied with industrial standard plug connections (Hirschmann, MIN-style, M12) or with AS interface bus connection. An integrated laser alignment aid for multiple light beam safety devices is also optional. A protective screen against spray water is available as an accessory.

1.1 Certifications

Company

Leuze electronic GmbH + Co. KG in D-73277 Owen - Teck, Germany, has a certified quality assurance system in compliance with ISO 9001.

Products

COMPACT Safety Light Curtains and Multiple Light Beam Safety Devices are developed and manufactured in compliance with applicable European directives and standards.

EC prototype test in accordance with
EN IEC 61496 Part 1 and Part 2
carried out by:
TÜV PRODUCT SERVICE GmbH, IQSE
Ridlerstrasse 65
D-80339 Munich

1.2 Symbols and terms

Symbols used:

	Warning notice. This symbol indicates possible dangers. Please pay especially close attention to these instructions!
	Notes on important information.
	Warning notes for the safety of laser devices
➢	A note, which also refers to a course of action, provides information about special attributes or describes set-up procedures.
⇒	Signal output
⇐	Signal input
⇔	Signal input and/or signal output
Symbols for COMPACT transmitters	
	General transmitter symbol
 a b	a) Transmitter not active b) Transmitter active
Symbols for COMPACT receivers	
	General receiver symbol
 a b c d	a) Active protective field not free, outputs in OFF state b) Active protective field free, outputs in ON state c) Active protective field not free, outputs still in ON state d) Active protective field free, outputs in OFF state
Symbols for COMPACT transceivers	
	General transceiver symbol

Table 1.2-1: Symbols

Terms used:

Access guarding	Requires person detection with entry into the danger area
AOPD	**A**ctive **O**pto-electronic **P**rotective **D**evice
AOPD	Active Opto-electronic Protective Device
AOPD response time	Time between penetration/entry into 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.
C	COMPACT consisting of transmitter and receiver
Contactor Monitoring (EDM)	The contactor monitoring monitors the break contacts of downstream positive-guided contactors and relays
CR	COMPACT Receiver
CRT	COMPACT Transceiver
CT	COMPACT Transmitter
Danger area guarding	Requires detection in the foot/leg area
Danger point guarding	Requires finger, hand or arm detection
DoubleScan (d-scan)	Multiple scanning: safety outputs turn off after a beam has been interrupted in two consecutive scans. DoubleScan affects the response time!
EDM	External Device Monitoring (contactor monitoring)
OSSD1 OSSD2	Safety-related switching output **O**utput **S**ignal **S**witching **D**evice
Perimeter guarding	Requires person detection with entry into the danger area
RES	Start/**RES**tart interlock
Scan	All beams, beginning with the synchronization beam, are pulsed by the transmitter sequentially.
SingleScan	If a beam is interrupted in the first scan of the light curtain or multiple light beam safety device, safety outputs turn off
Start/restart function (RES)	RES prevents automatic start after the supply voltage has been turned on and after the protective field has been penetrated/entered.

Table 1.2-2: COMPACT Safety Light Curtain and Multiple Light Beam Safety Device terms/terminology

1.3 COMPACT Selection

1.3.1 Selecting safety light curtains, basic model/host

	Code	Meaning	
	C	**COMPACT**	
	t	**Type of device**	
	T	Transmitter	
	R	Receiver	
	rr	**Resolution**	**Range**
		14 mm	0-6 m
		30 mm	0-18 m
		50 mm	0-18 m
		90 mm	0-18 m
	hhhh	**Protective field heights**	
		In basic model: 150 ... 1,800 mm (for 14 mm resolution) 150 ... 1,800 mm (for 30 mm resolution) 450 ... 3,000 mm (for 50 mm resolution) 750 ... 3,000 mm (for 90 mm resolution)	
	k	**Cascading option***	
	M	Host (from protective field height: 225 mm)	
	ccc	**Machine interface/ connection system**	
	---	Transistor output, cable gland	
	/G, /W	Transistor output option, Hirschmann plug	
	/G	= incl. straight cable socket;	
	/W	= incl. angled cable socket;	
	/GW	= without cable socket	
	/BH	Transistor output option, MIN-style plug 5-pin transmitter 7-pin receiver	
	/BH3	3-pin transmitter	
	/BH5	5-pin receiver	
	/A	AS-i Safety at Work option	
	/M12	M12 plug option	
C **t** **rr-** **hhhh** **k** **ccc**		*) If no options are taken this point is not included in the product description	

1.3.2 Selecting safety light curtains, guests

	Code	Meaning	
	C	**COMPACT**	
	t	**Type of device**	
	T	Transmitter	
	R	Receiver	
	rr	**Resolution**	**Range**
		14 mm	0-6 m
		30 mm	0-18 m
		50 mm	0-18 m
		90 mm	0-18 m
	hhhh	**Protective field heights**	
		In basic model: 150 ... 1,800 mm (for 14 mm resolution) 150 ... 1,800 mm (for 30 mm resolution) 450 ... 3,000 mm (for 50 mm resolution) 750 ... 3,000 mm (for 90 mm resolution)	
	kk	**Cascading**	
	S	Guest	

C **t** **rr-** **hhhh** **kk**

1.3.3 Selecting multiple light beam safety devices

	Code	Meaning	
	C	**COMPACT**	
	t	**Type of device**	
	T	Transmitter	
	R	Receiver	
	bbd	**Beam distance**	**Range**
	500	500 mm	0-18 m
	400	400 mm	0-18 m
	300	300 mm	0-18 m
	501	500 mm	6-70 m
	401	400 mm	6-70 m
	301	300 mm	6-70 m
	o	**Optics option**	
	L	Integrated laser alignment aid**	
	n	**Number of beams**	
		2; 3; 4;	
	ccc	**Machine interface/ connection system**	
	---	Transistor output, cable gland	
	/G, /W	Transistor output option, Hirschmann plug	
	/G	= incl. straight cable socket;	
	/W	= incl. angled cable socket;	
	/GW	= without cable socket	
	/BH	Transistor output option, MIN-style plug 5-pin transmitter 7-pin receiver	
	/BH3	3-pin transmitter	
	/BH5	5-pin receiver	
	/A	AS-i Safety at Work option	
	/M12	M12 plug option	
C **t** **bbd** **o** **/n** **ccc**		*) If no options are taken this point is not included in the product description **) As COMPACT/L C401L/3 or C501L/2	

1.3.4 Selecting transceivers

	Code	Meaning	
C	**C**	**COMPACT**	
RT	**RT**	**Transceiver**	
bbd	**bbd**	**Beam distance**	**Range**
	500	500 mm	0-6.5 m
	600	600 mm	0-6.5 m
/n	**n**	**Number of beams**	
		2 (1 beam folded)	
ccc	**ccc**	**Machine interface/ connection system**	
	---	Transistor output, cable gland	
	/G, /W	Transistor output option, Hirschmann plug	
	/G	= incl. straight cable socket;	
	/W	= incl. angled cable socket;	
	/GW	= without cable sockets	
	/BH	Transistor output option, MIN-style plug 5-pin transmitter 7-pin receiver	
	/BH3	3-pin transmitter	
	/BH5	5-pin receiver	
	/A	AS-i Safety at Work option	
	/M12	M12 plug option	

C **RT** **bbd** **/n** **ccc**

1.3.5 Examples

COMPACT Safety Light Curtain in basic model without options

CT14-1500		CR14-1500	
COMPACT Safety Light Curtain		COMPACT Safety Light Curtain	
Type of device:	Transmitter	Type of device:	Receiver
Resolution:	14 mm	Resolution:	14 mm
Range:	6 m	Range:	6 m
Protective field height:	1,500 mm	Protective field height:	1,500 mm
Design type:	Basic model	Design type:	Basic model
		Safety-related switching outputs (OSSDs):	2 transistor outputs
Connection system:	Cable gland	Connection system:	Cable gland

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

COMPACT Safety Light Curtain in host/guest combination with options

CT30-1200M/W		CR30-1200M/W	
COMPACT Safety Light Curtain		COMPACT Safety Light Curtain	
Type of device:	Transmitter	Type of device:	Receiver
Resolution:	30 mm	Resolution:	30 mm
Range:	18 m	Range:	18 m
Protective field height	1,200 mm	Protective field height:	1,200 mm
Design type:	Host	Design type:	Host
		Safety-related switching outputs (OSSDs):	2 transistor outputs
Connection system option:	Hirschmann plug with angled cable socket	Connection system option:	Hirschmann plug with angled cable socket

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

CT50-750S		CR5-750S	
COMPACT Safety Light Curtain		COMPACT Safety Light Curtain	
Type of device:	Transmitter	Type of device:	Receiver
Resolution:	50 mm	Resolution:	50 mm
Range:	18 m	Range:	18 m
Protective field height	750 mm	Protective field height:	750 mm
Design type:	Guest with 250 mm connection cable	Design type:	Guest with 250 mm connection cable

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

COMPACT Multiple Light Beam Safety Device in basis model

CT300/4		CR300/4	
COMPACT Multiple Light Beam Safety Device		COMPACT Multiple Light Beam Safety Device	
Type of device:	Transmitter	Type of device:	Receiver
Beam distance:	300 mm	Beam distance:	300 mm
Range:	18 m	Range:	18 m
Number of beams:	4	Number of beams:	4
		Safety-related switching outputs (OSSDs):	2 transistor outputs
Connection system:	Cable gland	Connection system:	Cable gland

Table 1.3-3: Example 3, multiple light beam safety device selection

COMPACT/*L* Multiple Light Beam Safety Device with options - integrated laser alignment aid and AS-i connection

CT501L/2/A		**CR501L/2/A**	
COMPACT Multiple Light Beam Safety Device		COMPACT Multiple Light Beam Safety Device	
Type of device:	Transmitter	Type of device:	Receiver
Beam distance:	500 mm	Beam distance:	500 mm
Range:	70 m	Range:	70 m
Number of beams:	2	Number of beams:	2
Optics option:	Integrated laser alignment aid	Optics option:	Integrated laser alignment aid
		Safety-related switching output (OSSD):	AS-i Safety at Work
Connection system option:	M12, 3-pin	Connection system option:	M12, 3-pin

Table 1.3-4: Example 4, multiple light beam safety device selection

COMPACT Transceiver

CRT-500/2/M12	
COMPACT Transceiver	
Beam distance:	500 mm
Range:	0 – 6.5 m
Number of beams:	2 (1 beam folded)
Safety-related switching output (OSSD):	2 transistor outputs
Connection system:	M12, 8-pin

Table 1.3-5: Example 5, Transceiver selection

Note!

In addition to the beam distances and numbers of beams named, multiple light beam devices with beam distances of 75 mm and 150 mm can also be supplied on request.

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 Safety Light Curtains and Multiple Light Beam Safety Devices" 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 Safety Light Curtain / Multiple Light Beam Safety Device.

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 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) 2, 3 and 4 beam 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	 $6.60 \times 10^{-9}\ 1/h$ $7.30 \times 10^{-9}\ 1/h$ $8.30 \times 10^{-9}\ 1/h$ $9.50 \times 10^{-9}\ 1/h$
Service life (T_M)	20 years

Table 2.1-1: Safety-related characteristic parameters of the COMPACT Safety Light Curtain / Multiple Light Beam Safety Device

- The safety sensor protects persons at access points or at points of operation of machines and plants.
- The safety sensor as light curtain with vertical mounting detects the penetration by fingers and hands at points of operation or by the body at access points.
- The safety sensor as Multiple Light Beam Device 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 as light curtain 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 Using the laser alignment aid

The optional internal laser alignment aid is available for transmitter-receiver systems.

Warning

The laser light source corresponds to laser class 2 according to EN 60825-1. Extended looking into the beam path may damage the eye's retina.
Never look directly into the laser beam or into the direction of reflected beams.

Warning

Adjustment work with lasers must be carried out by competent and instructed persons only.

Laser alignment aids must only be switched on for the purpose of alignment or testing the alignment of transmitters, receivers and Deflecting Mirror Columns.

- Do not switch on the laser if persons are present in the laser path.
- Inform persons in the vicinity before embarking on alignment work with lasers.
- After switch-on the laser lights up for about 10 minutes. Do not leave the installation location during this time.
- Interrupt the laser beam using a non-transparent, non-reflective object if the laser beam has inadvertently been pointed at a human.
- Note the current legal and local laser protection regulations according to EN 60825-1.

Laser warning sign

There are laser warning signs near each laser beam egress point (see fig. 2.2-1).

Figure 2.2-1: Laser warning sign

2.3 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

2.4 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 company operating 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

2.5 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

2.6 COMPACT Safety Light Curtains, resolutions 14 mm and 30 mm

are used for guarding **danger points**, preferably in a vertical position. Depending on the resolution selected, they can detect fingers or hands.

Type of device	Resolution	Detection at maximum resolution for persons age 14 and over	Range	Preferred area of application
CT14-.../CR14-...	14 mm	Finger	0 to 6 m	Danger point guarding
CT30-.../CR30-...	30 mm	Hand/arm	0 to 18 m	Danger point guarding

Table 2.6-1: COMPACT Safety Light Curtains for **danger point** guarding

2.7 COMPACT Safety Light Curtains, resolutions 50 mm and 90 mm

are preferably used for safeguarding **danger** areas. Primarily in a horizontal position, the presence of people within the protective field is continuously monitored (see, fig. 3.2-1).

Type of device	Physical resolution	Detection at maximum resolution for persons age 14 and over	Range	Preferred area of application
CT50-.../CR50-...	50 mm	From the foot upwards	0 to 18 m	Danger area guarding
CT90-.../CR90-...	90 mm	From the thigh upwards	0 to 18 m	Danger area guarding

Table 2.7-1: COMPACT Safety Light Curtains for danger area guarding

Safety light curtains with > 40 mm resolution are not suitable for danger point guarding for which finger, hand or arm resolution is required. The correct choice for this are COMPACT safety light curtains with 14 mm or 30 mm resolution.

2.8 COMPACT Multiple Light Beam Safety Devices

are used in a vertical position, preferably for access guarding or perimeter guarding of danger areas. They only detect a person's body during the access. When one or more beams are interrupted by a person, the machine control unit must go into safe interlock (see, fig. 3.2-3).

The start/restart interlock function is therefore obligatory for access or perimeter guarding! The start/restart button for unlocking the device must be mounted outside the danger area in such a way that it cannot be reached from inside the danger area and the entire danger area is fully visible from its installation position.

Type of device	Number of beams	Detection	Range	Preferred area of application
CT300/4-/CR300/4-	4	People	0 to 18 m*	Access and perimeter guarding
CT400/3-/CR400/3-	3	People	0 to 18 m*	Access and perimeter guarding
CT500/2-/CR500/2-	2	People	0 to 18 m*	Access and perimeter guarding

* The maximum range is reduced with each deflection by 15 %

Table 2.8-1: COMPACT Multiple Light Beam Safety Devices as access and perimeter guarding, range up to 18 m

Type of device	Number of beams	Detection	Range	Area of application
CT301/4-/ CR301/4-	4	People	6 to 70 m*	Access and perimeter guarding
CT401(L)/3-/ CR401(L)/3-	3	People	6 to 70 m*	Access and perimeter guarding
CT501(L)/2-/ CR501(L)/2-	2	People	6 to 70 m*	Access and perimeter guarding

* The maximum range is reduced with each deflection by 15 %

Table 2.8-2: COMPACT Multiple Light Beam Safety Devices as access and perimeter guarding, range up to 70 m

Type of device	Number of beams	Detection	Range	Area of application
CRT500/2	2	People	0 to 6.5 m	Access guarding
CRT600/2	2	People	0 to 6.5 m	Access guarding

Table 2.8-3: COMPACT Transceiver access and perimeter guarding

Multiple light beam safety devices are designed for detecting people during the access to danger areas. They are also not suitable for guarding danger points where finger, hand or arm detection is required. The correct choice for this are COMPACT safety light curtains with 14 mm or 30 mm resolution.

They are also not suitable for danger area guarding where the presence of people in the area between the protective device and the danger point must be continuously monitored. The correct choice for this are COMPACT safety light curtains with a resolution of 50 mm or 90 mm, or if safety category 3 in accordance with ISO 13849 is sufficient for the application, ROTOSCAN scanners (information on ROTOSCAN is available from Leuze sales offices and partners or at www.leuze.de).

2.9 COMPACT/*L* Multiple Light Beam Safety Devices: Additional safety instructions for the integrated laser alignment aid

Warning!

The laser light source corresponds with laser class 2. Never look directly into the laser beam. This can damage your eye.

Alignment work may only be performed by commissioned, qualified personnel.

Alignment lasers may only be switched on for aligning or checking the alignment of transmitters, receivers or deflecting mirror columns.

Do not switch on the laser if a person is in the laser path. Inform people that are nearby before you begin alignment work with lasers.

After switching on the laser lights for approx. 14 minutes. Do not leave the installation position during this time

Interrupt the light beam with an opaque, non-reflective object if the laser beam has been unintentionally directed at a person.

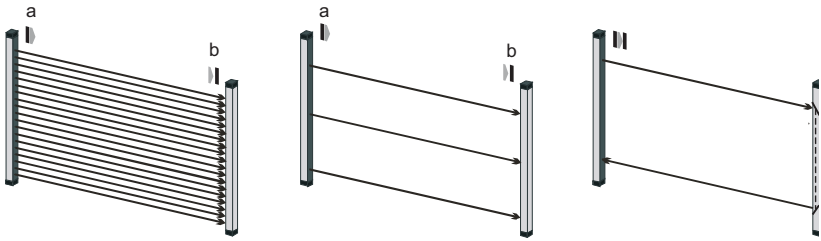
NEVER look directly into the laser beam or in the direction of reflected beams.

3 System design and possible uses

3.1 The opto-electronic protective device

Mode of operation

COMPACT consists of a CT transmitter and a CR receiver. Beginning with the first beam (the synchronizing beam) directly after the display panel, the transmitter pulses beam for beam in rapid sequence. The synchronization between transmitter and receiver is performed optically. COMPACT transceivers consist of a transmitter/receiver combination and a passive deflecting mirror.



a = Transmitter
b = Receiver

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

The CR 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 safety 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, before the receiver switches the OSSDs off. This is referred to as the DoubleScan mode and it influences the receiver's response time. If DoubleScan mode is active, the receiver switches to the OFF state as soon as one and the same beam has been interrupted during two consecutive scans (H=2).

The following scan factors "H" apply in the factory setting (FS):

- Light curtains (8…240 beams): H = 1
- Multiple light beam safety devices (2, 3 or 4 beams): H = 1

Warning!

DoubleScan 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 COMPACT receiver with devices from version P22 upwards so that there is generally no need for a downstream safety interface.

3.2 Application examples

3.2.1 Danger point guarding: COMPACT with 14 mm or 30 mm resolution

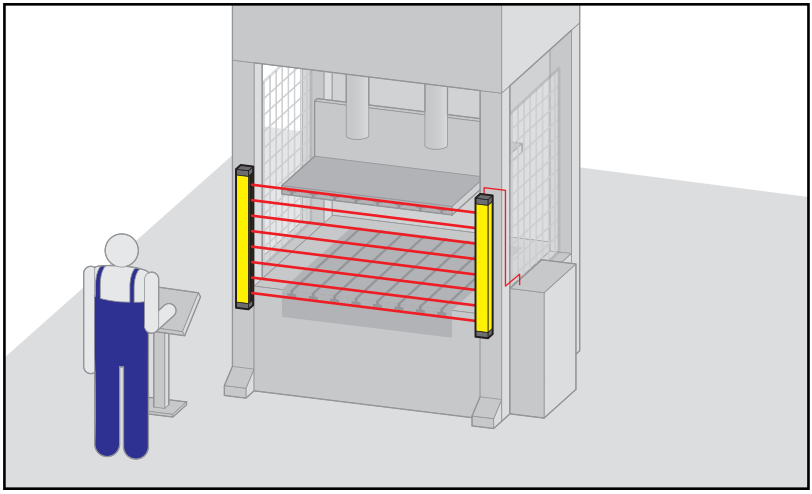


Fig. 3.2-1: COMPACT Safety Light Curtain – Application for a press

3.2.2 Danger area guarding: COMPACT with 50 mm resolution

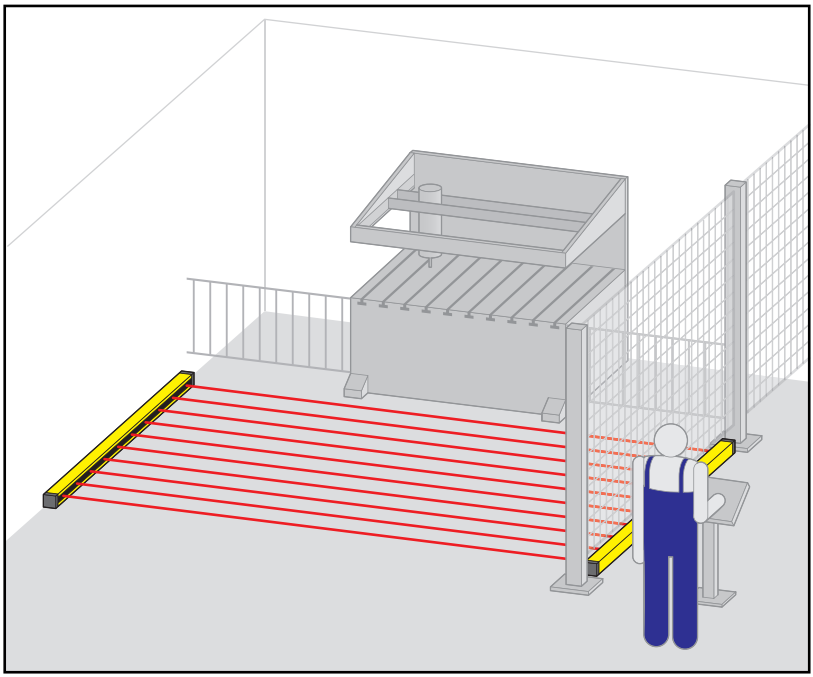


Fig. 3.2-2: COMPACT Safety Light Curtain – Application for a routing machine

3.2.3 Access guarding COMPACT with 2, 3 or 4 beams

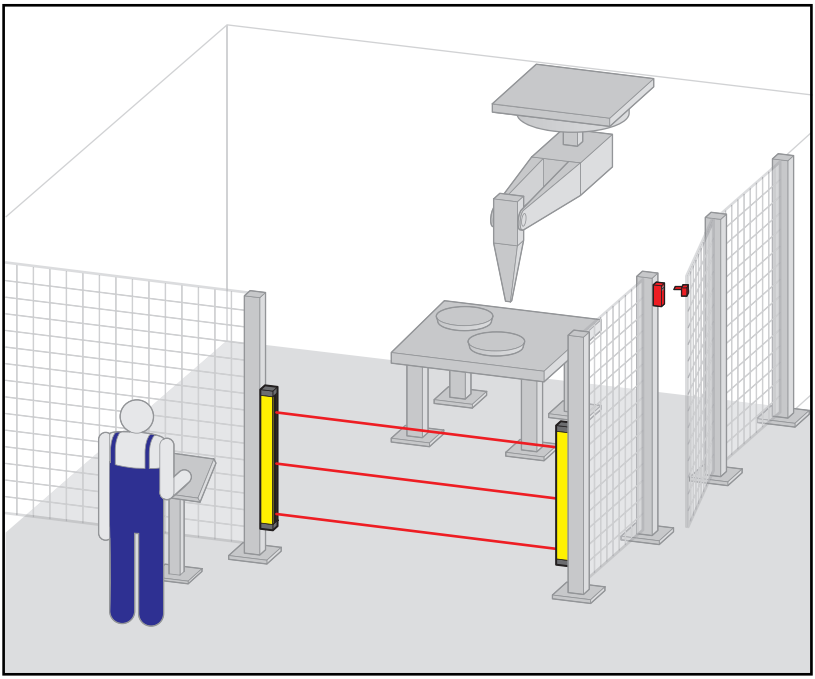


Fig. 3.2-3: COMPACT multiple light beam safety device guarding an access

3.2.4 Perimeter guarding: COMPACT with 2, 3 or 4 beams

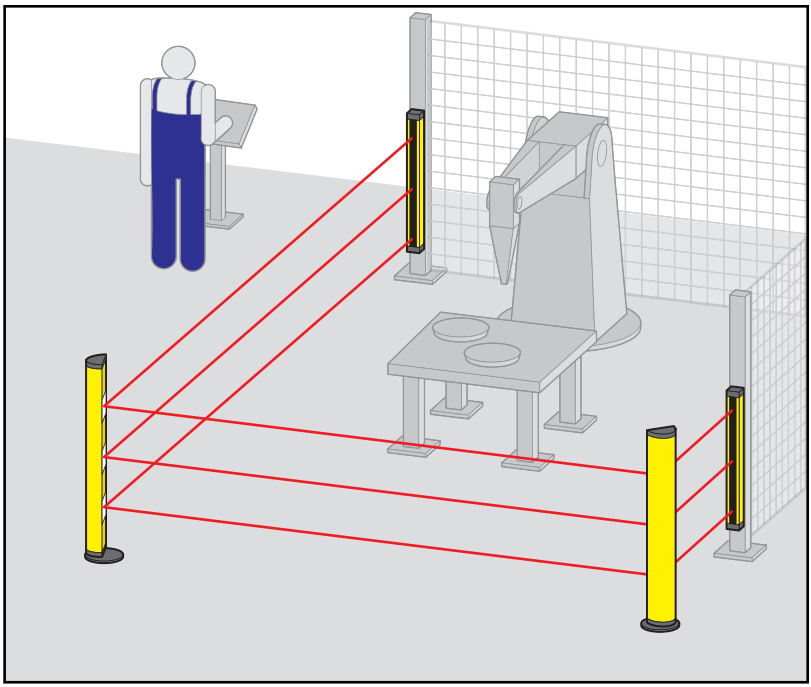


Fig. 3.2-4: COMPACT multiple light beam safety device with two deflecting mirror columns

