Leuze electronic

the sensor people

CML 730-PS
Measuring light curtain

Original operating instructions

⌬ Leuze electronic
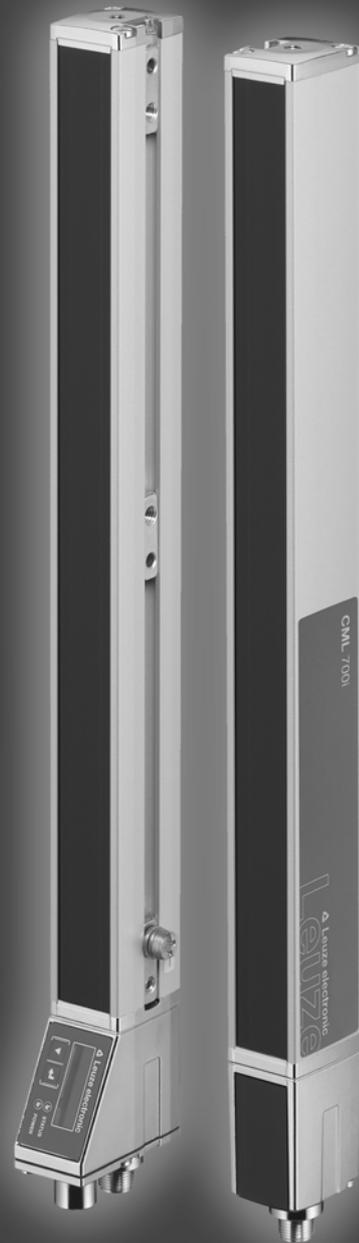
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1 About this document

These original operating instructions contain information regarding the proper use of the CML 700i measuring light curtain series. It is included in the delivery contents.

1.1 Used symbols and signal words

Table 1.1: Warning symbols, signal words and symbols

⚠	Pay attention to passages marked with this symbol. Failure to observe the provided instructions could lead to personal injury or damage to equipment.
NOTE	Signal word for property damage Indicates dangers that may result in property damage if the measures for danger avoidance are not followed.
⊙̤	Symbol for tips Text passages with this symbol provide you with further information.
⇲	Symbol for action steps Text passages with this symbol instruct you to perform actions.

Table 1.2: Operating on the display

⬇ **Main Settings**	Bold text Indicates that this field is currently selected and appears highlighted in the receiver display.
➡ Digital IOs	Normal text Indicates that this field is not currently selected (is not highlighted in the receiver display).

1.2 Terms and abbreviations

Table 1.3: Terms and abbreviations

DTM (**D**evice **T**ype **M**anager)	Software device manager of the sensor
IO	Input Output
FB (**F**irst **B**eam)	First beam
FIB (**F**irst **I**nterrupted **B**eam)	First interrupted beam
FNIB (**F**irst **N**ot **I**nterrupted **B**eam)	First not interrupted beam
FDT (**F**ield **D**evice **T**ool)	Software frame for management of device managers (DTM)
LB (**L**ast **B**eam)	Last beam
LIB (**L**ast **I**nterrupted **B**eam)	Last interrupted beam
LNIB (**L**ast **N**ot **I**nterrupted **B**eam)	Last not interrupted beam
TIB (**T**otal **I**nterrupted **B**eams)	Total of interrupted beams
TNIB (**T**otal **N**ot **I**nterrupted **B**eams)	Total of not interrupted beams (TNIB = n - TIB)
n	Number of all logical beams of a light curtain; dependent on the selected measurement field length and resolution as well as the beam mode (parallel- / diagonal- / crossed-beam scanning)
IODD	IO Device Description (IODD file for IO-Link interface) Description of the device for the control

GUI (**G**raphical **U**ser **I**nterface)	Graphical user interface
PS (**P**ower **S**etting)	Separate adjustment of the transmitter/receiver relative to transmitting power and receiving sensitivity.
PLC	Programmable Logic Control (corresponds to Programmable Logic Controller (PLC))
Response time per beam	Length of time for the evaluation of a beam
Resolution	The minimum size of an object that can be reliably detected. With parallel-beam evaluation, the smallest object to be detected corresponds to the sum of beam spacing and optic diameter.
Delay before start-up	Duration between the switching on of the supply voltage and the start of operational readiness of the light curtain
Function reserve (sensitivity adjustment)	Ratio of the optical reception power set during the teach event and the minimum light quantity required to switch the individual beam. This compensates for the light attenuation caused by dirt, dust, smoke, humidity and vapor. High function reserve = low sensitivity Low function reserve = high sensitivity
Measurement field length	Optical detection range between the first and last beam
Beam spacing	Center-to-center spacing between two beams
Cycle time	Sum of the response times of all beams of a light curtain plus the duration of the internal evaluation. Cycle time = number of beams x response time per beam + evaluation time
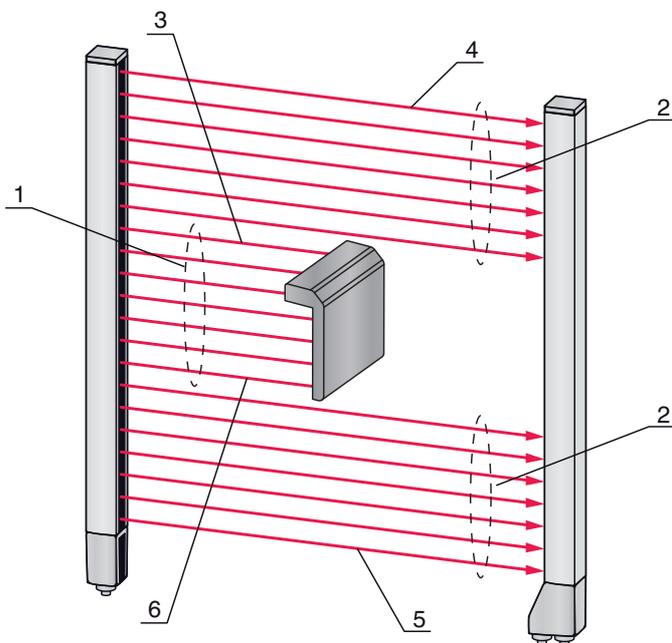
1   TIB (total of interrupted beams)
2   TNIB (total of not interrupted beams)
3   LIB (Last interrupted beam)
4   LNIB (Last not interrupted beam)
5   FNIB (First not interrupted beam)
6   FIB (First interrupted beam)

Figure 1.1:   Definition of terms

2   Safety

This sensor was developed, manufactured and tested in line with the applicable safety standards.
It corresponds to the state of the art.

2.1   Intended use

The device is designed as a measuring and object-detecting, configurable, multi-sensor unit.

Areas of application

The measuring light curtain is designed for the measurement and detection of objects for the following areas of application in handling and warehousing systems, the packaging industry or a comparable environment:

  • Height measurement
  • Width measurement
  • Contour measurement
  • Orientation detection

⚠ CAUTION
Observe intended use!
↳ Only operate the device in accordance with its intended use.
The protection of personnel and the device cannot be guaranteed if the device is operated in a manner not complying with its intended use.
Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use.
↳ Read the original operating instructions before commissioning the device.
Knowledge of the original operating instructions is an element of proper use.

NOTICE
Comply with conditions and regulations!
↳ Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

2.2   Foreseeable misuse

Any use other than that defined under "Intended use" or which goes beyond that use is considered improper use.

In particular, use of the device is not permitted in the following cases:

  • in rooms with explosive atmospheres
  • in circuits which are relevant to safety
  • for medical purposes

NOTICE
Do not modify or otherwise interfere with the device!
↳ Do not carry out modifications or otherwise interfere with the device.
The device must not be tampered with and must not be changed in any way.
The device must not be opened. There are no user-serviceable parts inside.
Repairs must only be performed by Leuze electronic GmbH + Co. KG.

2.3   Competent persons

Connection, mounting, commissioning and adjustment of the device must only be carried out by competent persons.

Prerequisites for competent persons:

- They have a suitable technical education.
- They are familiar with the rules and regulations for occupational safety and safety at work.
- They are familiar with the original operating instructions of the device.
- They have been instructed by the responsible person on the mounting and operation of the device.

Certified electricians

Electrical work must be carried out by a certified electrician.

Due to their technical training, knowledge and experience as well as their familiarity with relevant standards and regulations, certified electricians are able to perform work on electrical systems and independently detect possible dangers.

In Germany, certified electricians must fulfill the requirements of accident-prevention regulations BGV A3 (e.g. electrician foreman). In other countries, there are respective regulations that must be observed.

2.4   Exemption of liability

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

- The device is not being used properly.
- Reasonably foreseeable misuse is not taken into account.
- Mounting and electrical connection are not properly performed.
- Changes (e.g., constructional) are made to the device.

3 Device description

3.1 General information

The light curtains of the CML 700i series are designed as measuring and object-detecting, configurable, multi-sensor units. Depending on the configuration and model, the devices are suitable for a variety of tasks with various resolutions and can be integrated in different control environments.

The total system of the light curtain consists of a transmitter and a receiver, including the connection and interconnection cables.

- Transmitter and receiver are connected to one another via a synchronization cable.
- The integrated control panel with indicators and operational controls for configuring the total system is located on the receiver.
- The shared power supply is provided via connection X1 on the receiver.

1	Transmitter
2	Receiver
3	IO Logic with control panel
4	Control (PLC)
5	Synchronization cable
6	Connection cable for supply voltage and measurement data interface
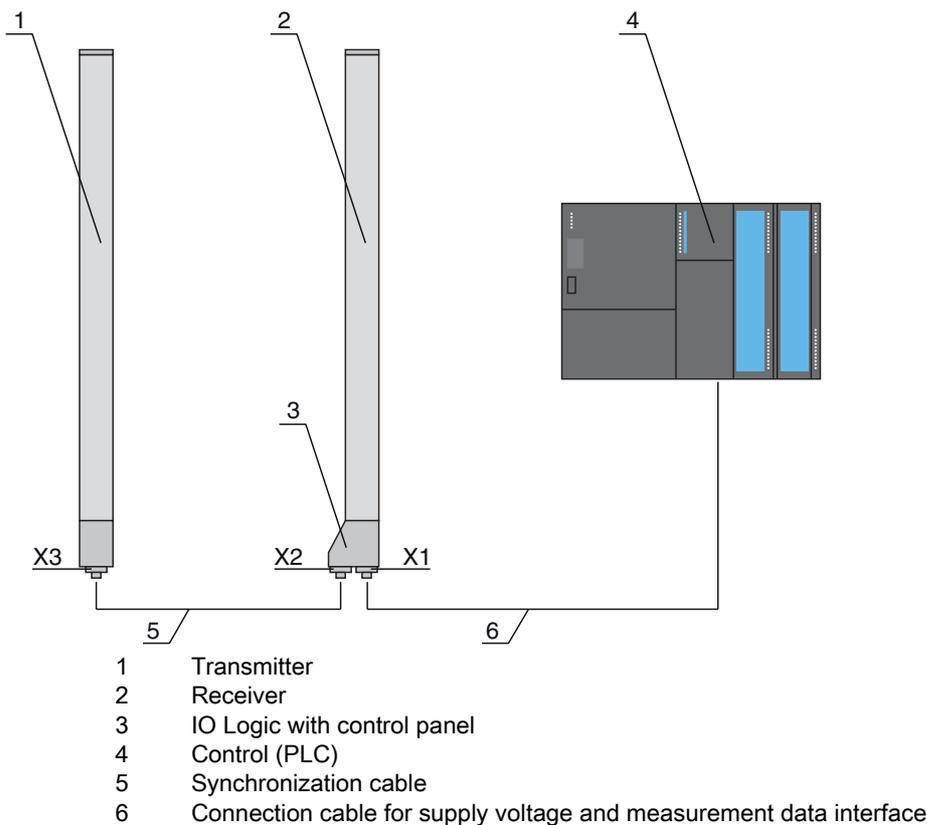
Figure 3.1:   Total system in combination with a programmable logic control