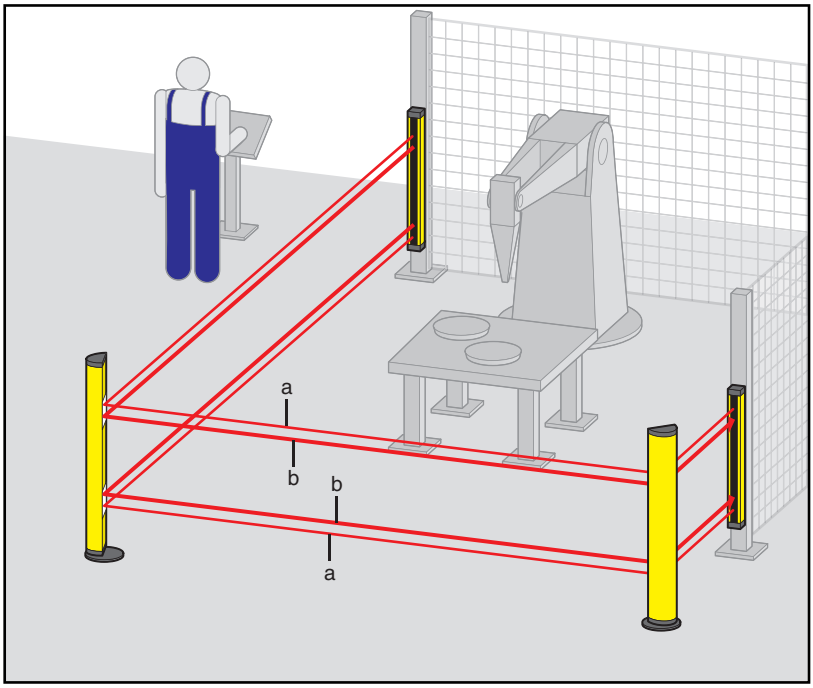
3.3 Optics option

The following option can also be selected as an alternative

- Option L: Integrated laser alignment aid

3.3.1 Option L, integrated laser alignment aid

2 and 3-beam COMPACT multiple light beam safety devices with 6 to 70 m range are offered with an optional integrated laser alignment aid. The transmitter has an integrated laser light source per beam, which can be switched on with the MagnetKey, briefly set to the laser symbol directly beside the laser light exit. The laser beam simplifies the alignment of the individual mirrors of the deflecting mirror columns with multiple-side protection.



a = Invisible infrared beams
b = Visible laser beams as integrated alignment aids for deflecting mirrors

Fig. 3.3-1: COMPACT/L C501L/2 with two swiveling mounting brackets, BT-SSD-270 and two deflecting mirror columns, UMC-1002

You will find detailed alignment instructions (alignment procedure description) of the COMPACT/L system in conjunction with the UMC deflecting mirror columns in the appendix, Chapter 13.3.4.

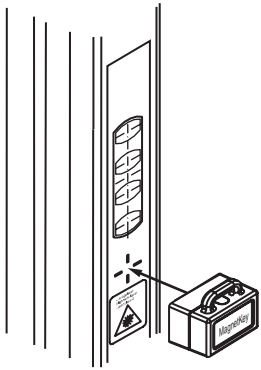


Fig. 3.3-2: Setting the MagnetKey on the COMPACT transmitter with integrated laser alignment aid

Warning!

Please take not of the safety notes in Chapter 2, especially the safety notes and proper use of the laser alignment aid.

3.3.1.1 Ranges depend on the number of deflections

With each beam deflection (via deflecting mirror columns) the maximum range of 70 m, which is specified for an arrangement without deflections, is reduced:

Number of deflections		1	2	3	4	5	6
Maximum range [m]		55	48	42	37	32	28

Table 3.3-1: Ranges depend on the number of deflections

Note!

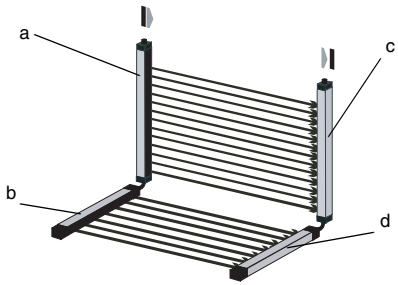
The maximum range between transmitter and 1st deflecting mirror column is 7 m.

Warning!

For project planning the system please observe the information on minimum distances to reflective surfaces with the use of deflecting mirror columns in Chapter 6.1.5.1.

3.4 Cascading option

To implement multiple linked protective fields, COMPACT light curtains can be cascaded one after the other via plug-in cable connections. This allows devices with different resolutions to be combined with each other.



a = CT transmitter, host (M)
b = CT transmitter, guest (S)
c = CR receiver, host (M)
d = CR receiver, guest (S)

Fig. 3.4-1: 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 225mm.
- 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 connection 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.

Warning!

The safety distance must be calculated in accordance with the set resolution and the response time of the entire system (see, Chapter 6).

3.5 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.

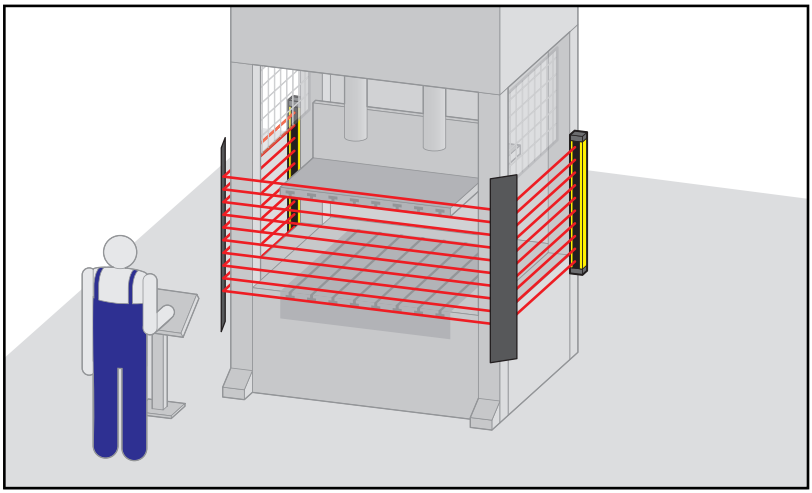


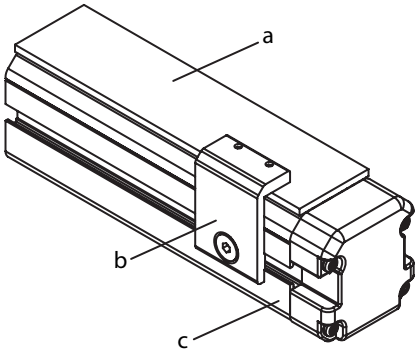
Fig. 3.5-1: Example: Multiple-side protection of a danger point using deflection mirrors.

3.6 UDC mounting columns and UMC deflecting mirror columns as accessories

Mounting columns with self-resetting function for floor mounting are available for the devices of the COMPACT series. In the same construciton form deflecting mirrors can also be used for both the COMPACT light curtains and for the COMPACT multiple light beam safety devices. Additionally there are also variants for COMPACT/L, which are already pre-installed in the UDC device column (see, Chapter 13.1.9).

3.7 Protective screens against welding sparks

If COMPACT is to be used in places exposed to welding sparks, we recommend ordering transmitters and receivers with an additional protective screen to protect against welding sparks. The additional protective screen can also be easily exchanged after heavy stresses and demanding work. Depending on the device length, the protective screen is fixed with two or three brackets to the COMPACT safety light curtain or the COMPACT multiple light beam safety device. With setting up protective screens the range is reduced by approx. 10 % per screen (see, Chapter 13.1.3).



a = Protective screen, PS-C-CP
b = Screen clamp, AC-PS-MB-C-CP
c = COMPACT safety light curtain or multiple light beam safety device

Fig. 3.7-1: COMPACT with protective screen

4 Functions

4.1 Parameterizable functions of the CT transmitter

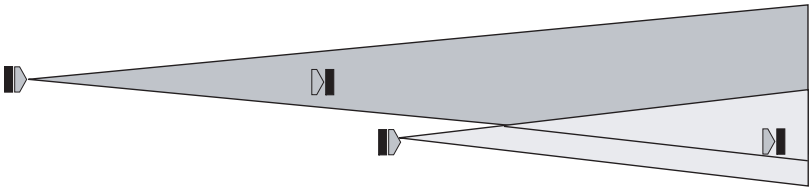
4.1.1 Transmission channel

The infrared beams are modulated with specially shaped pulse bundles so that they are distinct from ambient light and undisturbed operation is consequently ensured. Welding sparks or warning flash lights from passing forklifts 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 safety 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 safety devices from transmission channel 1 to 2, thereby switching them to differently formed pulse bundles. This solution should be considered when more than two optical safety systems must be 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 functions of the CR receiver

Additional functions have been integrated into the COMPACT receiver from version P22. These are start/restart interlock, contactor monitoring and the possible changing of the restart time. The activation of these functions is described in Chapter 7.

4.2.1 Transmission channel

When delivered, both the receiver and the transmitter are set to transmission channel 1. If the corresponding transmitter is switched to transmission channel 2, the receiver must also be set to transmission channel 2. For this, see also Chapter 8.

4.2.2 Start/restart interlock (RES)

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. Only by pressing and releasing the start button within a time window is the receiver switched to the ON-state.

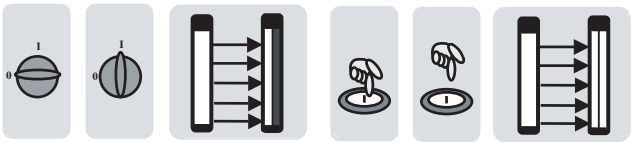


Fig. 4.2-1: Start/restart interlock function in effect when the supply voltage is turned on

If the protective field is penetrated, the start/restart interlock function ensures that the receiver will stay in the OFF state after the protective field is released again. The receiver will then not be switched back to the ON state until the start button is pressed and released again within a time window of 0.3 to 4 seconds.

Note!

The start button may not be pressed for longer than 10 seconds. An error message appears if this is exceeded.

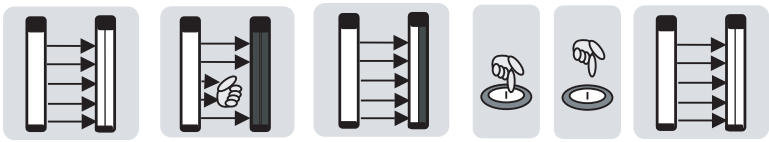


Fig. 4.2-2: Start/restart interlock function after interrupting the protective field

Warning!

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 IEC 12100-1 and EN IEC 12100-2. It must in particular be ensured here that it is impossible to walk or slip through the protective field.

In case of access guarding applications, the start/restart interlock function is obligatory due to the fact that only access, but not the area between the protective field and the danger points is monitored.

Warning!

Before unlocking the start/restart interlock, the operator must be absolutely certain that nobody is inside the danger zone.

Activate the start/restart interlock

With the corresponding wiring and parametering of the COMPACT receiver (see, Chapter 8.3.5)

- ➢ or in the downstream safety interface (e.g. MSI series for Leuze electronic muting or control functions)
- ➢ 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 8.3.5 the interlock functions are monitored dynamically. The SD4R-E receiver is only switched back to the ON-state after the start button has been pressed and released again. A further precondition here is, of course, that the active protective field is free.

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

4.2.3 Contactor monitoring (EDM)

The COMPACT contactor monitoring can be activated with the corresponding wiring and parametering (see, Chapter 8.3.4)!

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

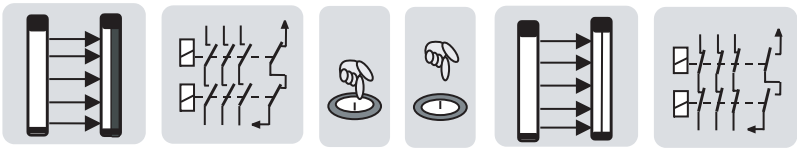


Fig. 4.2-3: Contact monitoring function, combined in this example with a start/restart interlock

You can implement the contactor monitoring function,

- ➢ with the corresponding wiring and parametering of the COMPACT receiver (see, Chapter 8.3.4)
- ➢ or the external contactor monitoring of the downstream safety interface, (e.g. Leuze electronic MSI series)
- ➢ or the contactor monitoring of the downstream safety PLC (optionally connected via a safety bus).

If the internal contactor monitoring is activated (see Chapter 8.3.4), it works dynamically, i.e. the system also checks whether the feedback circuit has opened within 500 ms of being enabled and whether it has closed again within 500 ms after turning off the OSSDs. 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 (F34) and the receiver goes to the error locking status, from which it can only be returned to normal operation by switching the supply voltage off and back on again.

4.2.4 Extended restart delay time

The restart delay time is the minimum period between switching off the OSSDs and their restarting. The default time for restarting with COMPACT safety light curtains and COMPACT multiple light beam safety devices is 100ms. The restart delay time can be extended by parametering to 500 ms (see, Chapter 8.3.1).

4.2.5 DoubleScan

The receiver provides an option for increasing the availability with difficult environmental conditions. It doesn't switch off immediately after a beam interruption, but rather waits to see if the interruption is still present in the next scan, before the receiver switches the OSSDs off. If DoubleScan is active, the receiver switches to the OFF state as soon as the same beam is interrupted in two consecutive scans.

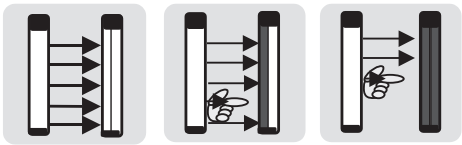


Fig. 4.2-4: Example: DoubleScan, scan factor H = 2

Warning!

The change to DoubleScan mode is described in Chapter 8. It results in an extension of the response time. The values are shown in the tables in Chapter 12. The safety distance to the danger point must be recalculated in accordance with Chapter 6.1!

4.3 Diagnostics function: Dirt and error signal output

For diagnostic purposes COMPACT has a short circuit-proof "Weak Beam/Error Indication" signal output for forwarding to the machine control unit. Information on connection of the signal output and connection examples can be found in Chapter 7.2.2, Chapter 7.3.2 and Chapter 7.4.2.

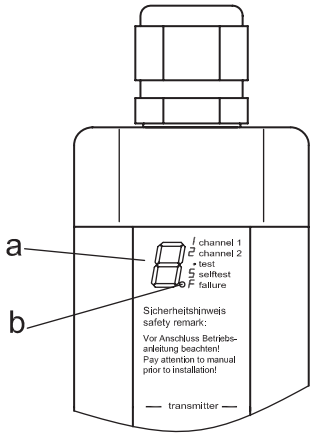
4.4 Test input

As a type 4 AOPD, COMPACT has a constant self-monitoring function that independently detects errors in the system as well as cross and short circuits on the output cables of the machine interface. An external test signal is not required for this. To test the downstream contactors, an external control (e.g. protective combination) via activation of the test signal on the transmitter can switch off the OSSD outputs of the receiver and test the drop-out of the switching elements. The test signal time is a maximum 3 seconds. If this test function is not required, the transmitter's connecting terminals (terminal 3 and 4) are connected with a jumper. For this, see also Chapter 7.2, Chapter 7.3 and Chapter 7.4

5 Display elements

5.1 Status displays of the CT transmitter

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



a = 7-segment display
b = Test

Fig. 5.1-1: Transmitter status displays

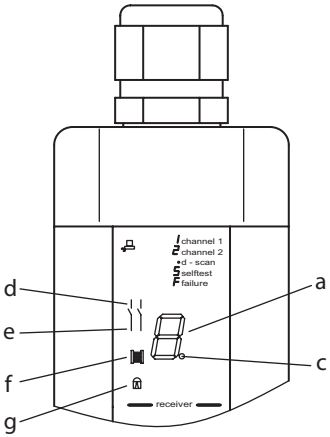
Display of the current state of the transmitter:

7-segment display	Meaning
8.	Hardware reset when turned on
S	Self test running (for approx. 1 s)
1	Normal operation, set to transmission channel 1
2	Normal operation, set to transmission channel 2
.	Dot next to the number: Transmitter display in test mode
F ⇄ x	F = Device fault x = Fault number, alternating with "F"

Table 5.1-1: Transmitter 7-segment display

5.2 Status displays of the CR receiver

Four LEDs and one 7-segment display report the receiver's operating status.



a = 7-segment display
c = DoubleScan mode display
d = LED1, red
e = LED2, green
f = LED3, orange
g = LED4, yellow

Fig. 5.2-1: CR and CR/A receiver status displays

5.2.1 7-segment displays

After the electrical supply voltage is turned on, the following data appears on the receiver's 7- segment display:

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
.	Double Scan
F x	F = Device fault x = Fault number, alternating with "F"

Table 5.2-1: CR and CR/A receiver 7-segment display

5.2.2 CR LED displays

LED	Color	Meaning		
LED1	Red	ON	=	Safety outputs (OSSDs) in the OFF state
LED2	Green	ON	=	Safety outputs (OSSDs) in the ON state
LED3	Orange	ON	=	Weak beam indication
LED4	Yellow	**Operating mode with internal RES function:**		
		ON	=	Internal restart interlock locked and protective field free
		OFF	=	Both OSSDs in OFF state (LED1=red) internal restart interlock locked and protective not field

Table 5.2-2: CR receiver LED status displays

Note!

If all LED displays are in the OFF-state at the same time, there is no supply voltage.

5.2.3 CR/A LED displays (AS-i version)

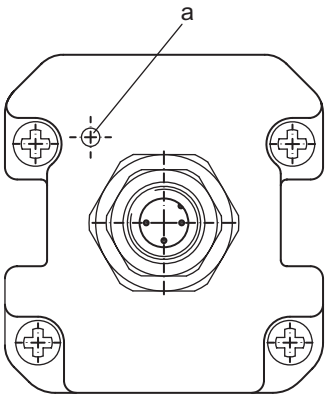
LED	Color	Meaning		
LED1	Red	RED	=	Safety outputs in the OFF state
LED2	Green	GREEN	=	Safety outputs in the ON state
LED3	Orange	ON	=	Weak beam indication

Table 5.2-3: CR/A receiver LED status displays

Note!

If all LED displays are in the OFF-state at the same time, there is no supply voltage.

An LED display is also included in the receiver interface of the CR/A (AS-i version). This LED is used for displaying the status of the COMPACT receiver on the AS-I network.



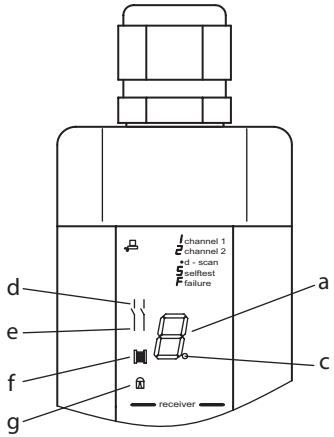
a = LED AS-i

Abb. 5.2-2: Receiver AS-i status display

LED-AS-i color	Meaning	Action
Green	Communication with the master	
Red	No communication with the master	New AS-i master setup
Red/yellow flashing	Address 0	Slave waits for an address to be assigned
Red flashing	Device fault	Send device in

5.3 CRT transceiver status displays

Four LEDs and one 7-segment display signal the transceiver's operating statuses



a = 7-segment display
c = DoubleScan mode display
d = LED1, red
e = LED2, green
f = LED3, orange
g = LED4, yellow

Fig. 5.3-1: CRT transceiver status displays

After the electrical supply voltage is turned on, the following data appear on the transceiver's 7- segment display:

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
.	Double Scan
F x	F = Device fault x = Fault number, alternating with "F"

Table 5.3-1: CRT transceiver 7-segment display

LED	Color	Meaning		
LED1	Red	RED	=	Safety outputs (OSSDs) in the OFF state
LED2	Green	GREEN	=	Safety outputs (OSSDs) in the ON state
LED3	Orange	ON	=	Weak beam indication with free protective field
LED4	Yellow	**Operating mode with internal RES function:**		
		ON	=	Internal restart interlock locked and protective field free
		OFF	=	With OSSDs in OFF state (LED1=red) internal restart interlock locked and protective not field

Table 5.3-2: CR receiver LED status displays

Note!

If all LED displays are in the OFF-state at the same time, there is no supply voltage.

6 Installation

In this chapter you will find important information on installing COMPACT, 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/ISO13855 and EN 294/ISO 13857. If COMPACT is used in countries outside of the EU, the valid requirements in those countries must also be observed.

Installation is dependent on the type of protection as described in Chapter 3.2. The situations,

- danger point guarding,
- danger area guarding,
- access and perimeter guarding,

are therefore considered separately below. The applicable distance from the protective device to reflective surfaces in the surrounding area are presented for all types of protection based on these situations.

6.1 Calculating minimum distances

Light curtains can only perform their protective function if they are mounted 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/ISO 13855, “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 following protection types:

The formula for the required distances to reflective surfaces is based on the European standard for “Active opto-electronic protective devices” pr EN IEC 61496-2.

In accordance with ISO 13855, the machine response times given in the following must contain at least an additional 10 %.

6.1.1 Safety distance for danger point guarding

Calculation of the safety distance for a COMPACT safety light curtain with a resolution of 14 mm for danger point guarding.

The safety distance “S” for guarding danger points is calculated in accordance with EN 999 with the formula:

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

S = Safety distance in mm
If the result is less than 100 mm, a distance of at least 100 mm must still be maintained.

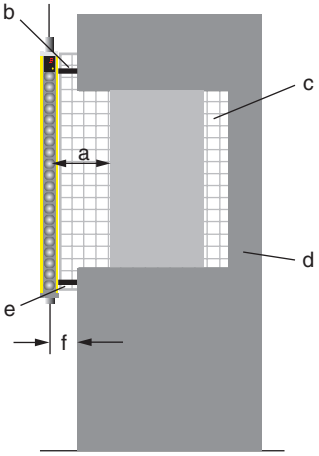
K = Approach speed in mm/s
In the close area of 500 mm, the speed is calculated at 2000 mm/s. If the distance is greater than 500 mm, K can be calculated as 1600 mm/s. In this case, however, a minimum of 500 mm applies to the safety distance.

T = Total time of the delay in seconds
Total of:
the response time of the protective device t_{AOPD} a)
the evaluation instrument, if any $t_{Evaluation\ instrument}$ b)
and the machine’s stopping $t_{Machine}$ c)

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

d = Resolution of the AOPD

a) See Chapter 12
b) See technical data of the data evaluation instrument
c) See technical data of the machine or stopping time measurement



a = Safety distance (S)
b = Measures to prevent penetration from above
c = Measures to prevent penetration from the sides
d = Measures to prevent penetration from the rear
e = Measures to prevent penetration from below
f = 75 mm – Maximum distance to avoid walking behind*

Fig. 6.1-1: Safety distance (a) for danger point guarding

*) If this value cannot be achieved because of the safety distance, other measures, e.g. mechanical barriers, must guarantee the required maximum distance of 75 mm.

Warning!

If AOPDs with additional control functions are used, the resolution must be ≤ 30 mm and the minimum distance must be S ≥ 150 mm.

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

Calculation example for danger point guarding:

A safety light curtain C14-1500 with transistor output is in direct use on a press with a 150 ms stopping time. The response time of the evaluation instrument is 20 ms.

Stopping time of the machine, $t_{Machine}$ =		150 ms.
Response time t_{AOPD}	=	33 ms.
Response time $t_{Interface}$	=	20 ms
Resolution d of the AOPD	=	14 mm
T = 0.150 + 0.033 + 0.020	=	0.203 s
S = 2000 x 0.203 + 8 x (14 -14)	=	406 mm

Warning!

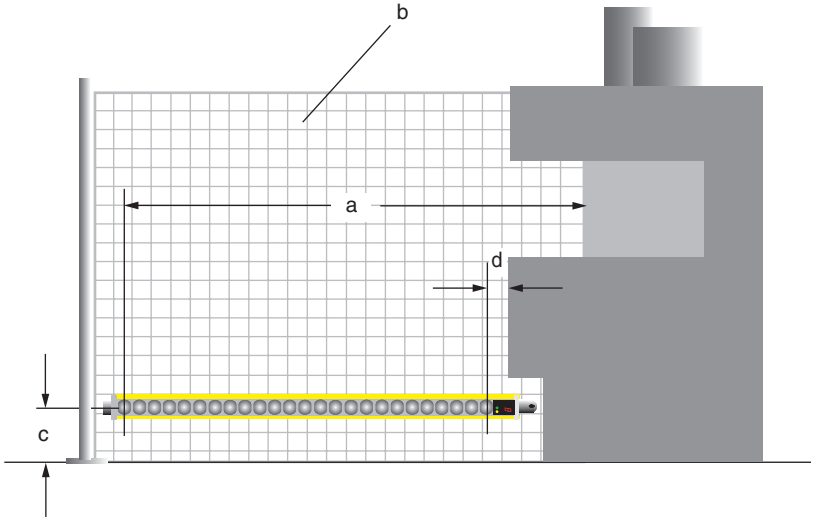
Make certain during assembly that it is not possible to reach over, around or under or to walk behind the protective device.

To prevent someone from walking behind the safety equipment, the distance between the machine table and the light curtain may only be a max. 75mm. Walking undetected behind

can be prevented, for example, by mechanical barriers or with a host/guest arrangement of the safety light curtain.

6.1.2 Safety distance for danger area guarding

Calculating the safety distance and the resolution required for a safety light curtain for danger area guarding.



a = Safety distance (S)
b = Measures to prevent access from the sides
c = Height above the floor
d = 50 mm – Maximum distance to avoid walking behind*

Fig. 6.1-2: Safety distance (a) and height (c) for danger area guarding

* If this value cannot be achieved because of the safety distance, other measures, e.g. mechanical barriers, must guarantee the required maximum distance of 50 mm. From 375 mm height above the floor 75 mm are permissible.

The height of the protective field H above the reference plane and the resolution d of the AOPD are related to each other as follows:

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

H_{min} = minimum height of the protective field above the reference plane, maximum height = 1000 mm
Heights equal to or less than 300 mm are considered too low for adults to crawl under

d = Resolution of the AOPD

The safety distance "S" for danger area guarding is calculated in accordance with EN 999/ ISO 13855 using the formula:

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

S = Safety distance in mm

K = Approach speed of 1600 in mm/s

T = Total time of the delay in seconds

Total of,

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

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

H = Height of the protective field above the floor

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

Calculation example for danger area guarding:

The area in front of an assembly press is to be protected.

It is decided to use C50-xxx transistor output, whereby the length of the protective device is at first not known before the calculation of the safety distance. The resolution of the C50 series safety light curtain is 50 mm.

H_{min} = 15 x (50-50) = 0 mm

The AOPD can therefore be set up at heights between 0 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 H = 100 mm above the floor. The stopping time of the assembly press is determined at 520 ms. The length of the light curtain must be estimated in order to calculate T. A length of 2100 mm is assumed. According to Chapter 12.2 this results in the value t_{AOPD} = 12 ms. An additional safety interface is not required as RES function and contactor monitoring are already used in COMPACT.

T = 12 + 520 = 532 ms

C = 1200 - 0.4 x 100 = 1,160 mm
The calculated value is higher than the minimum value of 850 mm

S = 1600 x 0.532 + 1160 = 2,012 mm

The protective field height of 2100 mm first estimated is sufficient, however the switching position with parallel approach at the end of the protective field is around the amount of the resolution d, i.e. 50 mm before the end of the protective field:

S + d = 2012 + 50 mm = 2,062 mm

-> COMPACT C50-2100 is therefore selected.

What result would there be if DoubleScan was switched to instead of SingleScan?

A response time of 23 ms is given in Chapter 12.2 for C50-2100 in DoubleScan mode. The safety distance is therefore calculated again:

T = 23 + 520 = 543 ms

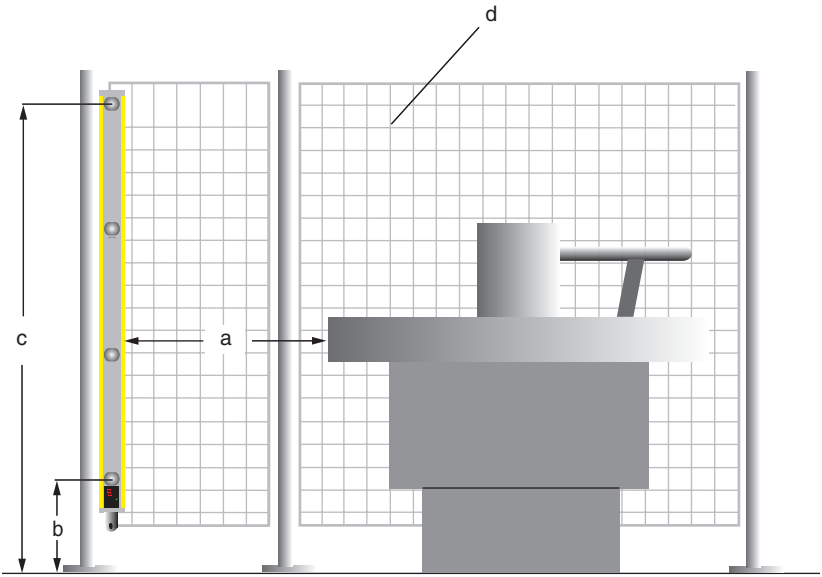
C = 1200 0.4 x 100 = 1,160 mm
The calculated value is higher than the minimum value of 850 mm

S = 1600 x 0.545 + 1160 = 2,029 mm

In this case with the use of C50-2100 the safety distance is also sufficient for the specified switching point 50 mm before the end of the protective field. In contrast to the SingleScan mode with H = 1, with the same effort with DoubleScan mode with H = 2 more interference immunity can be achieved, as an interruption must take place in two consecutive scans to switch off the machine. The change to DoubleScan mode is described in Chapter 8.

6.1.3 Beam heights and safety distance with access and perimeter guarding

Determination of beam heights above reference level and calculation of the safety distance of COMPACT multiple light beam safety devices and COMPACT transceivers



a = Safety distance S (protective field/danger point)
b = Height of the lowest beam above reference plane, see Table 6.1-1
c = Height of the highest beam, see Table 6.1-1
d = Measures to prevent access from the sides

Fig. 6.1-3: Beam heights and safety distance(a) with access and perimeter guarding

Beam heights for access and perimeter guarding in accordance with EN 999:

Design	Number of beams	Beam distance in mm	Beam heights above reference level in mm
C30x/4	4	300 mm	300, 600, 900, 1200
C40x/3	3	400 mm	300, 700, 1100
C50x/2	2	500 mm	400, 900
C600/2	2	600 mm	300, 900 (in accordance with ANSI - USA)

Table 6.1-1: Beam heights above reference level depending on number of beams

Calculation formula for safety distance S in accordance with EN 999:

The safety distance "S" for access and perimeter guarding is calculated in accordance with EN999/ISO 13855 using the formula:

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

S = Safety distance in mm

K = Approach speed of 1600 in mm/s

T = Total time of the delay in seconds

Total of,

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

C = 850 mm (arm's length)

$S\ [mm] = 1600\ [mm/s] \times (t_{AOPD} + t_{Interface} + t_{Machine})\ [s] + 850\ [mm]$

Access and perimeter guarding calculation example

A robot with a stopping time of 250 ms is to be guarded with a C400/3 multiple light beam safety device with transistor output. The beam heights are determined at 300, 700 and 1,100 mm.

In accordance with the table the AOPD's response time in the SingleScan mode (factory setting H = 1) is 5 ms. An additional interface is not required as C400/3 is already operated with RES function and contactor monitoring.

T = 5 + 250	=	255 ms
C = 850 mm	=	850 mm
S = 1600 x 0.255 + 850	=	1,258 mm

In the DoubleScan mode (H = 2) the response time is 8 ms. The safety distance is therefore calculated again:

T = 8 + 250	=	258 ms
C = 850 mm	=	850 mm
S = 1600 x 0.286 + 850	=	1,263 mm

The lower increase in the required 5 mm safety distance is caused by a greater interference immunity.

Warning!

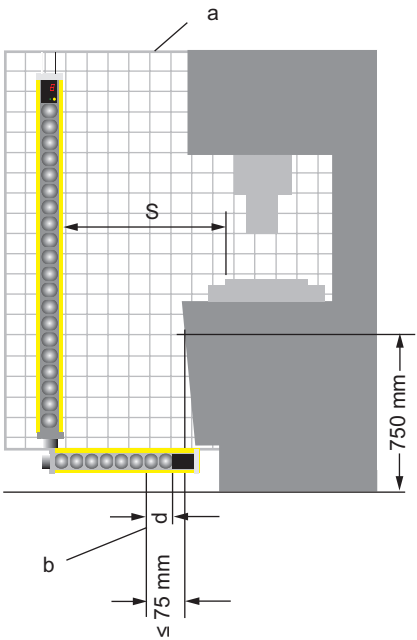
With access and perimeter guarding, it must be ensured that the start/restart interlock function is active and that unlocking from inside the danger area is not possible.

6.1.4 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 resolution and the protective field height of the light curtain (see, Chapter 12.2.1).

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 guarding with parallel approach to the protective field.



a = Measures to prevent access from the sides
b = Switching position: End of protective field minus resolution d

Fig. 6.1-4: Example: Host/guest application

Warning!

The presence of a person between the protective device and machine table must ALWAYS be 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 guarded with a safety light curtain that is mounted horizontally or inclined up to 30°, and the end of the protective field points toward the machine.

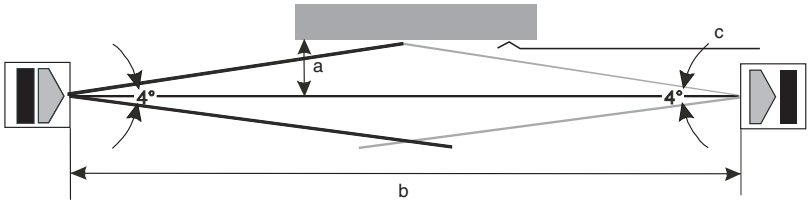
Warning!

The total response time of a host/guest configuration is the total of the response times of the host receiver and the guest receiver. The safety distance must be configured in accordance with the calculated values.

6.1.5 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 an object in the protective field not to be detected! 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 depends on the distance “b” between the transmitter and the receiver.

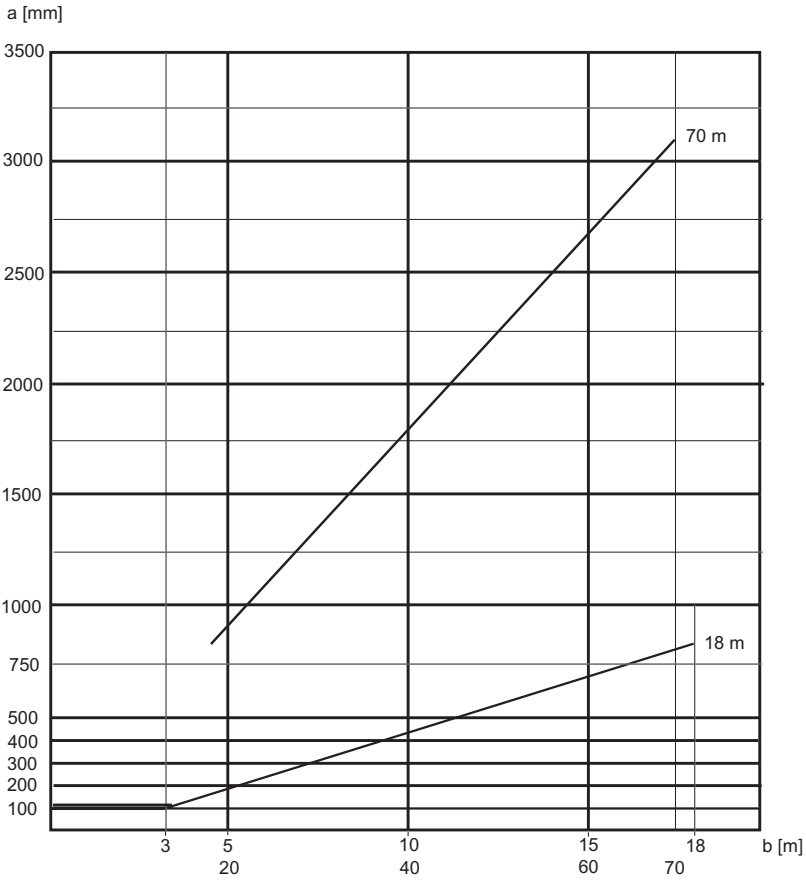


a = Distance
b = Protective field width
c = Reflective surface

Fig. 6.1-5: Minimum distances from reflective surfaces

With the calculation of the minimum distance to reflective surfaces it must be ensured that with a protective field width of 3 m or less, at least a minimum distance of 131 mm is achieved. With protective field widths over 3 m the minimum distance “a” is calculated using the following formula:

a [m] = 0.044 x b [m]

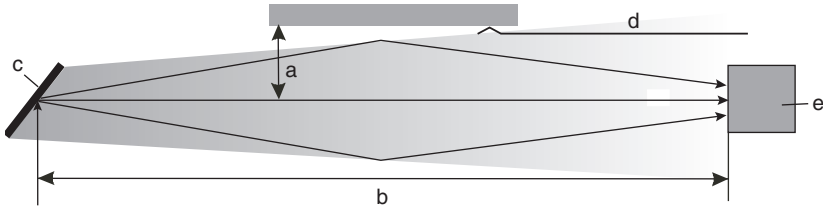


a = Distance [mm]
b = Width of protective field [m]

Fig. 6.1-6: Minimum distances from reflective surfaces dependant on the width of the protective field

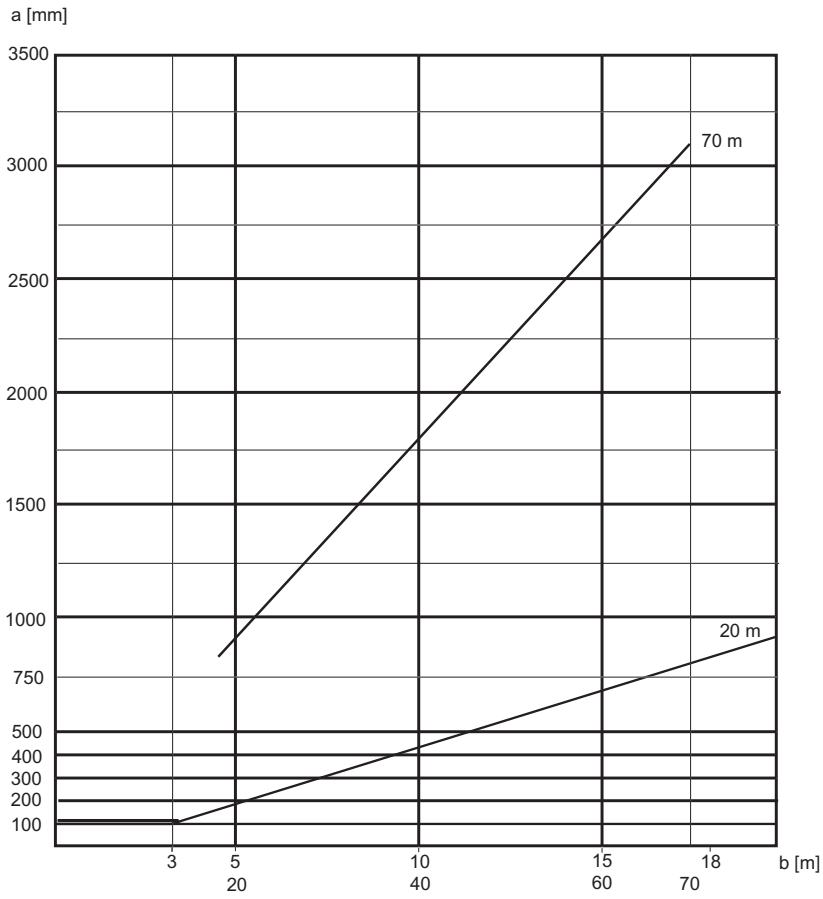
6.1.5.1 Minimum distances to reflective surfaces with the use of deflecting mirror columns

The minimum distance "a" is dependent on the distance of the last deflecting mirror from the receiver. fig. 6.1-7 and fig. 6.1-8 show the beam path from the last deflecting mirror to the receiver, and the chart for determining the minimum distances to reflective surfaces, dependent on the distance of the last deflecting mirror from the receiver.



a = Minimum beam distance to reflective surfaces
b = Distance of last deflecting mirror column to receiver
c = Last deflecting mirror column before receiver
d = Reflective surface
e = Receiver

Fig. 6.1-7: Distance “a” to reflective surfaces



a = Minimum beam distance to reflective surfaces [mm]
b = Distance of last deflecting mirror column to receiver [m]

Fig. 6.1-8: Chart for minimum distance to reflective surfaces

With the use of deflecting mirrors the above consideration only applies to the last section before the receiver. Any other possible deflections in upstream sections must be determined by test interruptions of the top and bottom beams separately before reflective surfaces along the protective field.

6.2 Mounting notes

Special notes on mounting a COMPACT safety light for **danger point guarding**:

➢ Calculate the safety distance according to the formula in Chapter 6.1.1.

➢ 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 safety light for **danger area guarding**:

➢ Calculate the safety distance according to the formula in Chapter 6.1.2. The resolution determines the minimum height of the protective field above the floor.

➢ 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 considered impossible for an adult to crawl under (also see EN 999).

➢ It must not be possible to step into the danger area from the sides. Suitable hard guards must be provided.

➢ When assembling, ensure that it is impossible to pass onto the housings of the optical components (thereby allowing entrance into the danger area).

Note!

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. See Chapter 6.1.4.

Special notes on mounting a COMPACT multiple light beam safety device for **access and perimeter guarding**:

➢ Calculate the safety distance according to Chapter 6.1.3.

➢ Consider the beam heights as set out in Table 6.1-1, i.e. with 2-beam safety light curtains the lowest beam is 400 mm above the reference level; with 3 and 4-beam safety light curtains it is 300 mm above the reference level.

➢ If safety light curtains are used as access guarding the lowest beam is also 300 mm above the reference level. The highest light beam and consequently the protective field height is determined by the requirements in accordance with EN 294/ISO 13857.

➢ Access and perimeter guarding may only be operated with the start/restart interlock function. Activate the internal RES function internal or the RES function of a downstream interface and check to make sure it is working properly.

➢ Ensure while installing the start/restart button, that it is impossible to press this button from inside the danger area. Make sure, that from the location of the button there is a complete overview over the danger area.

6.3 Mechanical mounting

Note!

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 is feasibly possible. It is therefore

recommended that the necessary settings be made before starting installation (Chapter 4 and Chapter 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.
- ➢ Use screws for mounting that can only be loosened with 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 range, 0.8 m for devices with 18 m range and 6 m for devices with 70 m range for safety reasons.
- ➢ The connections of transmitter and receiver must be pointing in the same direction.
- ➢ 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).

6.4 Mounting types

6.4.1 Standard mounting

Four standard mounting brackets (with sliding nuts and screws) are included in the delivery.

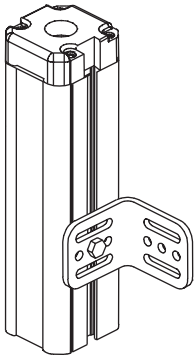


Fig. 6.4-1: L-mounting bracket, BT-L

6.4.2 Option: Mounting with swiveling brackets

If the shock and vibration load mentioned in the technical data is exceeded, swiveling brackets with shock absorbers must be used. They also allow the devices to be turned on their axis to make the transmitter-receiver alignment easier.