3.2 General performance characteristics

The most important performance characteristics of the CML 730-PS series are:

- Operating range up to 4000 mm
- Measurement field length from 150 mm to 1280 mm
- Beam spacing: 5 mmResponse time 10 µs per beam
- Beam modes: parallel, diagonal, crossed-beam
- Single-beam evaluation (beam-stream)
- Evaluation functions: TIB, TNIB, LIB, LNIB, FIB, FNIB, status of beam areas 1 … 32, status of the digital inputs/outputs
- Local control panel with display
- Interfaces to the machine control:

    - 1 analog current/voltage output plus IO-Link

3 digital inputs/outputs (configurable, including validation output)
- Blanking of unnecessary beams
- Smoothing for interference suppression
- Cascading of multiple devices
- Block evaluation of beam areas
- Position / hole recognition with continuous web material
- Detection of transparent media
- Power setting
  Separate adjustment of the transmitting power and the receiving sensitivity enables optimum results for the objects which need to be detected.
- Key lock
  The *Key lock* function prevents entries and configuration changes from being made via the membrane keyboard on the receiver control panel.

3.3   Connection technology

The transmitter and receiver feature an M12 connector with the following number of pins:

Device type	Designation on device	Plug/socket
Receiver	X1	M12 plug, 8-pin
Receiver	X2	M12 socket, 5-pin
Transmitter	X3	M12 plug, 5-pin

3.4   Display elements

The display elements show the device status in operation and provide support during commissioning and error analysis.

Located on the receiver is a control panel with the following display elements:
- two LEDs
- one OLED display (Organic Light-Emitting Diode), two-line

Located on the transmitter is the following display element:
- one LED

3.4.1   Operation indicators on the receiver control panel

Two function indicator LEDs are located on the receiver control panel.
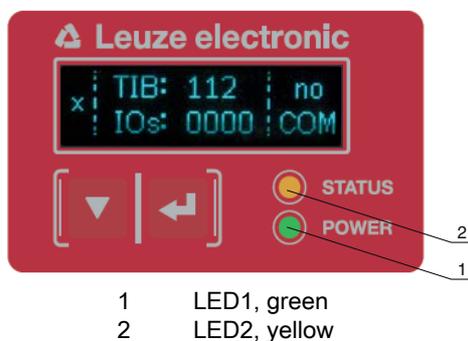
1   LED1, green
2   LED2, yellow

Figure 3.2:   LED indicators on the receiver

Table 3.1:   Meaning of the LEDs on the receiver

LED	Color	State	Description
1	Green	ON (continuous light)	Light curtain ready (normal mode)
		Flashing	see chapter 13.2
		OFF	Sensor not ready
2	Yellow	ON (continuous light)	All active beams are free - with function reserve
		Flashing	see chapter 13.2
		OFF	At least one beam interrupted (object detected)

3.4.2   Display on the receiver control panel

Located on the receiver is an OLED display which serves as a function indicator.

Figure 3.3:   OLED display on the receiver

The type of display on the OLED display is different for the following operating modes:
- Alignment mode
- Process mode

Display indicators in alignment mode

In alignment mode, the OLED display shows the received signal level of the first active logical beam (FB) and of the last active logical beam (LB) via two bar graph indicators.
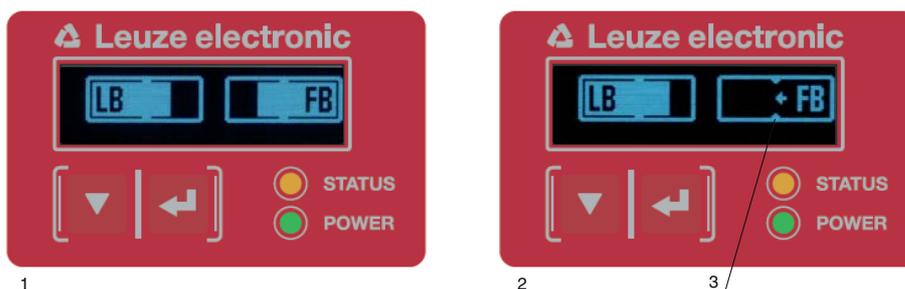
1   Evenly aligned light curtain
2   No reception signal from first beam (FB); good reception signal from last beam (LB)
3   Marker for the minimum signal level which is to be achieved