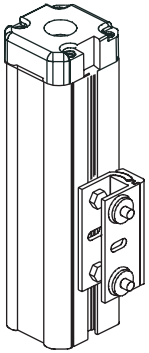


Fig. 6.4-2: Mounting bracket, swiveling with shock absorber, BT-SSD

Four swivel mounting brackets, BT-SSD, with shock absorbers can be ordered optionally. They are not included with delivery. The swiveling range is ± 8 °.

Note!

With the use of COMPACT/L multiple light beam safety devices with integrated laser alignment aid that are not installed in a UDC device mounting column, the long swiveling mounting bracket, BT-SSD-270, is used as default device mounting. With just one long swiveling mounting bracket the setting of the alignment laser built into the COMPACT/L is considerably easier.

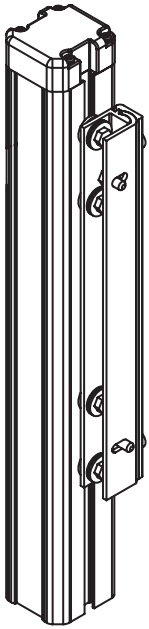


Fig. 6.4-3: Mounting bracket, swiveling with shock absorber, 270 mm, BT-SSD-270

The use and mounting of the long swiveling mounting bracket, BT-SSD-270, in conjunction with COMPACT/L systems is described in Chapter 13.3.

The long swiveling mounting bracket, BT-SSD-270, is not included in the scope of delivery and must be ordered separately.

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 in accordance with IEC 60742 and be able to bridge a power outage period of at least 20ms for the devices with transistor outputs. Leuze electronic offers suitable power supplies (see list of accessories in the Appendix). Transmitter and receiver must be fused against overcurrent (see Chapter 7 and Chapter 12).
- Basically both safety related switching outputs OSSD1 and OSSD2 must be looped into the work circuit of the machine.
- The weak beam signal output may not be used for switching safety-relevant signals.
- The start/restart button for unlocking the restart interlock must be mounted in such a way that it cannot be reached from the danger area and the entire danger area 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 and locked, so that the dangerous movements cannot be started unintentionally.

The machine interface is available in the following design types:

Design type	Transmitter interface	Machine interface Receiver/transceiver	
	Connection system	Safety-related switching outputs (OSSDs - output signal switching devices)	Connection system
---	Cable gland, PG13.5 (standard)	Transistor outputs	Cable gland, PG13.5
/G, /W, /GW	Hirschmann plug (6-pin+FE)	Transistor outputs	Hirschmann plug (6-pin+FE)
	/G = with straight cable socket, included in delivery!		
	/G = with angled cable socket, included in delivery!		
	/GW = for connecting straight and angled cable socket, cable socket not included in delivery!		
/BH (MIN-style)	MIN-style plug (5-pin)	Transistor outputs	MIN-style plug (7-pin)
/BH3 (MIN-style3) /BH5 (MIN-style5)	MIN-style plug (3-pin)	Transistor outputs	MIN-style plug (5-pin)
/A	M12 plug (3-pin)	AS-Interface Safety at Work	M12 plug (3-pin)
/M12	M12 plug (5-pin)	Transistor outputs	M12 plug (8-pin)

Table 7.0-1: Machine interface selection table

By changing the polarity on the voltage supply, extended functions can be selected on the COMPACT receivers with PG 13.5 cable gland, MIN-stype plug (/BH), Hirschman plug (/G, /W, /GW) and M12 plug (/M12). These functions are dynamic contactor monitoring, start/ restart interlock and minimum restart delay time.

7.1 Standard: Machine interface cable gland, PG13.5

7.1.1 Transmitter interface

The terminal strip 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.

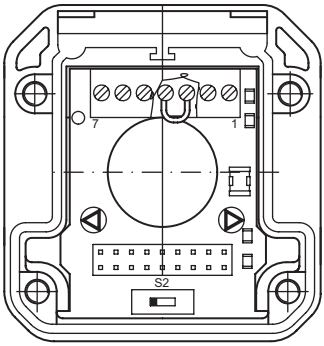


Fig. 7.1-1: Transmitter connection cap removed, inside view/terminal strip

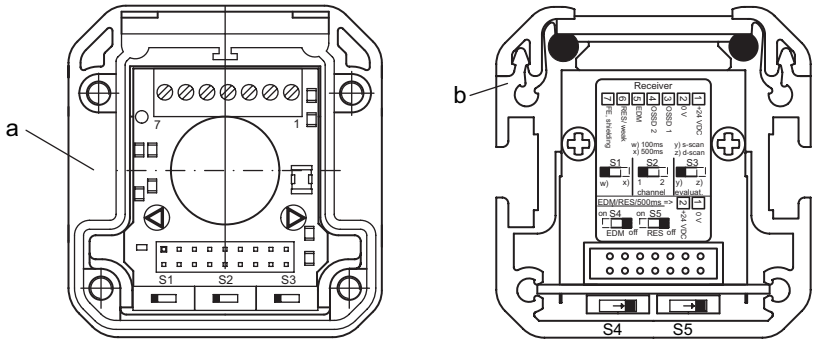
Terminal	Assignment		Inputs/outputs	
1	⇐	Supply voltage	24 V DC	
2	⇐	Supply voltage	0 V	
3	⇒	Test out	Jumper to 4	Jumper set in factory
4	⇐	Test in	Jumper to 3	
5		Reserved		
6		Reserved		
7	⇐	Functional earth, shield	FE	

Table 7.1-1: Transmitter interface – terminal strip connection assignment

7.1.2 Receiver/transceiver, machine interface

The receiver/transceiver has safety-related transistor outputs.

The terminal strip for the machine interface connection cable fixed with the M20x1.5 cable gland is located inside the connection cap.



a = Receiver/transceiver end cap
b = Receiver/transceiver, device-side

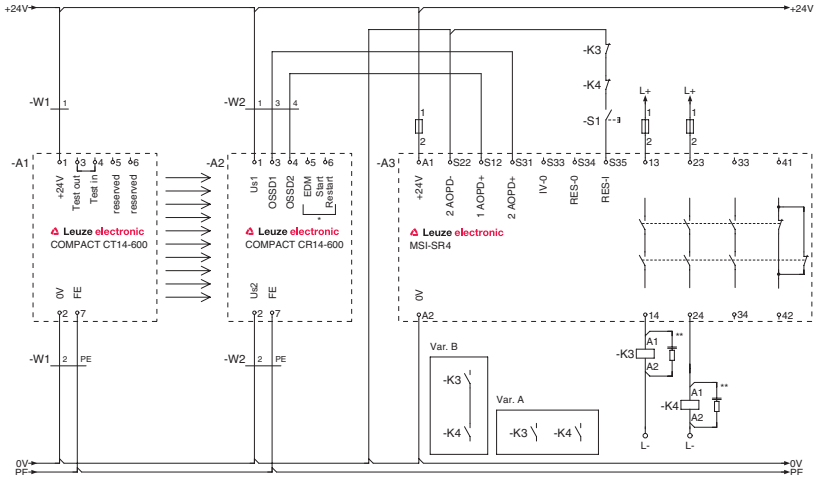
Fig. 7.1-2: Receiver/transceiver connection cap removed, inside view/terminal strip

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

➢ Use insulated conductor sleeves.

Terminal	Assignment		Inputs/outputs Standard	Inputs/outputs Extended
1	⇐	Supply voltage	24 V DC	0 V
2	⇐	Supply voltage	0 V	24 V DC
3	⇒	OSSD1 output	Transistor output	Transistor output
4	⇒	OSSD2 output	Transistor output	Transistor output
5	⇐	Input	n.c.	EDM, contactor monitoring Against 24 V DC (S4 = 1)
6	⇐ ⇒	Input Output	Collective malfunction/dirt signal	RES, start/restart Button against 24 V DC, collective malfunction/dirt signal (S5 = 1)
7	⇐	Functional earth, shield	FE	FE

Table 7.1-2: Receiver/transceiver, machine interface, connection assignment

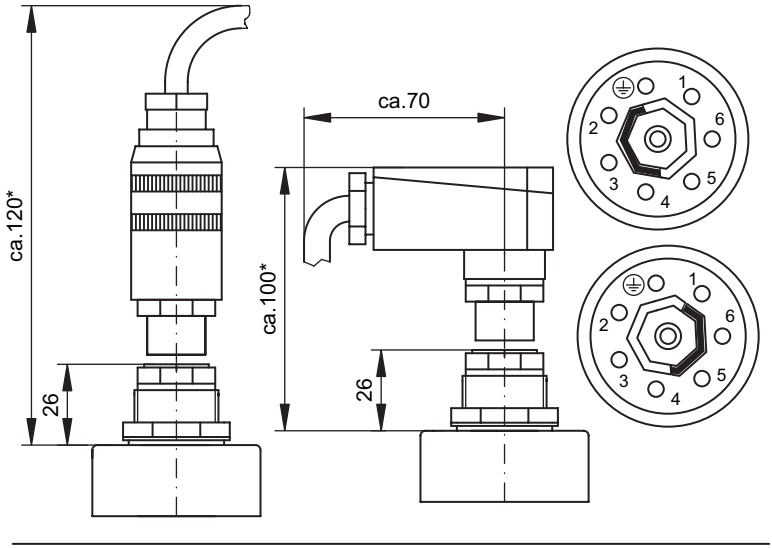


Shielded connection cables are recommended for extreme electromagnetic interferences. The shield should be connected with FE on a large surface.
The safety-related transistor outputs carry out the spark extinction. With devices with transistor outputs, it is therefore not necessary to use the spark extinction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

Fig. 7.1-3: Connection example, machine interface cable gland, PG13.5

7.2 Option: Machine interface /G, /W, /GW – Hirschmann plug (6-pin+FE)

The COMPACT/G,/W,/GW device type is equipped to connect both the transmitter and the receiver/transceiver machine interface with a 7-pin Hirschmann plug. Depending on the version, the cable socket incl. crimp contacts in straight (/G) or angled version (/W) is part of the scope of delivery or can be provided as an accessory (/GW). Ready prepared connection cables in different lengths are also available.



a = Transmitter encoding
b = Receiver/transceiver encoding

Fig. 7.2-1: Transmitter and receiver/transceiver, machine interface

7.2.1 Transmitter interface /G,/W,/GW

Pin	Wire colors	Assignment		Inputs/outputs	
1	White	⇐	Supply voltage	24 V DC	
2	Brown	⇐	Supply voltage	0 V	
3	Green	⇒	Test out	Ext. jumper to 4 Jumper to 4	Factory setting: **no** internal jumper set
4	Yellow	⇐	Test in	Ext. jumper to 4 Jumper to 3	
5	Gray	⇔	Not assigned		
6	Pink		Not assigned		
7	Blue		Functional earth, shield	FE	

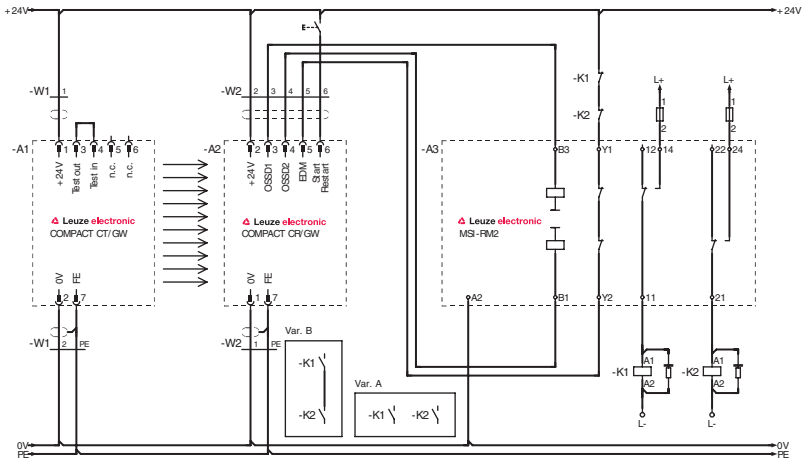
Table 7.2-1: Transmitter interface /G,/W,/GW, Hirschmann plug connection assignment

7.2.2 Receiver/transceiver machine interface /G,/W,/GW

The receiver/transceiver has safety-related transistor outputs.

Pin	Wire colors	Assignment		Inputs/outputs Standard	Inputs/outputs Extended
1	White	⇐	Supply voltage	24 V DC	0 V
2	Brown	⇐	Supply voltage	0 V	24 V DC
3	Green	⇒	OSSD1 output	Transistor output	Transistor output
4	Yellow	⇒	OSSD2 output	Transistor output	Transistor output
5	Gray	⇐	Input	n.c.	EDM, contactor monitoring Against 24 V DC (S4 = 1)
6	Pink	⇐ ⇒	Input Output	Collective malfunction/dirt signal	RES, start/restart button Against 24 V DC, collective malfunction/dirt signal (S5 = 1)
7	Blue	⇐	Functional earth, shield	FE	FE

Table 7.2-2: Receiver/transceiver machine interface /G,/W,/GW, Hirschmann plug connection assignment



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 safety/valve manufacturers etc. (RC modules, varistors or recovery diodes). These extend the delay times of inductive switching elements.

Fig. 7.2-2: Connection example, machine interface /G,/W,/GW, Hirschmann plug

7.3 Option: Machine interface/MIN-style plug

The COMPACT/BH (MIN-style) device type is equipped to connect the transmitter with a 5-pin and the receiver/transceiver machine interface with a 7-pin MIN-style plug. Connection cables are not included in the delivery.

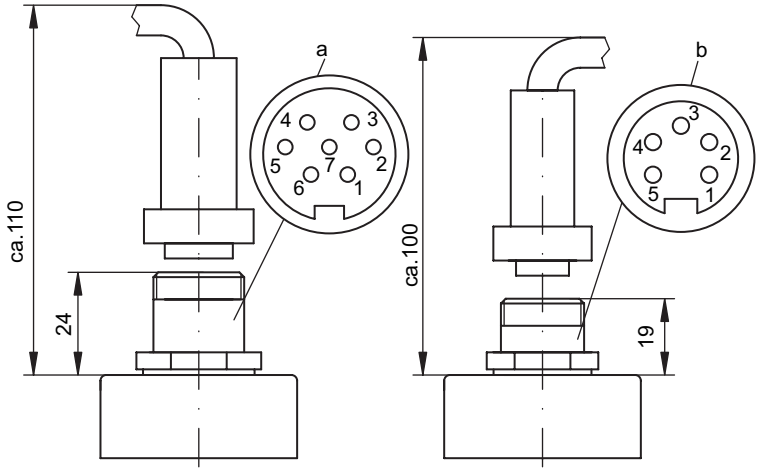


Fig. 7.3-1: Transmitter-receiver/transceiver interface /MIN-style plug

7.3.1 Transmitter interface/MIN-style

Pin	Color	Assignment		Inputs/outputs	
1	White	⇐	Supply voltage	24 V DC	
2	Red	⇐	Supply voltage	0 V	
3	Green	⇒	Test output	Ext. jumper to 4	Factory setting: **no** internal jumper set
4	Orange	⇐	Test input	Ext. jumper to 3	
5	Black	⇐	Functional earth, shield	FE	

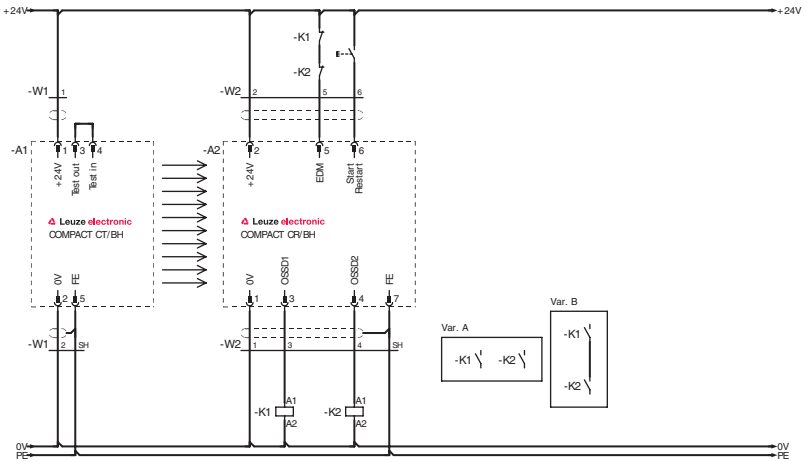
Table 7.3-1: Transmitter interface/MIN-style, 5-pin MIN-style cable socket connection assignment

7.3.2 Receiver/transceiver, machine interface /MIN-style

The receiver/transceiver has safety-related transistor outputs.

Pin	Color	Assignment		Inputs/outputs Standard	Inputs/outputs Extended
1	White/ black	⇐	Supply voltage	24 V DC	0 V
2	Black	⇐	Supply voltage	0 V	24 V DC
3	White	⇒	OSSD 1 output	Transistor output	Transistor output
4	Red	⇒	OSSD 2 output	Transistor output	Transistor output
5	Orange	⇐	Input	n.c.	Contactor monitoring (EDM) Against 24 V DC (S4 = 1)
6	Blue	⇒ ⇐	Input Output	Collective malfunction/dirt signal	RES, start/restart button, against 24 V DC, collective malfunction/ dirt signal (S5 = 1)
7	Green	⇐	Functional earth, shield	FE	FE

Table 7.3-2: Receiver/transceiver machine interface /MIN-style, MIN-style plug connection assignment



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 safety/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/MIN-style, MIN-style plug

7.4 Option: Machine interface/MIN-style3 and MIN-style5 – MIN-style plug

The COMPACT/BH device type is equipped to connect the transmitter with a 3-pin and receiver/transceiver machine interface with a 5-pin MIN-style plug. Connection cables are not included in the delivery.

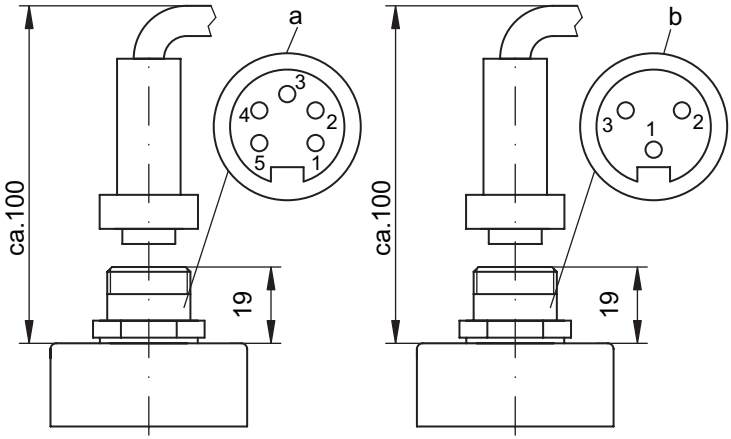


Fig. 7.4-1: Transmitter-receiver/transceiver interface /MIN-style3-MIN-style5 – MIN-style plug

7.4.1 Transmitter interface/MIN-style3

Pin	Color	Assignment		Inputs/outputs
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/MIN-style, 3-pin MIN-style cable socket connection assignment

7.4.2 Receiver/transceiver, machine interface /MIN-style5

The receiver/transceiver has safety-related transistor outputs.

Pin	Color	Assignment		Inputs/outputs Standard
1	White	⇐	Supply voltage	24 V DC
2	Red	⇒	Output	OSSD2, transistor output
3	Green	⇐	Functional earth, shield	FE
4	Orange	⇒	Output	OSSD1, transistor output
5	Black	⇐	Supply voltage	0 V

Table 7.4-2: Receiver/transceiver machine interface /MIN-style, MIN-style plug connection assignment

Note!

With COMPACT/BH5 (MIN-style5) device variants the restart interlock (RES) and contactor monitoring (EDM) functions cannot be addressed. These functions must therefore be performed in the downstream safety interface.

7.5 Option: Machine interface /A, AS-i Safety at Work

COMPACT/A device types are equipped with a 3-pin M12 plug for connecting the transmitter and receiver/transceiver to the AS interface bus system.

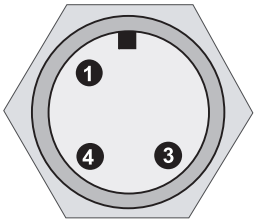


Fig. 7.5-1: Transmitter-receiver/transceiver interface /A, M12 3-pin device plug

Pin	Assignment
1	AS-i +
3	AS-i –
4	Not assigned

Table 7.5-1: Transmitter-receiver/transceiver interface /A, cable socket connection assignment, M12 3-pin

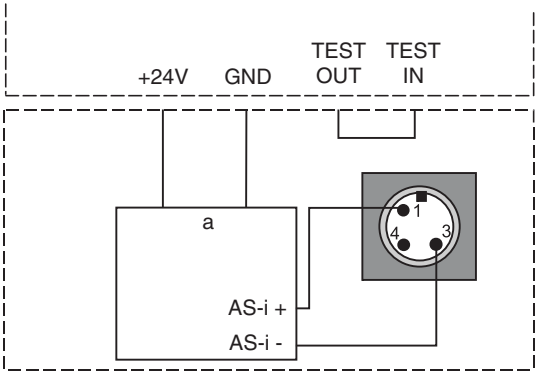
7.5.1 Transmitter interface /A

Note!

The transmitter is only supplied with voltage via the AS-i cable. The transmitter does not have an AS-i address. It can also be optionally operated with 24 V DC (as with standard devices).

Note!

The transmitter device burdens the AS-i network with impedance, with use of a COMPACT/A system an address should therefore remain free per system (transmitter + receiver) for taking the transmitter impedance into account (example: 2 COMPACT/A (corresponds with 4 AS-i slaves and 27 standard slaves).



a = Decoupling electronics

Fig. 7.5-2: Transmitter interface /A, schematic structure

Note!

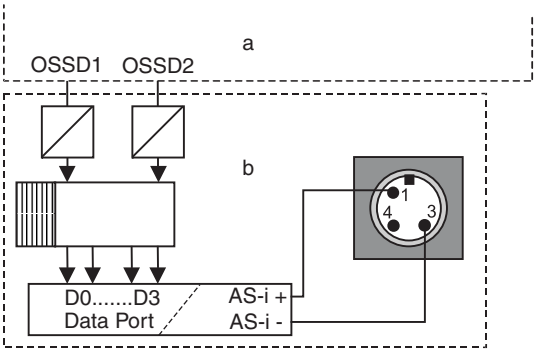
As a protective measure against damage caused by electrostatic discharge of the device it is recommended that the housing profile of the device be earthed. An earth set (AC-FES01) is offered for this (see accessories, Chapter 13.1.6).

7.5.2 Receiver/transceiver, machine interface /A

Both the data communication with the AS-i Master and the receiver/transceiver supply are made via the direct connection of the receiver/transceiver device. The receiver/transceiver must be programmed with an AS-i address for the data retrieval with the bus master.

The machine interface /A delivers the AS-i Safety at Work-specific code sequence, which the AS-i safety monitor saves and monitors permanently when the safety monitor is started.

The receiver/transceiver machine interface /A at the AS-I side has the following internal schematic structure. The data port of the AS-i chip is illustrated.



a = Sensor
b = AS-i slave (integrated)

Fig. 7.5-3: Receiver/transceiver, machine interface /A, schematic structure

The potential-separated OSSD outputs control the generator for the code sequence, which supplies the cyclically changing 4 data bits as long as both OSSD = 1. The data bits are evaluated by the AS-i safety monitor.

Note!

With COMPACT/A device variants the restart interlock (RES) and contactor monitoring (EDM) functions are not integrated, as these functions can always be configured via the AS-I safety monitor. You will find more details on this in the asimon configuration and diagnostics software user manual for AS-i safety monitors.

Note!

As a protective measure against damage caused by electrostatic discharge of the device it is recommended that the housing profile of the device be earthed. An earth set (AC-FES01) is offered for this (see accessories, Chapter 13.1.6).

Note!

Detailed information on AS-i Safety at Work and the AS-i safety monitor can be found in the connecting and operating instructions manual of the AS-i safety monitor.

7.5.3 COMPACT/A initial operation, interface to the AS-I bus 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).
2	**Install the AS-i slave in the AS interface** Connection of the COMPACT/A transmitter and receiver/transceiver is made via an M12 bus terminal(see accessories, Chapter 13.1.6).
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/A receiver/transceiver and transmitter.
4	**Check the communication between COMPACT/A transmitter and COMPACT/A receiver:** The 7-segment displays light up on the receiver and transmitter, the green LED2 lights up on the receiver (with weak beam the orange LED3 also lights up). The COMPACT/A safety light curtain may not be interrupted for the system integration, that is, with the teaching-in of the code table of the AS-i bus slave (bus participant) by the AS-i safety monitor.
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 Chapter 11, and connecting and operating instructions of the AS-i safety monitor, chapter 9 (status report, error and fault clearance).

7.5.4 COMPACT/A maintenance, interface to the AS-i master

Swapping out a safety-set AS-i slave (AS-i bus participant):

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 light up on the receiver and transmitter, the red LED1 lights up on the COMPACT/A receiver/transceiver.
5	**Check the communication between COMPACT/A transmitter and COMPACT/A receiver:** The 7-segment displays light up on the receiver and transmitter, the green LED2 lights up on the receiver (with weak beam the orange LED3 also lights up). The COMPACT safety light curtain 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.
6	**Press the SERVICE button on the AS-i safety monitor**
7	**Activate 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 safety monitor).

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.

Warning!

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:

Warning!

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/A) must be checked by a specialist and authorized person on a yearly basis.

To facilitate this, the COMPACT/A 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.

Note!

For tips and infos on the planning, installation and operation of AS interface systems we recommend the AS interface manual "Das Aktuator-Sensor-Interface für die Automation" (The Actuator Sensor Interface for Automation) by Werner R. Kriesel and Otto W. Madelung (Hrsg.), published by Carl Hanser Verlag München Wien under ISBN 3-446-21064-4.

7.5.5 Extended diagnostics option via AS interface

The status of the COMPACT alarm output can be queried via the AS interface with a parameter retrieval.

Warning!

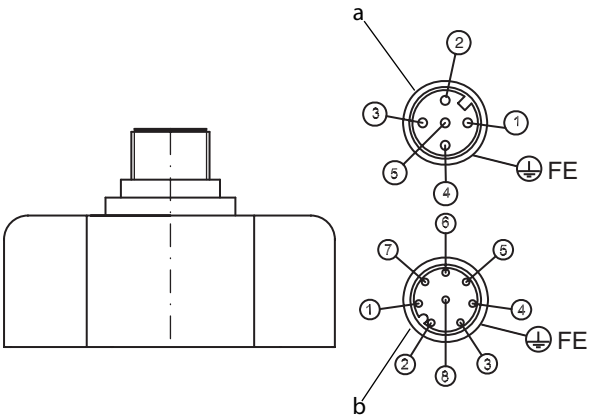
This information is only available for diagnostics purposes, because the parameter query is a non-secure transfer form of the AS-i data via the bus.

The minimum restart time of 500 ms (default) can be changed to 100 ms via the 1st parameter port P0. The change only becomes active the next time COMPACT/A is initialized.

Parameter bit	Function	Description
P0	Minimum restart time, default 500 ms (P0=1) [100 ms (P0=0)]	Process control
P1	Error signal output	Process diagnostics
P2	Not used	
P3	Not used	

7.6 Option: Machine interface M12

The COMPACT/M12 design type is equipped to connect the transmitter machine interface with a 5-pin M12 plug and the receiver/transceiver machine interface with an 8-pin M12 plug. Ready prepared connection cables in different lengths are available. (See accessories, Chapter 13.1.6)



a = Transmitter encoding
b = Receiver/transceiver encoding

Fig. 7.6-1: Transmitter and receiver/transceiver, machine interface M12

7.6.1 Transmitter interface M12

Pin	Wire colors, external	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 or 24 V DC
5	Shield		Functional earth, shield	FE

Table 7.6-1: Transmitter interface M12, connection assignment

7.6.2 Receiver/transceiver, machine interface /M12

The receiver/transceiver has safety-related transistor outputs.

Pin	Wire colors, external	Assignment		Inputs/outputs Standard	Inputs/outputs Extended
1	White	⇐ ⇒	Input Output	Collective malfunction/dirt signal	RES, start/restart button against 24 V DC, collective malfunction/dirt signal (S5 = 1)
2	Brown	⇐	Supply voltage	0 V	24 V DC
3	Green	⇐	Input	n.c.	EDM, contactor monitoring against 24 V DC (S4 = 1)
4	Yellow			n.c.	n.c.
5	Gray	⇒	OSSD1 output	Transistor output	Transistor output
6	Pink	⇒	OSSD2 output	Transistor output	Transistor output
7	Blue	⇐	Supply voltage	24 V DC	0 V
8	Shield	⇐	Functional earth, shield	FE	FE

Table 7.6-2: Receiver/transceiver machine interface, M12 connection assignment

8 Parameterization

8.1 Factory settings

When delivered, the CT transmitter is ready for operation, set to

- Transmission channel 1

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

The CR receiver and the CRT transceiver are also ready for operation and their switches S1 to S3 are set on L (left) and S4 and S5 to 0, which means:

- Transmission channel 1
- SingleScan
- Without contactor monitoring (EDM)
- Without start/restart function (RES)
- Minimum switch-on delay, 100ms

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 CT transmitter's connection cap.

➢ Turn the middle switch S 2 to the right setting R

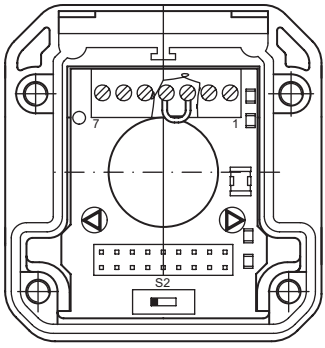


Fig. 8.2-1: Transmitter connection cap, switch positions

Switch	Function	Pos.	CT functions, can be set by switch	Factory setting (FS, default)
S2	Transmission channel	L	Transmission channel 1	L
		R	Transmission channel 2	

Table 8.2-1: CT transmitter functions depending on switch settings

➢ When replacing the connection cap, ensure that none of the plug pins extending out of the profile are bent.

➢ Check the 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.

i A change in the transmitter transmission channel also requires the transmission channel of the corresponding receiver to be changed.

8.3 Receiver/transceiver parameterization

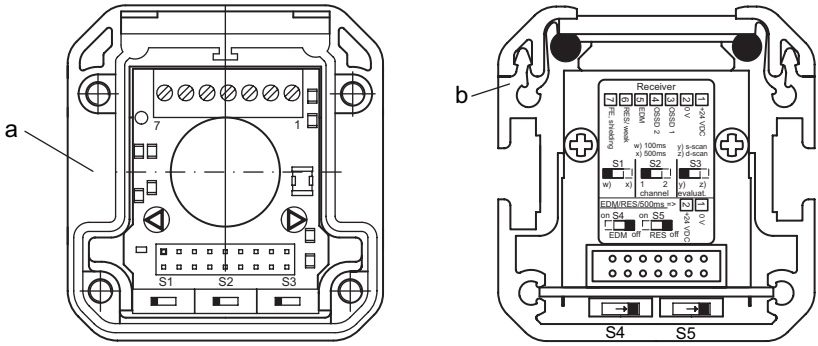
3 switches in the connection and two switches on the receiver processor module are used for switching the receiver functions. To do this:

➢ Turn off the CR receiver/CRT transceiver power

➢ Loosen the 4 screws on the connection cap and

➢ Pull the connection cap straight off

The operating elements are now exposed.



a = Receiver end cap
b = Device-side receiver

Fig. 8.3-1: Receiver/transceiver connection cap and receiver/transceiver processor module in COMPACT profile housing, switch positions

The following table shows the functions that are possible with the receiver/transceiver, which can be selected using switches S1 to S5. Plan the required settings carefully and always observe the safety notes for each of the individual functions. The functions identified as “extended” can only be selected by changing the polarity of the voltage supply.

Switch	Function	Pos	Functions can be set by switch	Factory setting (FS, default)	Operating mode (S= Standard/ E=Extended)
S1	Minimum restart delay time	L	100ms	L	E
		R	500ms		
S2	Transmission channel	L	Transmission channel 1	L	S/E
		R	Transmission channel 2		
S3	MultiScan	L	SingleScan, H = 1	L	S/E
		R	DoubleScan, H = 2		
S4	EDM	0	No contactor monitoring	0	E
		1	With dynamic contactor monitoring		
S5	RES function	0	No RES function	0	E
		1	With RES function		

Table 8.3-1: CR receiver functions depending on switch settings

Note!

With COMPACT/A device variants the start/restart interlock (RES) and contactor monitoring (EDM) functions are not integrated.

Note!

With COMPACT/MIN-style5 device variants the start/restart interlock (RES) and contactor monitoring (EDM) functions are not integrated. Settable functions only affect S1, S2 and S3.

Warning!

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

The parameterization options of the receiver/transceiver, which are possible by changing switches S1 to S5, are described below.

8.3.1 S1 – minimum restart delay time

The minimum restart delay time is the time that elapses with automatic start/restart between leaving the protective field and the machine's start-up, or with activated start/restart interlock, between releasing the start/restart button and the machine's start-up. In the factory setting (L) of switch 1 the minimum restart delay time is 100 ms. In position R the minimum restart delay time is 500 ms.

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 – MultiScan

In the factory setting L, SingleScan mode is active (s.-scan, H=1). If the switch is set to position R, DoubleScan mode (d.-scan, H=2) becomes active. The response times for both modes are provided in the tables in Chapter 12.2.

Warning!

The response time of the optical protective device is extended by the switchover. The safety distance must be corrected accordingly. You will find notes on this in Chapter 6 and Chapter 12.

8.3.4 S4 – Contactor monitoring (EDM)

The dynamic contactor monitoring is not activated in the factory setting 0. Place switch S4 in the 1 setting to activate the dynamic contactor monitoring function. As illustrated in the wiring examples in Chapter 7, the receiver expects the signal from the positive-guided normally closed contacts within 500 ms after the OSSDs are turned on or off.

If this signal is not received, the receiver will show an 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.

8.3.5 S5 – Start/restart interlock (RES)

COMPACT leaves the factory with the S5 switch in the 0 setting, therefore with automatic start/restart. You can select internal start/restart interlock by moving switch S5 to the 1 setting if no downstream machine interface takes over this function.

With internal start/restart interlock a start/restart button against 24 V DC must be connected on the machine inteface input. Release is made by pressing and releasing the start/restart button within 300 ms <= t <= 4s.. Precondition here is that the active protective field is free.

9 Initial operation

Warning!

Before the COMPACT is put into operation for the first time on a power-driven production machine, an experienced technician must check the entire setup and the integration of the optical protective device into the machine controls. For more information, see Chapter 2, Chapter 10 and Chapter 13.2.

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 correctly can it be integrated into the machine's control circuit!

9.1 Switching on

Make sure that the transmitter and receiver are protected against overcurrent (for fuse size see Chapter 12.1). There are special requirements for the supply voltage: The power supply unit must guarantee secure supply isolation, have a load current reserve of at least 1A and the ability to bridge a power outage for at least 20ms with the use of receivers with transistor output.

9.1.1 Display sequence with the CT transmitter

After the device is turned on, “8.” appears for a few moments on the transmitter display followed by an “S” for about 1 second 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.

Warning!

If the error display is shown on the transmitter (constant display of F or 8), then the 24 V DC supply voltage and wiring should be checked. If the error remains after it is turned on again, discontinue the setup process immediately and send in the malfunctioning transmitter to be checked.

9.1.2 Display sequence with CR receiver/CRT transceiver

After the device is turned on, “8.” appears for a few moments on the transmitter display followed by an “S” for about 1 second for the self test. The display then switches and permanently shows the selected transmission channel, "1" or "2".

Note!

A "." next to the number indicates that multi-scanning (DoubleScan mode, d-scan) has been selected.

Warning!

If the error display is shown on the transmitter (constant display of F or 8), then the 24 V DC supply voltage and wiring should be checked. If the error remains after it is turned on again, discontinue the setup process immediately and send in the malfunctioning transmitter to be checked.

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

The displays of the receiver LEDS after switching on: **Without start/restart interlock function (RES, FS)**.

Warning!

The receiver switches to the ON-state as soon as it receives all beams!

LED	Transmitter/receiver not aligned or protective field not free	Transmitter/receiver aligned and protective field free
Red	ON = OFF-state of the OSSDs	
Green		ON = ON state of the OSSDs
Orange	ON = Weak beam indication	ON = Weak beam indication
	OFF = No weak beam	OFF = No weak beam
Yellow	OFF = RES not selected	OFF = RES not selected

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

If the **internal start/restart interlock function** is activated (**RES**, see Chapter 8.3), after startup the LEDs of the receivers display:

LED	**Before** unlocking by the start/restart button	**After** unlocking by the start/restart button with free protective field
Red	ON = OFF-state of the OSSDs	
Green		ON = ON state of the OSSDs
Orange	ON = Weak beam indication	ON = Weak beam indication
	OFF = No weak beam	OFF = No weak beam
Yellow	ON = Protective field free	

Table 9.1-2: Receiver display sequence without internal start/restart interlock

LED	**Before** unlocking by the start/restart button	**After** unlocking by the start/restart button with free protective field
	OFF = Protective field interrupted	

Table 9.1-2: Receiver display sequence without 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 fixed 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.

Note!

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

9.2.1 Optimizing alignment by turning and/or tilting the transmitter and receiver

The fixing 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 cannot be met, swiveling brackets (accessories) can be used, as described in Chapter 6.4.2.

Alignment procedure with internal RES function

If the protective field is clear, the alignment can be optimized by observing the yellow LED4 on the receiver (protective field free). Precondition here is that the pre-alignment work has been completed to such an extent that the yellow LED4 is already constantly lit.

- ➢ Unscrew the locking screws on the transmitter's swiveling mounting brackets so that you can just turn it. Turn the transmitter until the yellow LED4 switches off. Memorize this position. Turn the transmitter back until the yellow LED4 is constantly lit again and then continue until it goes off again. Now turn 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 LED4 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 procedure without internal RES function

- ➢ The procedure is identical to that described above. Instead of the yellow LED4, LED1 and LED 2 of the receiver and their change from green to red are observed. LED3 can be lit at the transition points during the setup procedure (weak beam indication).

10 Testing

10.1 Testing before the initial operation

Testing by an experienced technician before initial startup must ensure that the optical protective 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 Work Equipment 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,Chapter 13.2 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 operating modes. When selecting the checklist, note the type of protection (danger point or danger area or access/perimeter guarding).
- ➢ 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 instructing of operation personnel by experienced technicians before work is started. Instruction of personnel is the responsibility of the machine owner.

Leuze electronic offers a specialist service in Germany, which undertakes the required testing and monitoring tasks in accordance with the European regulations (www.leuze.de). The results of these tests are documented for the machine owner consistent with ISO 9000.

10.2 Regular tests

Regular tests must also be carried out in accordance with local regulations. They are designed to discover changes (e.g. in stopping times) or manipulations to the machine or safety device.

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

Leuze electronic also provides a specialist service for regular tests.

10.3 Daily testing with the test rod

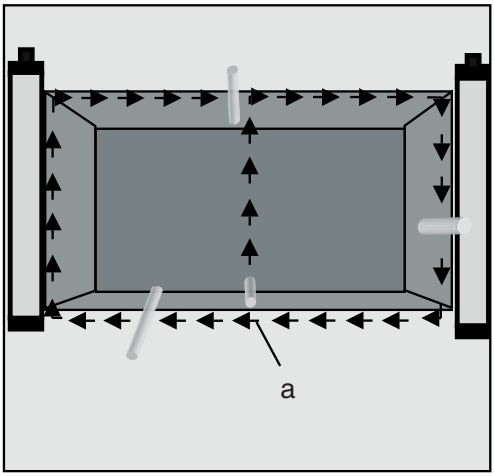
COMPACT are self-monitoring safety light curtains and multiple light beam safety devices. Nevertheless it is very important to check the protective field for its effectiveness daily to be sure that the protection also stays effective at every point after a parameter or tool change.

Warning!

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

➢ When selecting the test rod, use the nameplate of the receiver which shows the resolution.

➢ If for Receiver Extended the internal start/restart interlock function is selected and the AOPD is released, LED2 lights up green. When the test rod is inserted, LED1 switches to red. During the test procedure, the green LED2 and the yellow LED4 must not light up at any point.



a = Beginning of test

Fig. 10.3-1: Testing the protective field with the test rod

➢ If the AOPD is being operated without the internal start/restart interlock, it is sufficient to watch LED1 and LDE2 on the receiver during the testing procedure. When the test rod is inserted into the protective field, this LED1 must switch to “red” and LED2 must not switch back to “green” at any point during the test procedure.

Warning!

If the test does not yield the desired result, the cause could be a protective field height that is too low or reflections from reflective metals or tools brought into 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 LED3 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 the 6/Pin6 connecting terminal in the factory setting (depending on the machine interface variant). The dirt signal is generated with time filtering (10 min) from the internal weak beam signal. If this signal is activated, then cleaning of the front screen may be required with free protective field and switched LED3. If cleaning the screens does not improve this, the range and alignment must be checked. We recommend using a mild cleanser for cleaning the plexiglass cover 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 do 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 determined that the error cannot be clearly defined and remedied, your local Leuze office and/or the Leuze electronic 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 CT transmitter diagnostics

Symptom	Measure to eliminate error
7-segment display does not light up	Check 24 V DC supply voltage Check connection cable Replace transmitter if necessary
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 diagnostics

11.2.2 CR receiver and CRT transceiver diagnostics

Code	Cause / significance	Measure to eliminate error
	LEDs and 7-segment displays are not lit	Check 24 V DC supply voltage, check connection cable, replace the receiver if necessary
F4	Internal fault	Send the device in
F6*	Short circuit between ground and OSSD1 or cross-circuit	Clear grounded short circuit, overload or cross-circuit; turn supply voltage off and on again
F7	OSSD short circuit after VCC output 1 or cross-circuit	Clear short circuit after VCC or cross-circuit, if it occurs again send the device in

Table 11.2-2: Receiver diagnostics

Code	Cause / significance	Measure to eliminate error
F8*	Short circuit between ground and OSSD 2 or cross-circuit	Clear grounded short circuit, overload or cross-circuit; turn supply voltage off and on again
F9	OSSD short circuit after VCC output 2 or cross-circuit	Clear short circuit after VCC or cross-circuit, if it occurs again send the device in
F10*	Undervoltage on power supply	Check power supply and feed
F20	Internal fault	Send the device in
F21	Internal fault	Send the device in
F22	Internal fault	Send the device in
F23	Internal fault	Send the device in
F24	Internal fault	Send the device in
F25*	Different transmission channels discovered (during operation)	Turn supply voltage off and on again
F26*	Different evaluation procedures (SCAN) discovered (during operation)	Turn supply voltage off and on again
F27	Internal fault	Send the device in
F28	Internal fault	Send the device in
F29	Internal fault	Send the device in
F30*	Error in semiconductor test (multifuse)	Switch supply voltage off and on again, if it occurs again send the device in
F32*	RES operating mode changed (during operation)	Turn supply voltage off and on again
F33*	EDM operating mode changed (during operation)	Turn supply voltage off and on again
F34*	EDM timeout exceeded (feedback circuit closes or will not open)	Check EDM wiring, turn supply voltageoff and on again
F35*	Start/restart button pressed longer than 10 seconds	Check the start button wiring
F36	Test identification signal from transmitter longer than 3 seconds	Check transmitter test input
F37*	EDM configuration error	Check EDM wiring, turn supply voltage on and off again
F38	Internal fault	Send the device in

* Locking error - a system reset is only achieved by switching the supply voltage off and on again.

Table 11.2-2: Receiver diagnostics

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

- about 10 seconds for the transmitter
- about 10 seconds for the receiver

for the device in question. If the error or fault is then no longer present, the machine/ application can be started again. The temporary error signal then gets lost.

* The receiver is not automatically reset after 10 seconds with locking errors (F6, F8, F10, F25, F26, F30, F32, F33, F34, F35, F37). The receiver goes instead to the error locking status, from which it can **only** come out of by switching the supply voltage off and back on again.

11.4 COMPACT – Diagnostics Software

COMPACT diagnostics software is also available. The software that can be run from WINDOWS 3.1 accelerates the alignment of the COMPACT safety light curtains and multiple light beam safety devices by displaying the interrupted beams. (See accessories, Chapter 13.1.6)

12 Technical data

12.1 General data

12.1.1 Beam/protective field data

Safety light curtain	Range		Resolution	Protective field height	
	min.	max.		min.	max.
C14-	0 m	6 m	14 mm	150 mm	1,800 mm
C30-	0 m	18 m	30 mm	150 mm	1,800 mm
C50-	0 m	18 m	50 mm	450 mm	3,000 mm
C90-	0 m	18 m	90 mm	750 mm	3,000 mm

Multiple light beam safety device	Range		Beam distance in mm	Number of beams	Heights of beams above reference level in mm (EN 999)
	min.	max.			
C500/2-	0 m	18 m	500 mm	2	400, 900
C501/2-	6 m	70 m	500 mm	2	400, 900
C501L/2-	6 m	70 m	500 mm	2	400, 900
C400/3-	0 m	18 m	400 mm	3	300, 700, 1100
C401/3-	6 m	70 m	400 mm	3	300, 700, 1100
C401L/3-	6 m	70 m	400 mm	3	300, 700, 1100
C300/4-	0 m	18 m	300 mm	4	300, 600, 900, 1200
C301/4-	6 m	70 m	300 mm	4	300, 600, 900, 1200

Transceiver	Range		Beam distance in mm	Number of beams	Heights of beams above reference level in mm (EN 999)
	min.	max.			
C500/2-	0 m	6.5 m	500 mm	2 (1 beam folded)	400, 900
C600/2-	0 m	6.5 m	600 mm	2 (1 beam folded)	300, 900 (ANSI - USA)

Table 12.1-1: Beam/protective field data

12.1.2 Safety relevant tecnical 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 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) 2, 3 and 4 beam 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	 $6.60 \times 10^{-9}\ 1/h$ $7.30 \times 10^{-9}\ 1/h$ $8.30 \times 10^{-9}\ 1/h$ $9.50 \times 10^{-9}\ 1/h$
Service life (T_M)	20 years

12.1.3 General system data

Safety type in accordance with EN IEC 61496	Type 4
Synchronization	Optical via transmitter and receiver
Supply voltage	24 V DC, ± 20 %, external power supply with secure mains supply isolation and equalization of voltage failures up to 20 ms required, at least 380mA (plus OSSD load)
Residual ripple of supply voltage	± 5% within the limits of U_v
Shared value for external fuse in the supply line for transmitter and receiver	2 A melting fuse
Safety class (VDE 106)	III
Type of protection	IP 65*
Temperature range, operation	0 ... +55 °C
Temperature range, storage	-25 ... +70 °C
Relative humidity	15 ... 95%
Vibration fatigue limit	5 g, 10 - 55 Hz according to IEC/EN 60068-2-6
Resistance to shocks	10 g, 16 ms according to IEC/EN 60068-2-29
Profile cross-section Dimensions	See dimensional drawings and tables in Chapter 12.2
Weight	See table in Chapter 12.2

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

Table 12.1-2: General system data

Transmitter	
Light-emitting diodes: Class in accordance with EN 60825-1:1994+ A1:2002+A2001 Wavelength Power	 1 880 nm < 50 µW
Laser (with COMPACT/L) Class in accordance with DIN EN 60825-1/2003-10 Wavelength Power	 2 650 nm < 1 mW
Power consumption	75 mA (with 24 V DC supply voltage) (100mA CT/A)
Connection system	PG cable gland Hirschmann plug MIN-style plug, MIN-style, MIN-style3 ASI connection M12 plug
Receiver	
Power consumption	100 mA without external load (with 24 V DC supply voltage) (150 mA CR/A)
Safety related switching outputs (OSSDs, type-dependent)	2 pnp transistor outputs (short circuit-proof, cross-circuit monitored) AS-i Safety interface
Connection system	Cable gland Hirschmann plug MIN-style plug, MIN-style, MIN-style5 ASI connection M12 plug
*) Without additional measures the devices are not suited for outdoor use.	