Figure 3.4:   OLED display on the receiver in alignment mode

Display indicators in process mode

In process mode, the upper line shows the number of interrupted beams (TIB) and the lower line shows the logic state of the digital outputs. The value to be displayed is configurable.
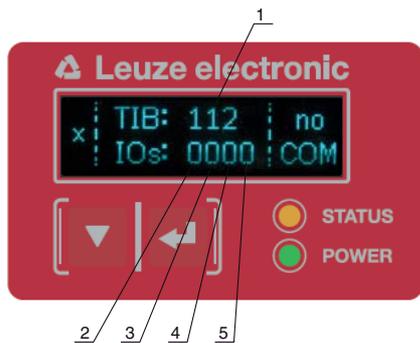
1   Total of interrupted beams
2   Logic state at pin 2 (0 = not active, 1 = active)
3   Logic state at pin 5 (0 = not active, 1 = active)
4   Logic state at pin 6 (0 = not active, 1 = active)
5   Logic state at pin 7 (0 = not active, 1 = active)

Figure 3.5:   OLED display on the receiver in process mode

If the control panel is not used for several minutes, the display darkens and switches off. Press a function button to again make the display visible. Settings for visibility, display duration, etc. can be changed via the Display menu.

3.4.3   Operating indicators on the transmitter

Located on the transmitter is an LED which serves as a function indicator.

Table 3.2:   Meaning of the LED on the transmitter

LED	Color	State	Description
1	Green	ON (continuous light or flashing in sync with the measurement)	Light curtain operates continuously with maximum measurement frequency
		OFF	No communication with the receiver Light curtain waits for external trigger signal

3.5   Operating elements on the receiver control panel

Located on the receiver below the OLED display is a membrane keyboard with two function buttons for entering various functions.

Figure 3.6:   Function buttons on the receiver

3.6   Menu structure of the receiver control panel

The following summary shows the structure of all menu items. In a given device model, only the actually available menu items are present for entering values or for selecting settings.

Menu level 0

Level 0

Main Settings
Digital IOs
Analog Output
Display
Information
Exit

Menu "Main Settings"

Level 1	Level 2	Description					
Commands		Teach	Reset	Factory Settings	Exit		
Operation Settings	Filter Depth	(enter value) min = 1 max = 255					
	Beam Mode	Parallel	Diagonal	Crossed-beam			
	Blanking Teach	Inactive Active					
	Power-Up Teach	Inactive Active					
	Smoothing	(enter value) min = 1 max = 255					
	Inv. Smoothing	(enter value) min = 1 max = 255					
	Counting Direction	Normal	Inverted				
Sensitivity Setting	Function Reserve	High	Medium	Low	Transparent	Target Function Reserve	Tx/Rx Power Reserve
	Nominal Value	(enter value) min = 1 max = 999					
	Receiving Sensitivity	(enter value) min = 1 max = 22					
	Transmitting Power	(enter value) min = 3 max = 100					
	Switch Threshold	(enter value) min = 5 max = 98					
	Hysteresis	(enter value) min = 5 max = 80					
IO-Link	PD Length	8 bytes	32 bytes				
	Data Storage	Inactive	Active	Event			

Menu "Digital IOs"

Level 1	Level 2	Description					
IO Logic		Negative NPN	Positive PNP				
IO Pin 2 IO Pin 5 IO Pin 6	IO Function	Trigger In	Teach In	Area Out	Warn Out	Trigger Out	Validation Out
	Inversion	Normal	Inverted				
	Teach height	Execute	Exit				
	Area Logic	AND	OR				
	Start Beam	(enter value) min = 1 max = 1774					
	End Beam	(enter value) min = 1 max = 1774					

Menu "Analog output"

Level 1	Level 2	Description						
Analog signals		Off	U: 0 … 5 V	U: 0 … 10 V	U: 0 … 11 V	I: 4 … 20 mA	I: 0 … 20 mA	I: 0 … 24 mA
Analog Function		Off	FIB	FNIB	LIB	LNIB	TIB	TNIB
Start Beam		(enter value) min = 1 max = 1774						
End Beam		(enter value) min = 1 max = 1774						

Menu "Display"

Level 1	Level 2	Description					
Language		English	German	French	Italian	Spanish	
Mode		Process Mode	Alignment				
Visibility		Off	Dark	Normal	Bright	Dynamic	
Time Unit (s)		(enter value) min = 1 max = 240					
Evaluation Function		TIB	TNIB	FIB	FNIB	LIB	LNIB

Menu "Information"

Level 1	Level 2	Description
Product Name		CML 730-PS
Product ID		Receiver Part No. (e.g., 50119835)
Serial Number		Receiver Serial Number (e.g., 01436000288)
Transmitter ID		Transmitter Part No. (e.g., 50119407)
Transmitter SN		Transmitter Serial No. (e.g., 01436000289)
FW Version		E.g., 02.40
HW Version		e.g., A001
Kx Version		e.g., P01.30e

3.7 Menu navigation on the receiver control panel

The ▼ and ↵ buttons have different functions depending on the operating situation. These functions are displayed at the left edge of the display above the icons.