Table 12.1-2: General system data

Transceiver	
Light-emitting diodes:	
Class in accordance with EN 60825-1:1994+ A1:2002+A2001	1
Wavelength	880 nm
Power	< 50 µW
Power consumption	105 mA (with 24 V DC supply voltage) (350 mA CRT/A)
Safety related switching outputs (OSSDs, type-dependent)	2 pnp transistor outputs (short circuit-proof, cross-circuit monitored) AS-i Safety interface
Connection system	Cable gland Hirschmann plug MIN-style plug, MIN-style, MIN-style5 ASI connection M12 plug

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

Table 12.1-2: General system data

12.1.4 Transmitter signal input

Terminal 4: Test input	Input:	Closed current principle, minimum open time, 50ms

Table 12.1-3: Transmitter, signal input

PG 13.5	Hirschm.	MIN-style5	MIN-style3	M12
Terminal 4	PIN 4	PIN 4	No test	PIN 4

Table 12.1-4: Terminal 4 on PG 13.5 transmitter end cap to Hirschmann, MIN-style and M12 transmitter end caps.

12.1.5 Signal inputs/outputs on receiver

Terminal 5: EDM (contactor monitoring) *	Input:	Contacts (break) against 24 V DC current load: max. 20 mA
Terminal 6:		
Start/restart button *	Input:	Contact (make) against 24 V DC current load: max. 15 mA
Collective malfunction/dirt signal	Output:	pnp: Typical 22 V DC switching, max. 80 mA

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

*The “restart interlock” and “dynamic contactor monitoring” functions are only available in the extended mode

PG 13.5	Hirschm.	MIN-style7	MIN-style5	M12
Terminal 5	PIN 5	PIN 5	Without EDM	PIN 3
Terminal 6	PIN 6	PIN 6	Without RES	PIN 1

Table 12.1-6: Terminal 5 and terminal 6 on PG 13.5 receiver end cap to Hirschmann, MIN-style and M12 receiver end caps.

12.1.6 Signal inputs/outputs on transceiver

Terminal 5: EDM (contactor monitoring) *	Input:	Contacts (break) against 24 V DC current load: max. 20 mA
Terminal 6:		
Start/restart button *	Input:	Contact (make) against 24 V DC current load: max. 15 mA
Collective malfunction/dirt signal	Output:	pnp: Typical 22 V DC switching, max. 80 mA

Table 12.1-7: Receiver, machine interface, status and control signals

* = The “restart interlock” and “dynamic contactor monitoring” functions are only available in the extended mode

PG 13.5	Hirschm.	MIN-style7	MIN-style5	M12
Terminal 5	PIN 5	PIN 5	Without EDM	PIN 5
Terminal 6	PIN 6	PIN 6	Without RES	PIN 6

Table 12.1-8: Terminal 5 and terminal 6 on PG 13.5 transceiver end cap to Hirschmann, MIN-style and M12 transceiver end caps.

12.1.7 Receiver machine interface, safety related transistor outputs

OSSDs safety related switching outputs	2 Safety related pnp transistor outputs, cross-circuit monitored, short circuit-proof		
	Minimum	Typical	Maximum
Switching voltage high active (Uv – 1.8V) Switching voltage low Switching current Leakage current Load capacity Load inductivity	-80 V**)	22 V DC 0 V 250 mA < 5 µA	 +2.8 V < 20 µA < 220 nF < 2 H
Permissible wire resistance for load	-	-	< 300 Ω*)
Permissible wire length between Receiver and load (at 0.25 mm²)	-	-	100 m
Test pulse width	30 µs	-	100 µs
Test pulse distance	-	-	22 ms
OSSD restart delay time after beam interruption	40ms	100 ms	-
OSSD response time	See Table 12.1-2		

*) Note the additional restrictions caused by cable length and load current.
**) Fast de-excitation voltage with contactors, otherwise 0 V.

Table 12.1-9: Receiver, machine interface, safety related transistor outputs

Note!

The output transistors carry out the spark extinction. It is therefore not necessary to use spark extinguishers recommended by manufacturers of contactors and valves (RC modules, varistors or recovery diodes) with transistor outputs. These extend the delay times of inductive switching elements.

Warning!

The output transistors carry out the spark extinction. It is therefore not necessary to use spark extinguishers recommended by manufacturers of contactors and valves (RC modules, varistors or recovery diodes) with transistor outputs. These extend the delay times of inductive switching elements.

12.1.8 Receiver machine interface, AS-i Safety at Work

OSSDs safety related switching outputs	4-bit AS-i data		
	Minimum	Typical	Maximum
Permissible wire length	-	-	100 m
Restart time after beam interruption		500 ms	
Slave address range	1	-	31
Slave address (FS)	0 (ex-factory)		
ID-code/transmitter IO-code	-		
ID-code, receiver	B		
IO-code, receiver	0		
AS-i profile	Safe slave		
Cycle time in accordance with AS-i specifications	5 ms		
OSSD response time	See Table 12.1-2		
Additional response time of the AS-i system WITHOUT sensor response time	40 ms		

Table 12.1-10: Receiver machine interface, AS-i Safety at Work

12.2 Dimensions, weights and response times

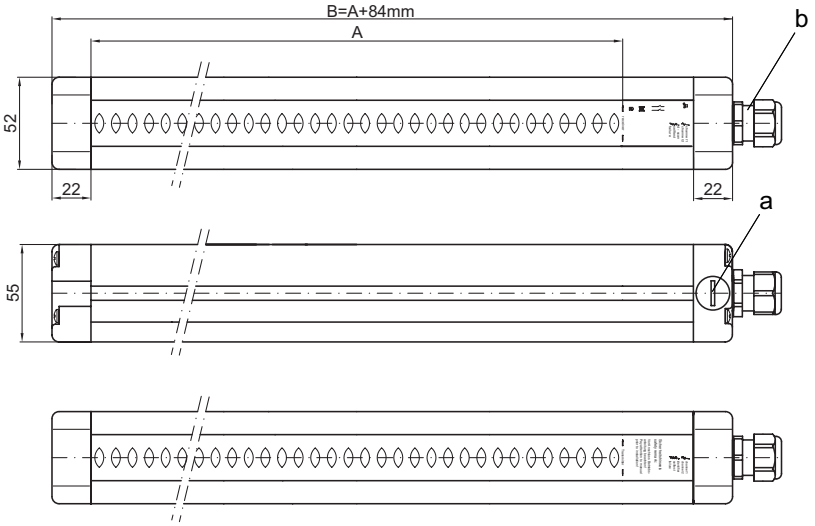
12.2.1 Safety light curtains with transistor or AS-i connection

Dim. A B [mm]	Dim. B B [mm]	Weight CT+ CR [kg]	tH1 [ms]= Response time of the AOPD with scan factor H=1 (FS) T = Transistor outputs; /A = AS-i bus connection n = Number of beams											
			C14-xxxx			C30-xxxx			C50-xxxx			C90-xxxx		
				tH1	tH1		tH1	tH1		tH1	TH1		tH1	tH1
			n	T	/A	n	T	/A	n	T	/A	n	T	/A
150	234	1.2	16	7	12	8	7	12						
225	309	1.7	24	10	15	12	10	15						
300	384	2.1	32	13	18	16	7	12						
450	534	3.0	48	10	15	24	10	15	12	10	15			
600	684	3.7	64	13	18	32	13	18	16	7	12			
750	834	4.6	80	17	22	40	9	14	20	9	14	10	9	14
900	984	5.5	96	20	25	48	10	15	24	10	15	12	10	15
1050	1134	6.4	112	23	28	56	12	17	28	12	17	14	6	11
1200	1284	7.3	128	26	31	64	13	18	32	13	18	16	7	12
1350	1434	8.2	144	30	35	72	15	20	36	8	13	18	8	13
1500	1584	8.6	160	33	38	80	17	22	40	9	14	20	9	14
1650	1734	10.0	176	36	41	88	18	23	44	9	14	22	9	14
1800	1884	10.9	192	39	44	96	20	25	48	10	15	24	10	15
2100	2184	12.7							56	12	17	28	12	17
2400	2484	14.5							64	13	18	32	13	18
2700	2784	16.3							72	15	20	36	8	13
3000	3084	18.1							80	17	22	40	9	14

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

Dim. A [mm]	Dim. B [mm]	Weight CT + CR [kg]	tH2 [ms]= Response time of the AOPD with scan factor H=2 (DoubleScan) T = Transistor outputs; /A = AS-i bus connection n = Number of beams											
			C14-xxxx			C30-xxxx			C50-xxxx			C90-xxxx		
				tH2	tH2		tH2	tH2		tH2	TH2		tH2	tH2
			n	T	/A	n	T	/A	n	T	/A	n	T	/A
150	234	1.2	16	10	15	8	10	15						
225	309	1.7	24	15	20	12	15	20						
300	384	2.1	32	20	25	16	10	15						
450	534	3.0	48	20	25	24	15	20	12	15	20			
600	684	3.7	64	26	31	32	20	25	16	10	15			
750	834	4.6	80	33	38	40	17	22	20	13	18	10	13	18
900	984	5.5	96	39	44	48	20	25	24	15	20	12	15	20
1050	1134	6.4	112	46	51	56	23	28	28	18	23	14	9	14
1200	1284	7.3	128	52	57	64	26	31	32	20	25	16	10	15
1350	1434	8.2	144	59	64	72	30	35	36	5	10	18	11	16
1500	1584	8.6	160	65	70	80	33	38	40	17	22	20	13	18
1650	1734	10.0	176	72	77	88	36	41	44	18	23	22	14	19
1800	1884	10.9	192	78	83	96	39	44	48	20	25	24	15	20
2100	2184	12.7							56	23	28	28	18	23
2400	2484	14.5							64	26	31	32	20	25
2700	2784	16.3							72	30	35	36	15	20
3000	3084	18.1							80	33	38	40	17	22

Table 12.2-2: Safety light curtains, dimensions and response times with DoubleScan (H = 2)



a = Connection cap PG9, both sides
b = PG13.5

Fig. 12.2-1: Dimensions for series with 14 mm, 30 mm and 50 mm resolution

12.2.2 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 C14-300S with H = 2: tS = 20 ms									
			C14-xxxxS			C30-xxxxS			C50-xxxxS			C90-xxxxS		
			n	tS [ms] H = 1	tS [ms] H = 2*	n	tS [ms] H = 1	tS [ms] H = 2*	n	tS [ms] H = 1	tS [ms] H = 2*	n	tS [ms] H = 1	tS [ms] H = 2*
150	284	0,7	16	7	10	8	7	10						
225	359	0,9	24	10	15	12	10	15						
300	434	1,1	32	13	20	16	7	10						
450	584	1,5	48	10	20	24	10	15	12	10	15			
600	734	1,9	64	13	26	32	13	20	16	7	10			
750	884	2,3	80	17	33	40	9	17	20	9	13	10	9	13
900	1034	2,7	96	20	39	48	10	20	24	10	15	12	10	15
1050	1184	3,1	112	23	46	56	12	23	28	12	18	14	6	9
1200	1334	3,5	128	26	52	64	13	26	32	13	20	16	7	10
1350	1484	3,9	144	30	59	72	15	30	36	8	10	18	8	11
1500	1634	4,3	160	33	65	80	17	33	40	9	17	20	9	13
1650	1784	4,7	176	36	72	88	18	36	44	9	18	22	9	14
1800	1934	5,1	192	39	78	96	20	39	48	10	20	24	10	15
2100	2184	5,9							56	12	23	28	12	18
2400	2484	6,7							64	13	26	32	13	20
2700	2784	7,5							72	15	30	36	8	15
3000	3084	8,3							80	17	33	40	9	17

* H = 2 corresponds with d-scan (double scan)

Table 12.2-3: Guests series dimensions and response times

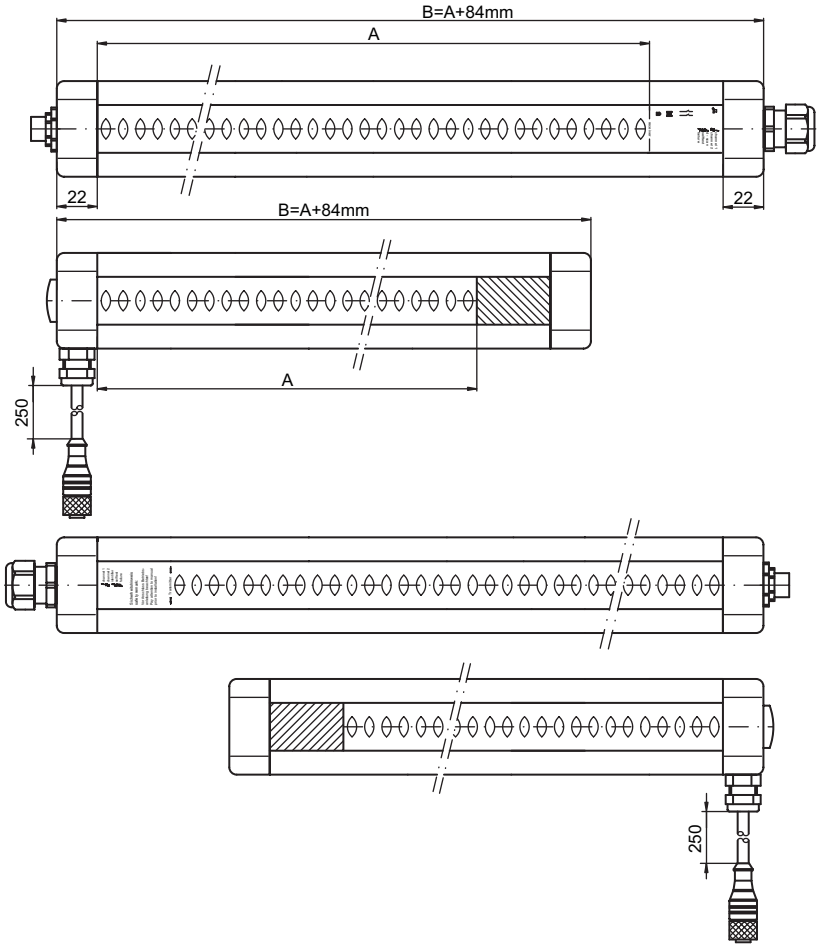


Fig. 12.2-2: Host-guest cascade

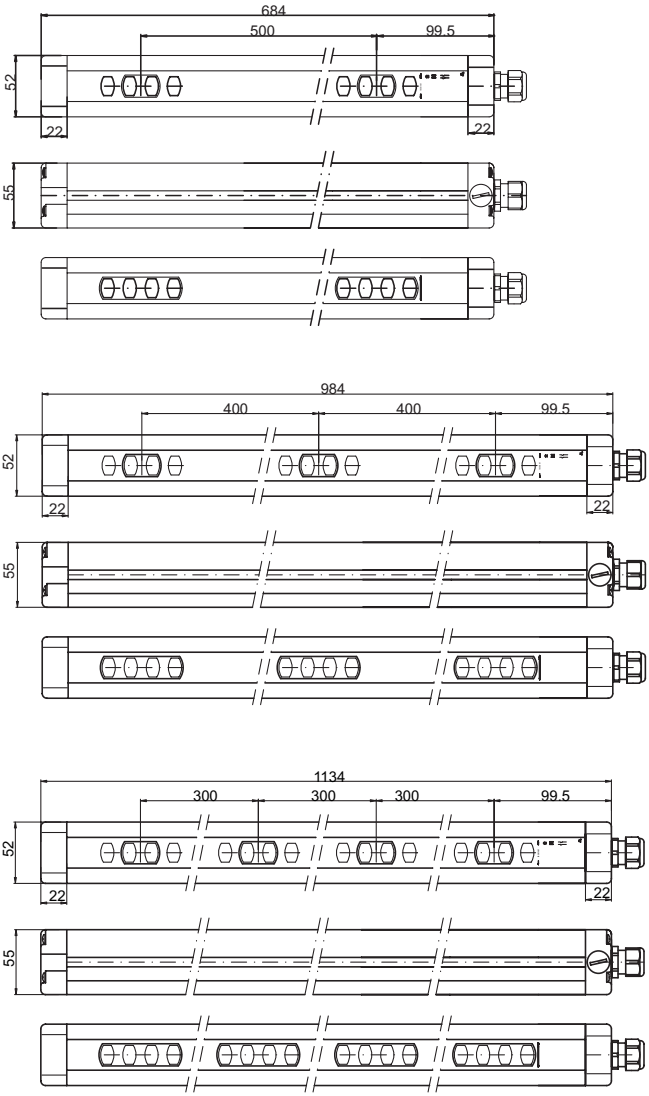
12.2.3 COMPACT multiple light beam safety devices

Dim. A [mm]	Dim. B [mm]	CT/ CR [kg]	tH1 [ms]= Response time of the AOPD with scan factor H=1 (FS) /T = Transistor outputs; /A = AS-i bus connection n = Number of beams								
			C500/2-.../ C501/2-...			C400/3-.../ C401/3-...			C300/4-.../ C301/4-...		
				tH1	tH1		tH1	tH1		tH1	tH1
			n	/T	/A	n	/T	/A	n	/T	/A
500	684	1.3	2	5	10						
400	984	2.0				3	5	10			
300	1134	2.3							4	5	10

Table 12.2-4: Multiple light beam safety devices, dimensions and response times with SingleScan (FS: H = 1)

Dim. A [mm]	Dim. B [mm]	CT/ CR [kg]	tH2 = Response time of the AOPD with scan factor H=2 /T = Transistor outputs; /A = AS-i bus connection n = Number of beams								
			C500/2-.../ C501/2-... / C501L/2-...			C400/3-.../ C401/3-.../ C401L/3-...			C300/4-.../ C301/4-...		
				tH2	tH2		TH2	tH2		tH2	tH2
			n	/T	/A	n	/T	/A	n	/T	/A
500	684	1.3	2	8	13						
400	984	2.0				3	8	13			
300	1134	2.3							4	8	13

Table 12.2-5: Multiple light beam safety devices, dimensions and response times with DoubleScan (H = 2)



a = Connection cap PG9, both sides
b = PG13.5

Fig. 12.2-3: Dimensions for series with 2, 3 and 4 beams

12.2.4 COMPACT, transceiver

Dim. A [mm]	Dim. B [mm]	CT/ CR [kg]	tH1 [ms]= Response time of the AOPD with scan factor H=1 (FS) /T = Transistor outputs; /A = AS-i bus connection n = Number of beams			
			CRT500/2-...			
				tH1		tH1
			n	/T		/A
500	684	1.3	1	5		10
600	784	1.5	1	5		10

Table 12.2-6: Transceiver, dimensions and response times with SingleScan (FS: H=1)

Dim. A [mm]	Dim. B [mm]	CT/ CR [kg]	tH1 [ms]= Response time of the AOPD with scan factor H=2 (FS) /T = Transistor outputs; /A = AS-i bus connection n = Number of beams			
			CRT500/2-...			
				TH2		TH2
			n	/T		/A
500	684	1.3	1	7		12
600	784	1.5	1	7		12

Table 12.2-7: Transceiver, dimensions and response times with DoubleScan (FS: H=2)

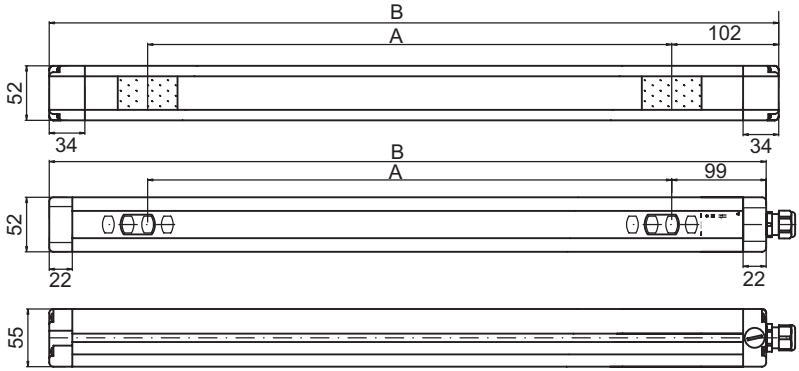
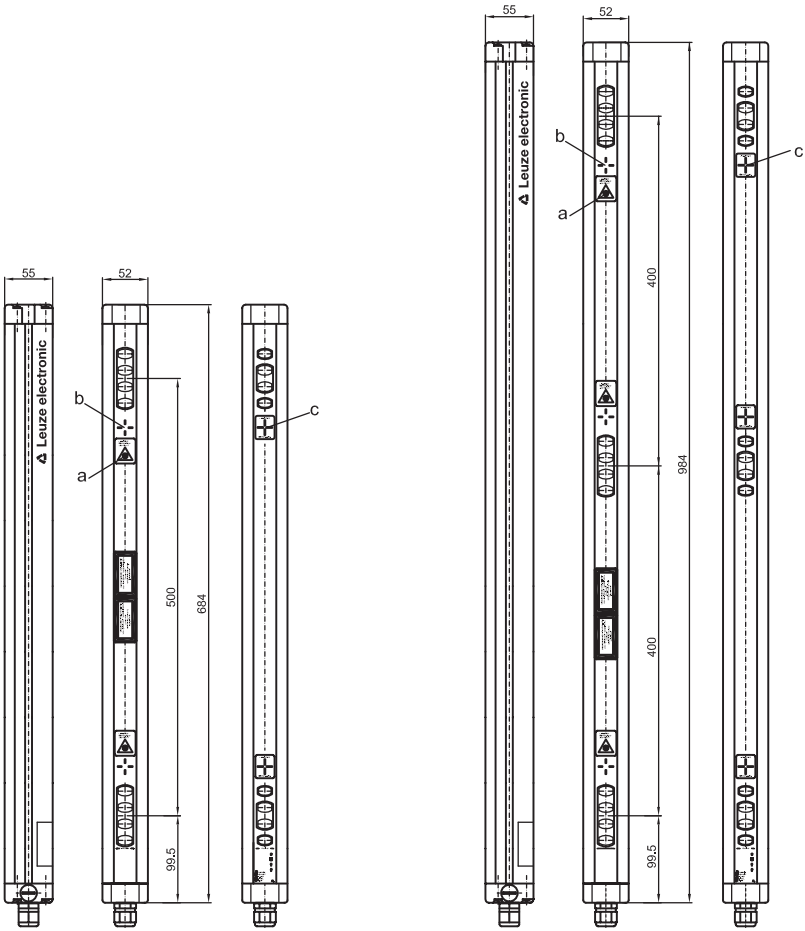


Fig. 12.2-4: Transceiver dimensions

12.2.5 Dimensions for COMPACT multiple light beam safety devices with integrated laser alignment aid

Dimensions in mm



a = Laser class 2 safety note
b = Alignment laser exit in transmitter, if MagnetKey activated
c = Alignment laser hit surface in receiver

Fig. 12.2-5: Dimensions for series with 2 and 3 beams
CR501L/2 and CT501L/2, CR401L/3 and CT401L/3

12.2.6 Dimensions for COMPACT multiple light beam safety devices installed in UDC mounting column

Dimensions in mm

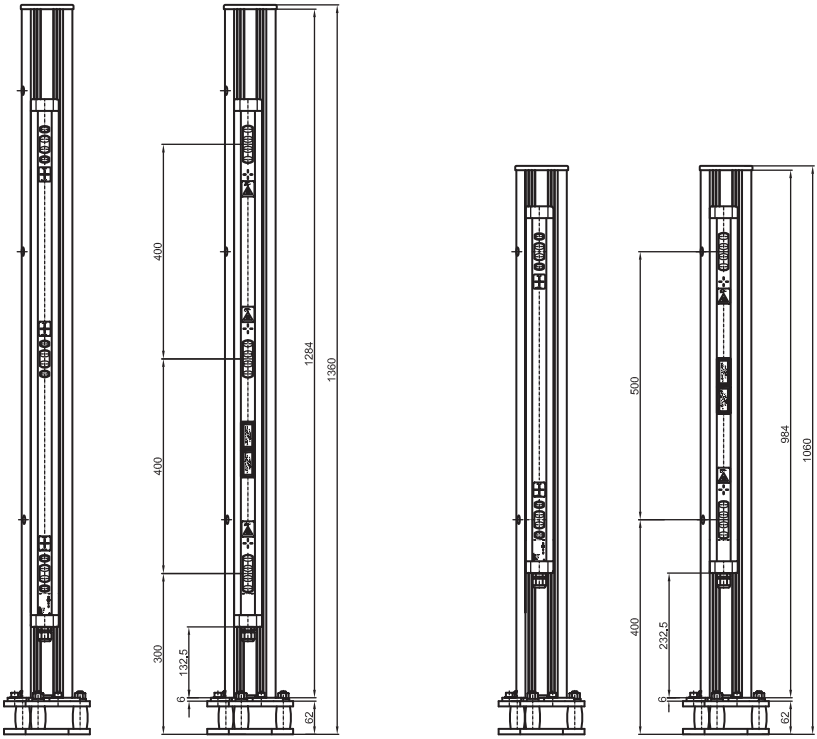


Fig. 12.2-6: Dimensions for series with 2 and 3 beams CR501L/2-UDC and CT501L/2-UDC, CR401L/3-UDC and CT401L/3-UDC

12.2.7 Dimensions for deflecting mirror columns

Dimensions in mm

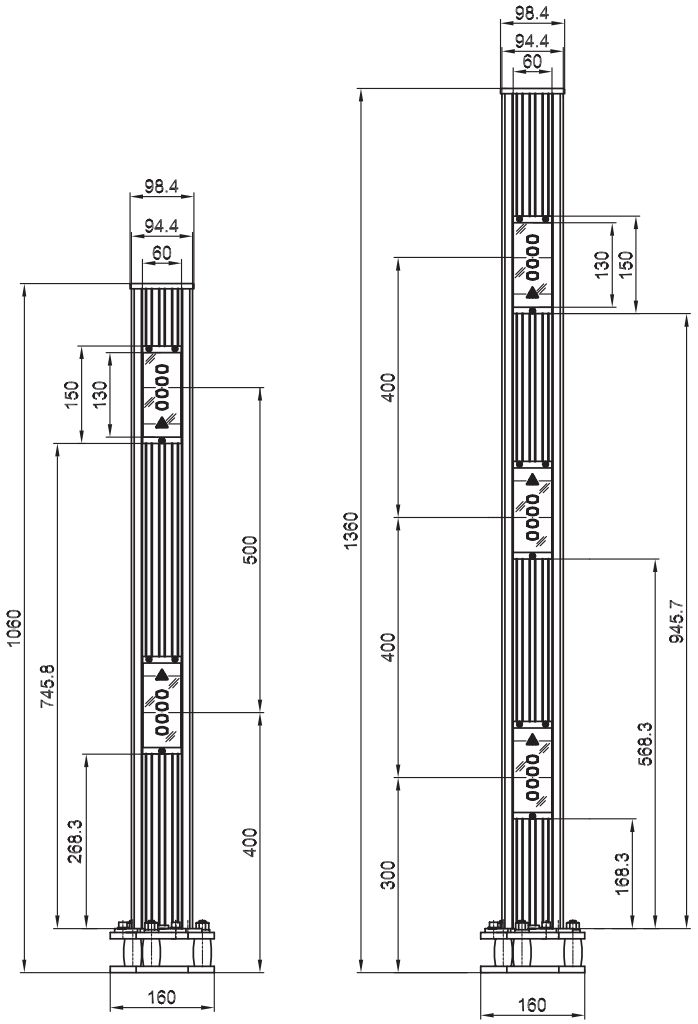


Fig. 12.2-7: Dimensions for deflecting mirror columns for 2 and 3 beams UMC-1002 and UMC-1303

12.2.8 Dimensions for UDC alignment plinth

Dimensions in mm

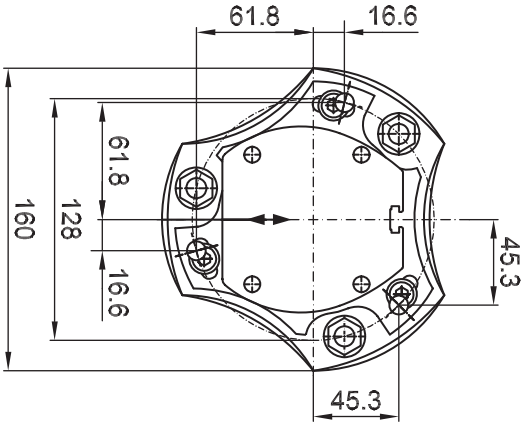


Fig. 12.2-8: UDC alignment plinth dimensions

12.2.9 Dimensions for UMC alignment plinth

Dimensions in mm

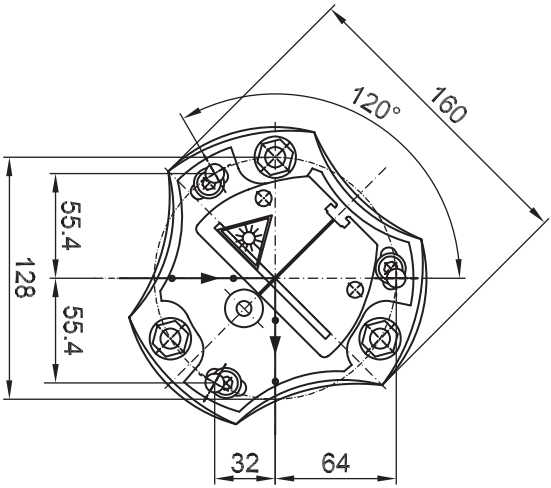


Fig. 12.2-9: UMC alignment plinth dimensions

12.2.10 Standard mounting dimensions

Dimensions in mm

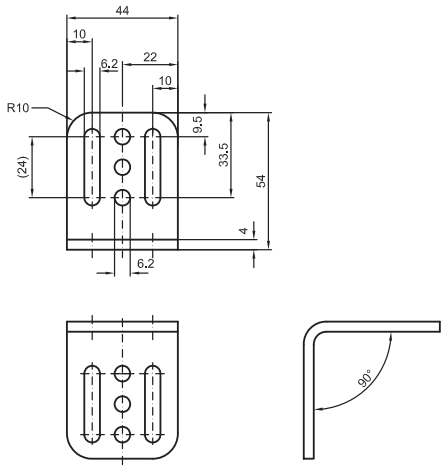
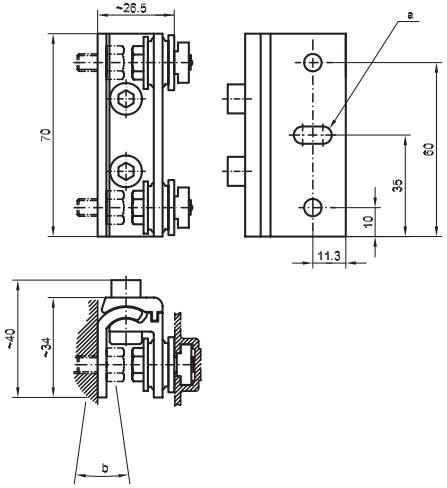


Fig. 12.2-10: Bracket, BT-L

12.2.11 Swiveling bracket dimensions

Dimensions in mm



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

Fig. 12.2-11: Option: Mounting bracket, swiveling with shock absorber, BT-SSD

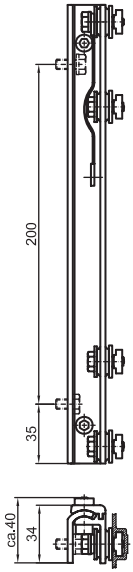


Fig. 12.2-12: Option: Mounting bracket, swiveling with shock absorber, 270 mm, BT-SSD-270

13 Appendix

13.1 Scope of delivery and accessories for COMPACT, COMPACT/A and COMPACT/L

13.1.1 COMPACT scope of delivery

All COMPACT are delivered with:

- 1 CT transmitter
- 1 CR receiver
- 2 BT-S bracket sets with accessories
- 4 sliding nuts
- 1 connecting and operating instructions manual

Additionally supplied for the C14 and C30 series:

- 1 test rod 14/30 mm

13.1.2 COMPACT ordering info

Article	Article no.			
	C14 bb = 14	C30 bb = 30	C50 bb = 50	C90 bb = 90
CTbb-150 CRbb-150	561101 564101	561301 564301		
CTbb-225 CRbb-225	561102 564102	561302 564302		
CTbb-300 CRbb-300	561103 564103	561303 564303		
CTbb-450 CRbb-450	561104 564104	561304 564304	561504 564504	
CTbb-600 CRbb-600	561106 564106	561306 564306	561506 564506	
CTbb-750 CRbb-750	561107 564107	561307 564307	561507 564507	561907 564907
CTbb-900 CRbb-900	561109 564109	561309 564309	561509 564509	561909 564909
CTbb-1050 CRbb-1050	561110 564110	561310 564310	561510 564510	561910 564910
CTbb-1200 CRbb-1200	561112 564112	561312 564312	561512 564512	561912 564912
CTbb-1350 CRbb-1350	561113 564113	561313 564313	561513 564513	561913 564913

Table 13.1-1: Article numbers for COMPACT C14, C30, C50, C90 safety light curtains

Article	Article no.			
	C14 bb = 14	C30 bb = 30	C50 bb = 50	C90 bb = 90
CTbb-1500 CRbb-1500	561115 564115	561315 564315	561515 564515	561915 564915
CTbb-1650 CRbb-1650	561116 564116	561316 564316	561516 564516	561916 564916
CTbb-1800 CRbb-1800	561118 564118	561318 564318	561518 564518	561918 564918
CTbb-2100 CRbb-2100			561521 564521	561921 564921
CTbb-2400 CRbb-2400			561524 564524	561924 564924
CTbb-2700 CRbb-2700			561527 564527	561927 564927
CTbb-3000 CRbb-3000			561530 564530	561930 564930

Table 13.1-1: Article numbers for COMPACT C14, C30, C50, C90 safety light curtains

The following article number groups apply for plug-in versions:

Plug type	Art. no.
W	57...
G	55...
MIN-style	58...
MIN-style3	58... + 8000 (transmitter)
MIN-style5	58... + 5030 (receiver)

Table 13.1-2: Article number groups

The following article numbers apply for COMPACT M12:

Article	Article no.			
	C14 bb = 14	C30 bb = 30	C50 bb = 50	C90 bb = 90
CTbb-150/M12 CRbb-150/M12	557601 567601	557701 567701		
CTbb-225/M12 CRbb-225/M12	557602 567602	557702 567702		
CTbb-300/M12 CRbb-300/M12	557603 567603	557703 567703		

Table 13.1-3: Article numbers for COMPACT C14/M12, C30/M12, C50/M12, C90/M12 safety light curtains

Article	Article no.			
	C14 bb = 14	C30 bb = 30	C50 bb = 50	C90 bb = 90
CTbb-450/M12 CRbb-450/M12	557604 567604	557704 567704	557804 567804	
CTbb-600/M12 CRbb-600/M12	557606 567606	557706 567706	557806 567806	
CTbb-750/M12 CRbb-750/M12	557607 567607	557707 567707	557807 567807	557907 567907
CTbb-900/M12 CRbb-900/M12	557609 567609	557709 567709	557809 567809	557909 567909
CTbb-1050/M12 CRbb-1050/M12	557610 567610	557710 567710	557810 567810	557910 567910
CTbb-1200/M12 CRbb-1200/M12	557612 567612	557712 567712	557812 567812	557912 567912
CTbb-1350/M12 CRbb-1350/M12	557613 567613	557713 567713	557813 567813	557913 567913
CTbb-1500/M12 CRbb-1500/M12	557615 567615	557715 567715	557815 567815	557915 567915
CTbb-1650/M12 CRbb-1650/M12	557616 567616	557716 567716	557816 567816	557916 567916
CTbb-1800/M12 CRbb-1800/M12	557618 567618	557718 567718	557818 567818	557918 567918
CTbb-2100/M12 CRbb-2100/M12			557821 567821	557921 567921
CTbb-2400/M12 CRbb-2400/M12			557824 567824	557924 567924
CTbb-2700/M12 CRbb-2700/M12			557827 567827	557927 567927
CTbb-3000/M12 CRbb-3000/M12			557830 567830	557930 567930

Table 13.1-3: Article numbers for COMPACT C14/M12, C30/M12, C50/M12, C90/M12 safety light curtains

Article no.	Article
567502 568502	CT 500/2 CR 500/2
567403 568403	CT 400/3 CR 400/3

Table 13.1-4: Article numbers for COMPACT C300, C301, C400, C401, C500, C501 multiple light beam safety devices

Article no.	Article
567304 568304	CT 300/4 CR 300/4
567512 568512	CT 501/2 CR 501/2
567413 568413	CT 401/3 CR 401/3
567314 568314	CT 301/4 CR 301/4

Table 13.1-4: Article numbers for COMPACT C300, C301, C400, C401, C500, C501 multiple light beam safety devices

Article no.	Article
587359 588359	CT 500/2/BH CR 500/2/BH
587353 588353	CT 400/3/BH CR 400/3/BH
587357 588357	CT 300/4/BH CR 300/4/BH
587360 588360	CT 501/2/BH CR 501/2/BH
587354 588354	CT 401/3/BH CR 401/3/BH
587358 588358	CT 301/4/BH CR 301/4/BH

Table 13.1-5: Article numbers for COMPACT C300/BH, C301/BH, C400/BH, C401/BH, C500/BH, C501/BH (BH=MIN-style) multiple light beam safety devices

Article no.	Article
567425 568425	CT 500/2/M12 CR 500/2/M12
567423 568423	CT 400/3/M12 CR 400/3/M12
567421 568421	CT 300/4/M12 CR 300/4/M12
567426 568426	CT 501/2/M12 CR 501/2/M12
567424 568424	CT 401/3/M12 CR 401/3/M12

Table 13.1-6: Article numbers for COMPACT C300/M12, C301/M12, C400/M12, C401/M12, C500/M12, C501/M12 multiple light beam safety devices

Article no.	Article
567422 568422	CT 301/4/M12 CR 301/4/M12

Table 13.1-6: Article numbers for COMPACT C300/M12, C301/M12, C400/M12, C401/M12, C500/M12, C501/M12 multiple light beam safety devices

Article no.	COMPACT-Transceiver	Article no.	Passive deflecting mirror for transceiver
568451	CRT500/2	909606	CPM 500/2V
568453	CRT500/2/BH	909606	CPM 500/2V
568454	CRT500/2/BH5	909606	CPM 500/2V
568456	CRT500/2/GW	909606	CPM 500/2V
568457	CRT500/2/M12	909606	CPM 500/2V
568458	CRT600/2	909605	CPM 600/2V
568459	CRT600/2/A	909605	CPM 600/2V
568460	CRT600/2/BH	909605	CPM 600/2V
568461	CRT600/2/BH5	909605	CPM 600/2V
568463	CRT600/2/GW	909605	CPM 600/2V
568464	CRT600/2/M12	909605	CPM 600/2V

Table 13.1-7: COMPACT CRT transceiver article numbers

13.1.3 COMPACT accessories

Article no.	Description
560300	BT-SSD bracket, swivels, with shock absorber
560120	BT-L bracket with accessories
549918 549986 on request	Relay module, MSI – RM2 Safety Relay, MSI-SR4 Safety interface module, MSI (muting, cycle control)
 150791 150792 150794	Connection cable “MIN-style” (BH) transmitter 4 m 12 m 20 m
 150781 150782 150783	Connection cable “MIN-style” (BH) receiver 4 m 12 m 20 m

Table 13.1-8: COMPACT accessories

Article no.	Description
429071 429072 429073 429074 429075 429076	Connection cable, “M12”, 5-pin 5m, straight socket 5m angled socket 10m, straight socket 10m, angled socket 15m, straight socket 15m, angled socket
429081 429082 429083 429084 429085 429086	Connection cable, “M12”, 8-pin 5m, straight socket 5m, angled socket 10m, straight socket 10m, angled socket 15m, straight socket 15m, angled socket
560020	Laser alignment aid, LA-78U
560030	Laser alignment aid LA-78C/R-UDC (for UDC mounting columns)
549810 549813 549816 549819	Mounting column bracket, swivels, with shock absorber UDC-1000 UDC-1300 UDC-1600 UDC-1900
529603 529604 529606 529607 529609 529610	Deflecting mirror with bracket, swiveling with shock absorber for safety light curtain UM60-300 UM60-450 UM60-600 UM60-750 UM60-900 UM60-1050
549710 549713 549702 549703 549704 549716 549719	UMC deflecting mirror columns for multiple light beam safety devices UMC-1000 UMC-1300 UMC-1002 UMC-1303 UMC-1304 UMC-1600 UMC-1900
560000	COMPACT diagnostics software (from Windows 3.1)
520072	PC adapter (CB-PC0-3000)

Table 13.1-8: COMPACT accessories

Article no.	Description
	Protective screen, PS-C-CP
346503	PS-C-CP-300
346504	PS-C-CP-450
346506	PS-C-CP-600
346507	PS-C-CP-750
346509	PS-C-CP-900
346510	PS-C-CP-1050
346512	PS-C-CP-1200
346513	PS-C-CP-1350
346515	PS-C-CP-1500
346516	PS-C-CP-1650
346518	PS-C-CP-1800
429044	AC-PS-MB-C-CP-1 (2 screen clamps up to 900 mm protective field height)
429045	AC-PS-MB-C-CP-2 (3 screen clamps from 900 mm protective field height)

Table 13.1-8: COMPACT accessories

13.1.4 Scope of delivery for COMPACT/A

All COMPACT/A all delivered with:

- 1 CT/A transmitter
- 1 CR/A receiver
- 2 BT-S bracket sets with accessories
- 4 sliding nuts
- 1 connecting and operating instructions manual

Additionally supplied for the C14 and C30 series:

- 1 test rod 14/30 mm

13.1.5 COMPACT/A ordering info

Article	C14/A	C30/A	C50/A	C90/A
	bb = 14	bb = 30	bb = 50	bb = 90
CTbb-150/A	581151	581351		
CRbb-150/A	584151	584351		
CTbb-225/A	581152	581352		
CRbb-225/A	584152	584352		
CTbb-300/A	581153	581353		
CRbb-300/A	584153	584353		
CTbb-450/A	581154	581354	581554	
CRbb-450/A	584154	584354	584554	
CTbb-600/A	581156	581356	581556	
CRbb-600/A	584156	584356	584556	
CTbb-750/A	581157	581357	581557	581957
CRbb-750/A	584157	584357	584557	584957
CTbb-900/A	581159	581359	581559	581959
CRbb-900/A	584159	584359	584559	584959
CTbb-1050/A	581160	581360	581560	581960
CRbb-1050/A	584160	584360	584560	584960
CTbb-1200/A	581162	581362	581562	581962
CRbb-1200/A	584162	584362	584562	584962
CTbb-1350/A	581163	581363	581563	581963
CRbb-1350/A	584163	584363	584563	584963
CTbb-1500/A	581165	581365	581565	581965
CRbb-1500/A	584165	584365	584565	584965
CTbb-1650/A	581166	581366	581566	581966

Article	C14/A	C30/A	C50/A	C90/A
	bb = 14	bb = 30	bb = 50	bb = 90
CRbb-1650/A	564116	584366	584566	584966
CTbb-1800/A	581168	581368	581568	581968
CRbb-1800/A	584168	584368	584568	584968
CTbb-2100/A			581571	581971
CRbb-2100/A			584571	584971
CTbb-2400/A			581574	581974
CRbb-2400/A			584574	584974
CTbb-2700/A			581577	581977
CRbb-2700/A			584577	584977
CTbb-3000/A			581580	581980
CRbb-3000/A			584580	584980

Art. no.	COMPACT/A multiple light beam safety device, 18 m range	
	C500/2/A	2-beam
587502	CT500/2/A	Transmitter
588502	CR500/2/A	Receiver
	C400/3/A	3-beam
587403	CT400/3/A	Transmitter
588403	CR400/3/A	Receiver
	C300/4/A	4-beam
587304	CT300/4/A	Transmitter
588304	CR300/4/A	Receiver

Device name and order numbers for C500/A, C400/A, C300/A, C501/A, C401/A, C301/A light grids:

Art. no.	COMPACT/A multiple light beam safety device, 60 m range	
	C501/2/A	2-beam
587512	CT501/2/A	Transmitter
588512	CR501/2/A	Receiver
	C401/3/A	3-beam
587413	CT401/3/A	Transmitter
588413	CR401/3/A	Receiver
	C301/4/A	4-beam
587314	CT301/4/A	Transmitter
588314	CR301/4/A	Receiver

Device name and order numbers for CRT500/A, CRT600/A transceivers:

Article no.	COMPACT/A transceiver, 6.5 m range	Art.-Nr.	Passive deflecting mirror for transceiver
568452	CRT500/2/A	909606	CPM 500/2V
568459	CRT600/2/A	909605	CPM 600/2V

13.1.6 COMPACT/A accessories

AS-i Safety accessories

Article no.	Article	Description
580003	APG-02	AS-i programming device for entering addresses for standard/A/B AS-i slaves
50024346	AM06	M12 AS-i bus terminal for AS-i flat cable
50024750	AKB 01	AS-i flat cable (unit per meter)
50024748	KB-095-1000-3AW	Connection cable 1 m axial/angled M12
50024749	KB-095-2000-3AW	Connection cable 2 m axial/angled M12
425730	AC-FES01	Earth set

13.1.7 COMPACT/L scope of delivery

All COMPACT/L are delivered with:

- 1 CTxxxL transmitter
- 1 CRxxxL receiver
- 1 MagnetKey
- 1 connecting and operating instructions manual

13.1.8 COMPACT/L order numbers

Article no.	Article	Weight in kg	Beam distance in mm	Number of beams	OSSD output	Connection system
568600	CT501L/2	1.9	500	2		PG 13.5 cable gland
568601	CR501L/2	1.9	500	2	Semiconductor	PG 13.5 cable gland
568602	CT401L/3	2.7	400	3		PG 13.5 cable gland
568603	CR401L/3	2.7	400	3	Semiconductor	PG 13.5 cable gland
568604	CT501L/2/GW	1.9	500	2		Hirschmann plug connection
568605	CR501L/2/GW	1.9	500	2	Semiconductor	Hirschmann plug connection
568606	CT401L/3/GW	2.7	400	3		Hirschmann plug connection
568607	CR401L/3/GW	2.7	400	3	Semiconductor	Hirschmann plug connection
567429	CT501L/2/M12	1.9	500	2		5-pin M12 plug connection
568429	CR501L/2/M12	1.9	500	2	Semiconductor	8-pin M12 plug connection
568608	CT501L/2/A*	1.9	500	2		3-pin M12 plug connection
568609	CR501L/2/A*	1.9	500	2	AS-i Interface	3-pin M12 plug connection
568610	CT401L/3/A*	2.7	400	3		3-pin M12 plug connection
568611	CR401L/3/A*	2.7	400	3	AS-i Interface	3-pin M12 plug connection

MagnetKey for activating the laser is included with the CTxxxL/x/x transmitter delivery.
A BT-SSD-270 bracket with shock absorber is required for fixing the transmitter and the receiver (one each).
Connection cable and counterplug are not included in the scope of delivery, see accessories, Chapter 13.1.6.