3.7.1 Meaning of the display icons

Icon	Position	Function
⬇	First line	Symbolizes that you can select the next parameter within a menu level by pressing the ▼ button.
⬆	First line	Symbolizes that you have reached the lowest menu level (not highlighted).
➡	Second line	Symbolizes the respective, next menu level that you have not yet selected (not highlighted).
⬅	Second line	Press the ↵ button to exit the menu level or the menu.
🖊	Second line	Symbolizes the input mode. The selected (highlighted) option field can be a fixed selection parameter or a multi-digit input field. With a multi-digit input field, you can increase the active digit by one with the ▼ button and use the ↵ button to switch from one digit to the next.
✓	Second line	Symbolizes the confirmation of a selection. This icon appears when you complete an option field with the ↵ button.
✕	Second line	Symbolizes the rejection of a selection. This icon is accessed from the previous icon (check mark) by pressing the ▼ button. This mode allows you to reject the current value or option parameter by pressing the ↵ button.
↻	Second line	Symbolizes the return to the selection. This icon is accessed from the previous icon (cross) by pressing the ▼ button. This mode allows you to reset the current value or option parameter for the purpose of entering a new value or selecting an option parameter by pressing the ↵ button.

3.7.2 Level display

The display of bars between icons and text that span both lines indicates the open menu levels. The example shows a configuration in the menu level 2:
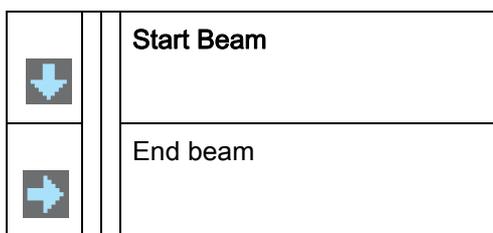
⬇	Start Beam
➡	End beam

3.7.3 Menu navigation

	Main Settings
⬇	
	Digital IOs
➡	

▼   Selects the next menu item ("Digital IOs"); the other menu items follow if pressed again.

↵   Selects the highlighted submenu ("Main Settings").

3.7.4 Editing value parameters

	Start Beam
⬇	
	End beam
➡	

↵   Selects the "Start Beam" menu item with the bright background.

	Start beam
⬆	
	0001

▼   Changes the value of the first digit (**0**).

↵   Selects additional numbers for configuring values.

After entering the last number, the total value can be saved, rejected or reset.

	Start beam
⬆	
✔	**0010**

↵   Saves the new value (**0010**).

▼   Changes the action mode; first ✖ and then ↻ appears on the second line.

If the selected option is not saved in the window above, but rather the ✖ action mode is selected with the ▼ button, this means:

⬆			Start beam
✕			**0010**

↵   Rejects the current input value. The display returns to the higher-order menu level: Start Beam/ End Beam

If the [↻] action mode is selected with the ▼ button, this means:

⬆			Start beam
↻			**0010**

↵   Resets the current input value (**0001**) and allows the entry of new values.

3.7.5 Editing selection parameters

⬇		**IO Logic**
➡		IO Pin 2

↵   Selects the "IO Logic" menu item with the bright background.

⬆		IO Logic
⟲		**Positive PNP**

▼   With each actuation, displays the next option on this menu level, i.e., the display switches between:
- Negative NPN
- Positive PNP

↵   Selects the "Positive PNP" menu item with the bright background.

		IO Logic
		Positive PNP

▼   Changes the action mode; appears; subsequent actuation displays or again.

↵   saves the selected option "Positive PNP".

4   Functions

This chapter describes the functions of the light curtain for adaptation to different applications and operating conditions.

4.1   Beam modes

4.1.1   Parallel

In "parallel"-beam mode (parallel-beam scanning), the light beam of each transmitter LED is detected by the directly opposing receiver LED.
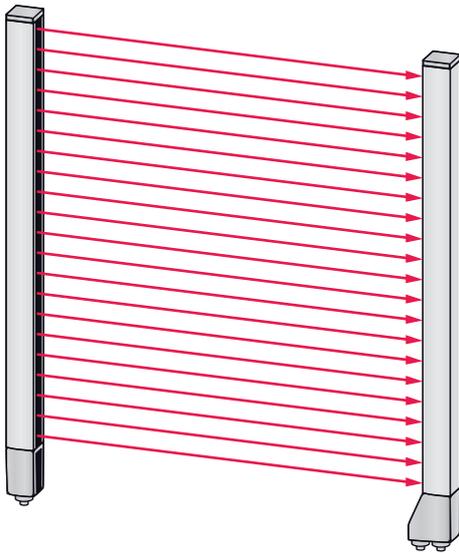
Figure 4.1:   Beam path in "parallel"

4.1.2   Diagonal

In "diagonal" beam mode, the light beam of each transmitter diode is received in succession both by the directly opposing receiver diode as well as by the next receiver diode in the counting direction (i-1) (parallel and diagonal beam path). This increases the resolution in the middle between the transmitter and receiver.
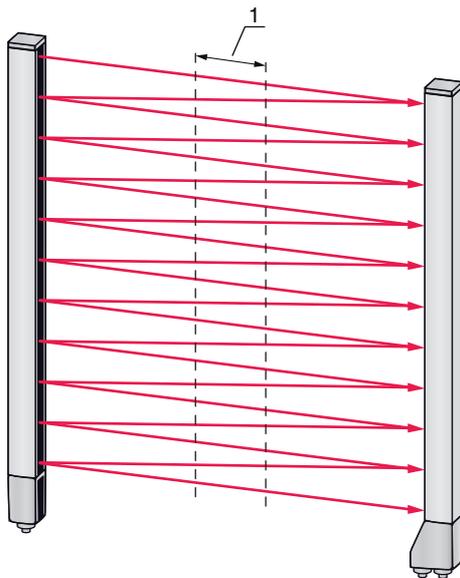
1   Area with increased resolution

Figure 4.2:   Beam path in "diagonal"

Calculation

The number of beams for diagonal-beam scanning n_p is calculated from the number of beams for parallel-beam scanning n_d.

Formula for calculating the number of beams for diagonal-beam scanning

$$n_d = 2n_p - 1$$

n_d	[number]	= number of beams for diagonal-beam scanning
n_p	[number]	= number of beams for parallel-beam scanning

Example: 288 beams in parallel-beam scanning become 575 logical individual beams in diagonal-beam scanning, which must be taken into account during evaluation functions. With a beam spacing of 5 mm, this spacing is reduced to 2.5 mm in the center area.

> The "diagonal" beam mode (diagonal-beam scanning) can be activated via the IO-Link interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

NOTICE

Minimum distance for diagonal-beam scanning!

⮂ For diagonal-beam scanning, the minimum distance that must be maintained between transmitter and receiver changes, whereby the values vary depending on beam spacing (see chapter 16).

NOTICE

Teach after changing the beam mode!

⮂ Changing the beam mode changes the number of beams used for the evaluation. Perform a teach after changing the beam mode (see chapter 8.2).

4.1.3 Crossed-beam

The "crossed-beam" mode (crossed-beam scanning) is available for increasing the resolution for an area of the measurement field. In "crossed-beam" mode, the light beam of each transmitter LED is detected in succession both by the directly opposing receiver LED as well as by the two adjacent receiver LEDs (i+1, i-1).
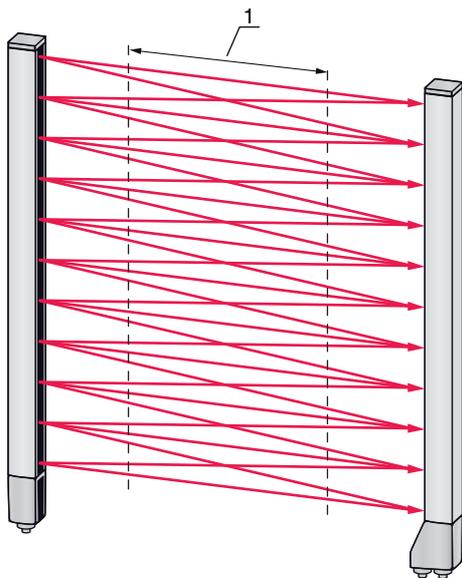
1   Area with increased resolution

Figure 4.3:   Beam path in "crossed-beam"

Calculation

The number of beams for crossed-beam scanning n_p is calculated from the number of beams for parallel-beam scanning n_k.

Formula for calculating the number of beams for crossed-beam scanning

$$n_k = 3n_p - 2$$

n_K	[number]	= number of beams for crossed-beam scanning
n_p	[number]	= number of beams for parallel-beam scanning

NOTICE
Minimum distance for crossed-beam scanning!
✎ For crossed-beam scanning, the minimum distance that must be maintained between transmitter and receiver changes, whereby the values vary depending on beam spacing (see chapter 16).

Example: 288 beams in parallel-beam scanning become 862 logical beams in crossed-beam scanning. With a beam spacing of 5 mm, this spacing is reduced to 2.5 mm in the center area.

The "crossed-beam" mode (crossed-beam scanning) can be activated via the IO-Link interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

4.2 Measurement beam sequence

By default, the counting direction of the beams begins at the sensor connection unit. It can, however, be reconfigured so that counting begins with 1 at the sensor head.

The simplest application case for the inverted beam sequence is vertical mounting with the connection unit at the top, e.g., for height measurement, where beam 1 is to begin at the bottom:

a	Receiver connection unit
b	Optical part
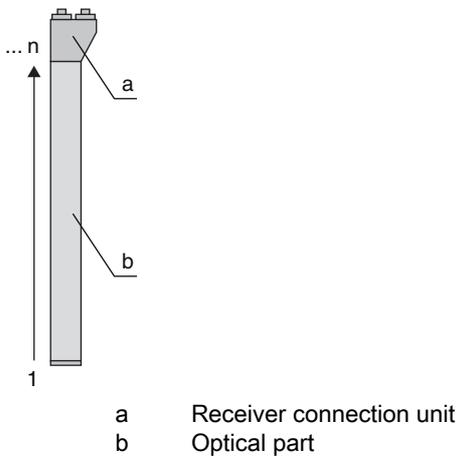
Another variant with two successive light curtains, where the second is rotated by 180° and counting again begins with 1, is illustrated as follows:

a	Receiver connection unit
b	Optical part
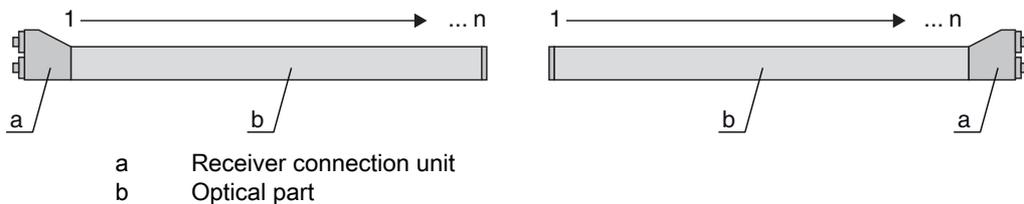
For width detection, counting can begin with 1 at either end at the head part of the sensor as shown below:

a	Receiver connection unit
b	Optical part
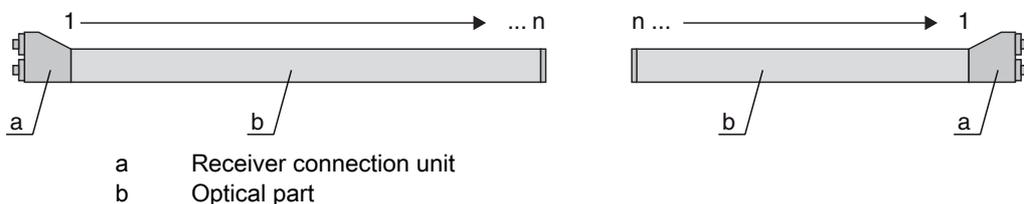
○
⫿ The counting direction can be changed via the respective fieldbus interface (see chapter 10 et seq.) or via the *Sensor Studio* configuration software (see chapter 12).

4.3   Beam-stream

The single-beam evaluation (beam-stream) returns the status of each individual beam (see figure 4.4). Uninterrupted beams (free beams) are represented as logical 1 in the output bit in this case.

○
⫿ The data is available via the respective fieldbus interface (et seq.) or via the *Sensor Studio* configuration software (see chapter 12).

For an example configuration, see chapter 11.1.
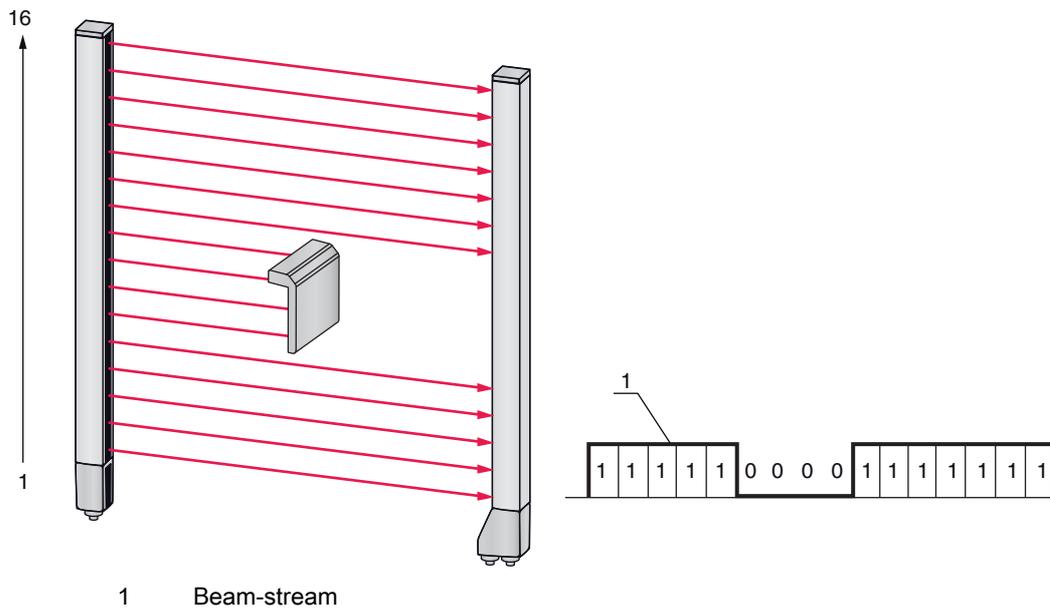
| | 1 | Beam-stream |

Figure 4.4:   Example: beam-stream evaluation

4.4   Evaluation functions

The states of the individual optical beams (free/interrupted) can be evaluated in the CML 700i and the result read out via various evaluation functions.
The most important evaluation functions are shown in the following figure:

1	Total of interrupted beams (TIB)
2	Total of not interrupted beams (TNIB)
3	Last interrupted beam (LIB)
4	Last not interrupted beam (LNIB)
5	First not interrupted beam (FNIB)
6	First interrupted beam (FIB)
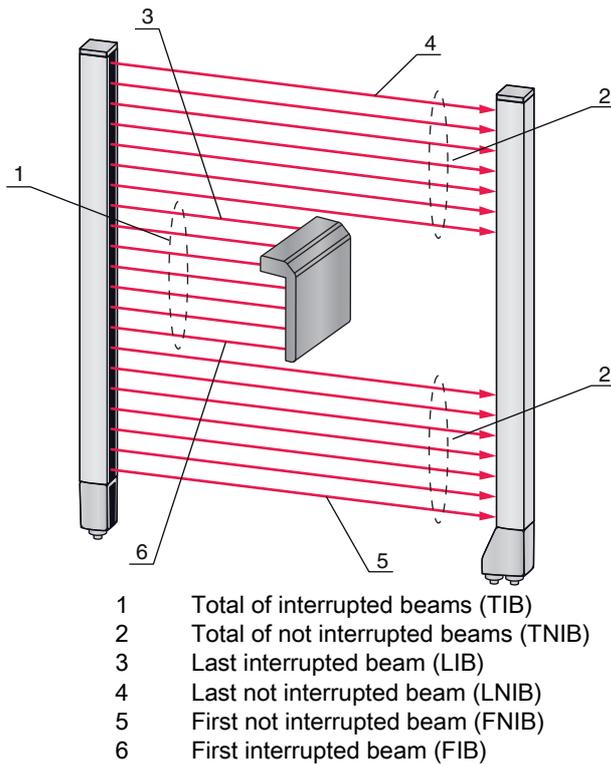
Figure 4.5: Evaluation functions

Also included among the evaluation functions are:
- the status of beam areas 1 … 32
- the status of the digital inputs/outputs

For the beam area mappings to an output pin or the status of the digital inputs/outputs, see chapter 4.10.