* Supplementary information on COMPACT/A must be observed.

Table 13.1-9: CT transmitter/CR receiver

Article no.	Article	Weight in kg	Description
560301	BT-SSD-270	0.5	Swiveling bracket with shock absorber 270 mm
4 sliding nuts and earth band included with delivery. 1 each required for transmitter and 1 each for receiver.			

Table 13.1-10: Bracket with shock absorber

Article no.	Article	Weight in kg	Beam heights in mm	OSSD output	Connection system
568700	CT501L/2-UDC	7.6	400, 900		PG 13.5 cable gland
568701	CR501L/2-UDC	7.6		Semicon-ductor	PG 13.5 cable gland
568702	CT401L/3-UDC	11.5	300, 700, 1100		PG 13.5 cable gland
568703	CR401L/3-UDC	11.5		Semicon-ductor	PG 13.5 cable gland
568704	CT501L/2/GW-UDC	7.6	400, 900		Hirschmann plug connection
568705	CR501L/2/GW-UDC	7.6		Semicon-ductor	Hirschmann plug connection
568706	CT401L/3/GW-UDC	11.5	300, 700, 1100		Hirschmann plug connection
568707	CR401L/3/GW-UDC	11.5		Semicon-ductor	Hirschmann plug connection
568708	CT501L/2/A-UDC*	7.6	400, 900		3-pin M12 plug connection
568709	CR501L/2/A-UDC*	7.6		AS-i Interface	3-pin M12 plug connection
568710	CT401L/3/A-UDC*	11.5	300, 700, 1100		3-pin M12 plug connection
568711	CR401L/2/A-UDC*	11.5		AS-i Interface	3-pin M12 plug connection
MagnetKey for activating the laser is included with the CTxxxL/x/x UDC delivery. Set of fixing parts for alignment plinth and UDC drill template included in scope of delivery. * Supplementary information on COMPACT/A must be observed (see Chapter 7).					

Table 13.1-11: CT transmitter/CR receiver mounted in the UDC mounting columns at the factory

Article no.	Article	Weight in kg	Description
549702	UMC-1002	6.5	Deflecting mirror columns with 2 individually alignable mirrors
549703	UMC-1303	8.5	Deflecting mirror columns with 3 individually alignable mirrors
2 or 3 alignment templates for the individual mirror alignment with lasers are included in the scope of delivery. Set of fixing/mounting parts for alignment plinth and UMC drill template included in scope of delivery.			

Table 13.1-12: UMC deflecting mirror columns with individually alignable mirrors

13.1.9 COMPACT/L accessories

Article no.	Article	Description
347402	CSG-110/07	Spare part: Flat earth for BT-SSD-270
540810	UDC-1000	Device mounting column
549813	UDC-1300	Device mounting column
425514	BT-UDC-CTL	Mounting set for UDC-1xxx CTL (2 units required per mounting column)
700980	BS-UDC	Spare part: UDC template
425508	UMC/130 mirror	Spare part: Individual mirror, 130 mm complete with mounting
700970	BS-UMC	Spare part: UMC template
700997	JS1002-T	Spare part: UMC-1002 alignment template, top, height 900 mm
700996	JS1002-B	Spare part: UMC-1002 alignment template, bottom, height 400 mm
700993	JS1303-T	Spare part: UMC-1303 alignment template, top, height 1,100 mm
700994	JS1303-C	Spare part: UMC-1303 alignment template, center, height 700 mm
700998	JS1303-B	Spare part: UMC-1303 alignment template, bottom, height 300 mm
520071	AC-MK1	Spare part: MagnetKey for activating alignment laser
426040	CT cable socket encoded	Hirschmann cable socket, straight, encoded for CT, 6-pin +PE, incl. crimp contacts
426041	CR cable socket encoded	Hirschmann cable socket, straight, encoded for CR, 6-pin +PE, incl. crimp contacts
426050	Cable socket/a, CT encoded	Hirschmann cable socket, angled, encoded for CT, 6-pin +PE, incl. crimp contacts
426051	Cable socket/a, CR encoded	Hirschmann cable socket, angled, encoded for CR, 6-pin +PE, incl. crimp contacts

13.2 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.

13.2.1 Checklist for danger point guarding

For a COMPACT safety light curtain (14 and 30 mm resolution), with normal approach to the protective field.

Note!

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

• Is the safety distance calculated in accordance with the valid formulas for danger point guarding, 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 side and positively tested according to 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 unprotected presence between the protective field and danger point safely excluded, e.g. through fixed mechanical measures or through the control of monitored mechanical components or cascading of the COMPACT?	Yes	No
• Are transmitter and receiver fixed against displacement/turning after the alignment?	Yes	No
• Are the protective device and the control devices in good condition?	Yes	No
• Are all connectors and connection cables in fault-free conditions?		
• Is the start/restart button for starting/restarting the AOPD positioned outside the danger zone and is it effective?	Yes	No
• Are the safety outputs (OSSDs), linked into the subsequent machine control unit 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 the dangerous movement stopped immediately if the supply voltage of the AOPD is interrupted and is the start/restart button required to start the machine again after the supply voltage returns? Yes No
- Is the plate with information about the daily check of the AOPD mounted so that it can be seen easily by operating personnel? Yes No

13.2.2 Checklist for danger area guarding

For a COMPACT safety light curtain (50 and 90 mm resolution),
with parallel approach to the protective field

Note!

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

• The minimum height of the protective field above the reference plane relates to the resolution of the AOPD. Was the resolution used for the calculation of the minimum height and is this result considered?	Yes	No
• Has the safety distance been calculated according to the valid formula for **danger area guarding** and has this minimum distance between the most distant beam and the danger point been observed?	Yes	No
• During risk assessment, has it been ensured 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 unprotected presence between the next beam and the danger point definitively excluded?	Yes	No
• Are transmitter and receiver fixed against displacement/turning after the alignment?	Yes	No
• Are the protective device and the control devices in good condition?	Yes	No
• Are all connectors and connection cables in fault-free conditions?	Yes	No
• Is the start/restart button for starting/restarting the AOPD positioned outside the danger zone and is it effective?	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 the dangerous movement stopped immediately if the supply voltage of the AOPD is interrupted and is the start/restart button required to start the machine again after the supply voltage returns?	Yes	No

13.2.3 Checklist for access or perimeter guarding

For a COMPACT multiple light beam safety device (2, 3 or 4 beams)
with normal approach to the protective field.

Note!

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

• Has the safety distance been calculated in accordance with the valid formula for access/perimeter guarding, and has this minimum distance between protective field and the danger points been considered?	Yes	No
• Has care been taken to ensure that the lowest infrared beam of a 2-beam AOPD is located 400 mm above the reference level, and that of 3 and 4-beam AOPDs is located 300 mm above the reference level?	Yes	No
• Was it considered during risk assessment that 2-beam AOPDs mounted above ground level are regarded as being capable of being crawled under (EN 999)?	Yes	No
• If access to the danger points is possible through other routes than the protective field of the AOPD, are the other access options suitably secured by other means?	Yes	No
• Are transmitter and receiver, and deflecting mirror if required, fixed against displacement/turning after the alignment?	Yes	No
• Are the protective device and the control devices in good condition?	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 of the danger area in line with specifications so that it cannot be reached from inside? Is there a complete overview of the danger area from the start/restart button position?	Yes	No
• Are both of 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
• Does the AOPD respond correctly when any beam is interrupted and does the start/restart interlock lock when the beam is interrupted? This is absolutely necessary, as the access, not the presence in the danger area is registered!	Yes	No
• Does the dangerous movement stop immediately if the supply voltage of the AOPD is interrupted and is the start/restart button required to reset the opto-electronic protective device again after the voltage returns?	Yes	No

13.3 COMPACT/L alignment instructions, alignment procedure description with integrated laser alignment aid

13.3.1 Required equipment and tools

- Components as in selection lists, Chapter 1.3 according to the application including delivered templates, mounting parts and MagnetKey
- For UDC; UMC column bases:
  - Torque-controlled expansion anchors: Masonry drill 10 mm, hammer, SW 17 wrench
  - Leveling: SW 16 wrench
  - Turning: SW 6 Allen wrench
- For UDC floor column with transmitter and receiver
  - Height adjustment: SW 10 socket wrench
  - Swiveling bracket: SW5 Allen wrench, SW10 socket wrench
- For UMC deflecting mirror columns
  - Individual mirror adjustment: SW4 Allen wrench

13.3.2 Preliminary note

The laser alignment aid in the transmitter (8) is used to correctly align the deflecting mirror columns and their individual mirrors. For technical reasons it is not possible to set up the two integrated laser aids with 100% beam parallelism.

With the delivered MagnetKey (7) the laser beams can be switched on by briefly setting the MagnetKey to the exit opening of the respective alignment laser. By adjusting the height and by turning the transmitter (8), a position must now be found in which the two beams are the furthest away from the the crosslines and are set so that they hit the crosslines on the template with the same distance. With the individually alignable individual mirrors of the first deflecting mirror columns (4) or (31) the differences can then be balanced out during the rest of the alignment process.

The alignment according to the described method is possible because the invisible infrared light beams that are active for the protective field are slightly cone-shaped (in contrast to the laser beams), and at a distance of just a few meters already radiate over the entire mirror surfaces of the individual mirrors (14).

Warning!

Safety note for all work steps of the entire alignment process

The alignment laser corresponds with laser class 2. Never look directly into the laser beam. This can damage your eye. The safety notes in Chapter 2 must be observed!

13.3.3 Mounting transmitter and receiver

Mount transmitter (8) and receiver (9) exactly vertical and at the same height using swiveling brackets (1) or with mounting using mounting columns above the floor so that the centers (13) of the beam exits and beam entries for the protective field (infrared beams) identified with a “+” run above the reference level.

• C 501L/2/x (2-beam)	• 900 mm		• 400 mm
• C 401L/3/x (3-beam)	• 300 mm	• 700 mm	• 1100 mm

Table 13.3-1: Height of the protective field beams in accordance with EN 999

Note!

2 drill holes/M6 thread at a distance of 200 mm (each 100 mm to the housing center) are required on a stable vertical surface for fixing the swiveling bracket (1).

Note!

If transmitter and receiver are installed in floor columns, use drill templates BS-UDC (6) and otherwise proceed as with the mounting of the UMC deflecting mirror columns (5.3 and following).

Note!

Mark protective field line (2) for the machine with a crayon or with a stringline on the floor. The line marking of the planned fixing mid-points must be at least 150 mm long.

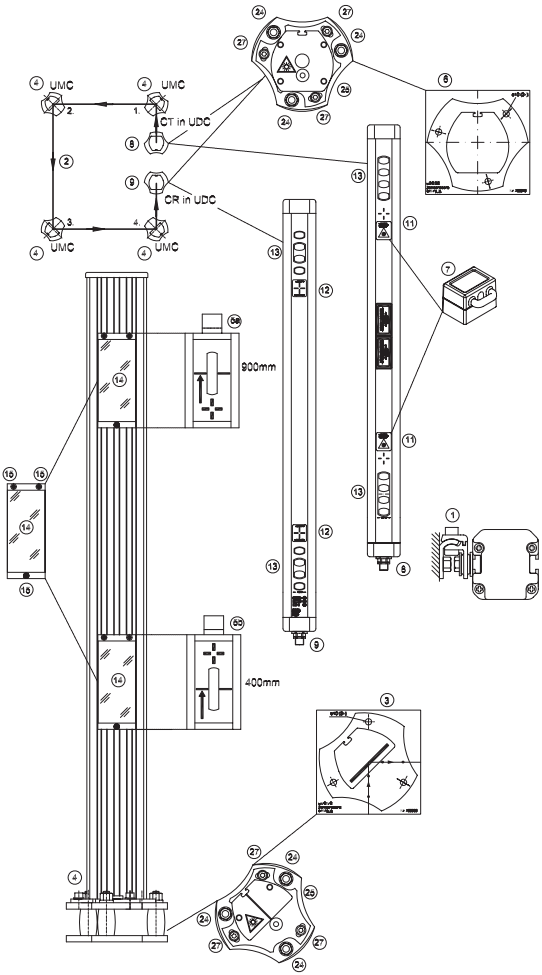
Warning!

The protective field line must take the safety distance between the protective field and danger point(s) into account. The calculating formula for this can be found in Chapter 6.1.

Warning!

The start/restart button for unlocking the restart interlock must be positioned so far outside the protective field line that it is not possible to activate it from the danger area. A good overview of the danger area from the installation location must be ensured so that the operator can be absolutely certain that nobody is present in the danger area when the dangerous movement of the machine starts up.

13.3.4 Using UMC deflecting mirror columns (alignment plinth)



1 = Swiveling mounting bracket with shock absorber
2 = Protective field line
3 = UMC template, BS-UMC
4 = UMC deflecting mirror column
5a = Alignment template, 900 mm
5ba = Alignment template, 400 mm
6 = UMC template, BS-UDC/DC
7 = MagnetKey
8 = Transmitter
9 = Receiver
11 = Beam exit
12 = Receiver target mark
13 = Centers of the invisible infrared beams
14 = Individual alignable mirror
15 = Mirror alignment screws
24 = Adjustment screws
25 = Level
26 = Allen screw

Fig. 13.3-1: Alignment process, perimeter guarding with UMC deflecting mirror columns

Note!

The deflecting mirror columns are positioned so that the connecting lines of the mounting mid-points form a 90° angle.

In the respective protective field corners use the drill template BS-UMC (3), which is to be aligned as precisely as possible with the marking of the protective field line described under 5.3.2, to drill three holes (d = 10 mm, **80 mm** deep) for each deflecting mirror.

Insert the expansion anchors delivered.

Set up the UMC deflecting mirror columns (4) and tighten with three nuts M10/SW17 with 40 Nm.

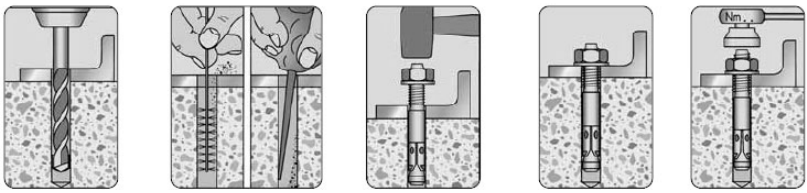


Fig. 13.3-2: Fixing the UMC deflecting mirror columns and UDC mounting columns, if required

Align UMC deflecting mirror columns vertically by tightening the alignment screws (24), use the level in the column base as a rough alignment aid here. With the spirit level vertically align the UMC deflecting mirror columns, and the UDC mounting columns if required, for the transmitter and receiver as precisely as possible.

13.3.5 Example: 2-beam perimeter guarding with 4 deflecting mirror columns; alignment of the two beams

Before switching on the transmitter and receiver ensure that the switching outputs of the receiver to the machine are switched off and are secured against restarting.

Note!

Using AS-i Safety at Work: The AS-i safety monitor remains in the OFF state until the alignment has been completely finished and the proper functioning of the protective device has been tested.

Switch transmitter and receiver on under the abovementioned conditions.

Note!

Using AS-i Safety at Work: Supply the bus system with voltage.

Set alignment template (5a) (included in UMC scope of delivery) on the top individual mirror of the 1st deflecting mirror column.

Set alignment template (5b) (included in UMC scope of delivery) on the bottom individual mirror of the 1st deflecting mirror column.

Note!

The templates must always lie flat on the mirror.

Activate both alignment lasers (11) by briefly setting the MagnetKey (7) to the positions of the laser exit mark on the front screen of the transmitter. Observe safety notes in Chapter 2! The lasers remain switched on for approx. 14 minutes and then switch off automatically. A renewed activation is possible in the same way if required.

Align transmitters that are already vertically set up with locked swiveling bracket (1) by cautiously swiveling and changing the height, if required (see Table 13.3-1), so that the red laser beams hit their target marks on the alignment templates at the same distance (see preliminary note Chapter 13.3.2).

After tightening all fixing screws of the swiveling bracket the vertical alignment of the transmitter must be checked again with the spirit level.

If the transmitter is installed in an already vertically aligned UDC floor column, loosen the allen screws (27) of the alignment plinth and turn the column until the laser beams hit the templates at the same distance to their assigned target marks. Adjust the height of the transmitter in the motuning column if required (see Table 13.3-1). After tightening all fixing screws check the vertical alignment of the mounting column again with the spirit level.

Set the alignment templates (5a) and (5b) flat on the individual mirrors of the 2nd deflecting mirror column. Ensure that (5a) is always set on the top and (5b) on the bottom individual mirror!

The following applies for UMC deflecting columns:

Loosen the allen screws (27) on the alignement plinth of the 1st deflecting mirror column and align the top laser beam by turning the column until it hits the center of the top alignment template. Tighten the Allen screws again; check the vertical alignment of the column.

Align the top individual mirror of the 1st deflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the top alignment template (5a) of the 2nd deflecting mirror column. Check the setting of the mirror alignment screws (15).

Align the bottom individual mirror of the 1st deflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the bottom alignment template (5b) of the 2nd deflecting mirror column. Check the setting of the mirror alignment screws (15).

Note!

A visual inspection must be made after the fine alignment of the individual mirrors is finished. All three mirror alignment screws (15) must butt against the metal mirror plates; the springs must not be pushed in all the way. After pressing and releasing the metal mirror plate with the hand the alignment must not change.

Set the alignment templates (5a) and (5b) flat on the individual mirror of the 3rd deflecting mirror column. Ensure that (5a) is always set on the top and (5b) on the bottom individual mirror!

The following applies for UMC deflecting columns:

Loosen the allen screws (27) on the alignement plinth of the 2nd deflecting mirror column and align the top laser beam by turning the column until it hits the center of the alignment template. Tighten the Allen screws again; check the vertical alignment of the column.

Align the top individual mirror of the 2nd deflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the top alignment template (5a) of the 3rd deflecting mirror column. Check the setting of the mirror alignment screws (15).

Align the bottom individual mirror of the 2nd deflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the bottom alignment template (5b) of the 3rd deflecting mirror column. Check the setting of the mirror alignment screws (15).

Set the alignment templates (5a) and (5b) flat on the individual mirror of the 4th deflecting mirror column. Ensure that (5a) is always set on the top and (5b) on the bottom individual mirror!

The following applies for UMC deflecting columns:

Loosen the allen screws (27) on the alignement plinth of the 3rd deflecting mirror column and align the top laser beam by turning the column until it hits the center of the alignment template. Tighten the Allen screws again; check the vertical alignment of the column.

Align the top individual mirror of the 3rd deflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the top alignment template of the 4th deflecting mirror column. Check the setting of the mirror alignment screws (15).

Align the bottom individual mirror of the 3rddeflecting mirror column by adjusting the Allen screws (15) so that the laser beam hits the target mark of the bottom alignment template (5b) of the 4th deflecting mirror column. Check the setting of the mirror alignment screws (15).

Remove and store alignment templates (5a) and (5b) somewhere safe.

The following applies for UMC deflecting columns:

Loosen the allen screws (27) on the alignment plinth of the 4th deflecting mirror column and align the top laser beam by turning the deflecting mirror column until it hits the center of the receiver. Tighten the Allen screws again; check the vertical alignment of the column.

Align the top individual mirror of the 4th deflecting mirror column by adjusting the allen screws (15) so that the laser beam hits the top target mark on the receiver. Check the setting of the mirror alignment screws (15).

Align the bottom individual mirror of the 4th deflecting mirror column by adjusting the allen screws (15) so that the laser beam hits the top target mark on the receiver. Check the setting of the mirror alignment screws (15)..

13.3.6 Aligning the receiver

The height of the reciever is already optimized with the alignment of the individual mirrors of the deflecting mirror columns. Improvements may be possible by turning the receiver. The vertical positioning of the receiver, which must be checked again with the spirit level after the adjusting work, is still very important.

When mounting with swiveling brackets(1): The receiver (9) can be turned when the swiveling bracket is loosened, without the height setting be changed.

After the alignment work on the individual mirrors the receiver should receive enough power from the invisible infrared light beams so that the LED display has switced from red to green. By turning the receiver without activated RES anti-clockwise a positon can be found at which the display switches from “green” to “red”. With the receiver with selected RES, a position can be found at which the orange LED 4 changes from “on” to “off” by turning anti-clockwise. "Orange" may also appear briefly, which signals a weak reception. This position and this angle must be noted.

The receiver is then turned clockwise until the green display appears and further until the red display lights again. This position must also be noted. The optimum setting is exactly in the middle of the two noted positions, to which the receiver is then turned back and fixed. The vertical alignment with the receiver must then also be checked with the spirit level.

If the receiver is installed in a mounting column, to optimize the receiver the three fixing screws (27) of the alignment plinth must be loosened so that the optimization process described above is possible by turning the column. The three Allen screws are then firmly tightened again, and the vertical alignment is checked with the spirit level.

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