4.5 Hold function

The setting of the hold times is performed via the respective fieldbus interface (et seq.) or via the *Sensor Studio* configuration software (see chapter 12).

The minima and maxima of the following evaluation functions can be temporarily stored for an adjustable period of time via this function:
- First interrupted beam (FIB)
- First not interrupted beam (FNIB)
- Last interrupted beam (LIB)
- Last not interrupted beam (LNIB)
- Total of interrupted beams (TIB)
- Total of not interrupted beams (TNIB)
- Single-beam evaluation (beam-stream): A beam that has been interrupted once is kept at logical 0 in the output bit until the hold time has expired.

Temporary storage simplifies the reading out of the measurement results if the used control cannot transmit the data at the same speed that the light curtain makes the data available.

4.6 Blanking

If light curtains are installed such that existing frames / cross bars etc. continuously interrupt some beams, these beams must be suppressed.

During blanking, beams that are not to be included in the evaluation are suppressed. The numbering of the beams is not affected, i.e., the suppression of beams does not change the beam numbers.

1	Interrupted beams
2	Suppressed beams (blanking)
3	Free beams
4	Object present at the installation site
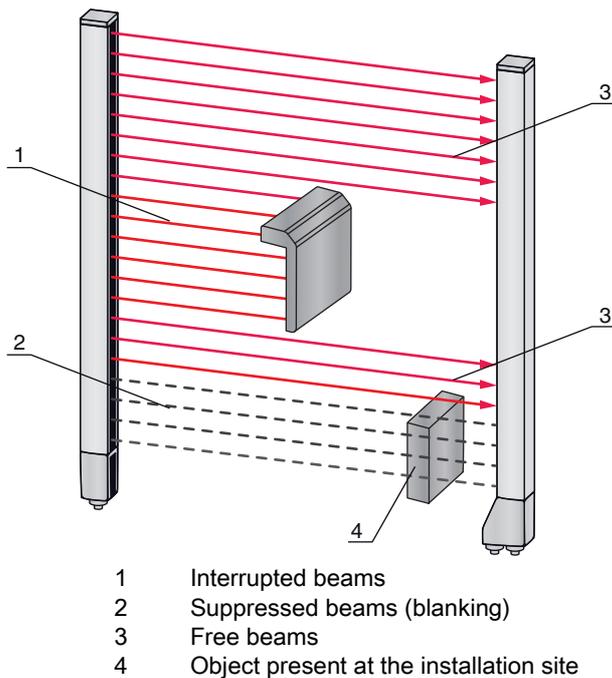
Figure 4.6:   Beam states

Up to four adjacent beam areas can be suppressed.

The beams can be activated or suppressed via the respective fieldbus interface (see chapter 10 et seq.), via the *Sensor Studio* configuration software (see chapter 12) and partially via the operational controls on the receiver.

The behavior of each blanking area can be adapted to the requirements of the application:

Logical value of a blanking area	Meaning in the application
No beams are blanked	All beams of the device are included in the evaluation.
Logical value 0 for blanked beams	All beams of the blanking area are taken into account as interrupted beams (logical value 0) in the evaluation.
Logical value 1 for blanked beams	All beams of the blanking area are taken into account as free beams (logical value 1) in the evaluation.
Logical value is the same as the adjacent beam with lower beam number	All beams of the blanking area behave in the evaluation like the previous beam.
Logical value is the same as the adjacent beam with higher beam number	All beams of the blanking area behave in the evaluation like the subsequent beam.

For an example configuration, see chapter 11.4.

NOTICE
Teach after changing the blanking configuration!
⇨ Perform a teach after changing the blanking configuration (see chapter 8.2).

Auto blanking during teaching

If there are obstacles present in the measurement field at the installation site and at least one blanking area is activated, interrupted beams can be mapped to the blanking area(s) during teaching. Existing settings for the blanking areas are then overwritten (see chapter 8.2).

If no beams are interrupted during teaching, no blanking areas are configured.

If the *Auto blanking* function is activated via the receiver control panel, up to four blanking areas are automatically permitted.

Auto blanking cannot be used to detect transparent objects.

Deactivated beams are lost if the beam mode is changed while auto blanking is active.

NOTICE
Deactivate auto blanking in process mode!
✇ Deactivate auto blanking in process mode.
Activate auto blanking only during commissioning of the device to suppress distracting objects.

NOTICE
Deactivate auto blanking during Power-Up Teach!
✇ Deactivate auto blanking if "Power-Up Teach" is activated (see chapter 4.7).

NOTICE
Resetting all blanking areas!
✇ To deactivate blanking areas, leave auto blanking active with at least the same number of blanking areas.
Perform a new teach in a free measurement field.
✇ To deactivate blanking with the *Sensor Studio* configuration software, configure the number of blanking areas as zero and, at the same time, deactivate each area.
Perform a new teach.

4.7 Power-Up Teach

After applying operating voltage, the "Power-Up Teach" function performs a teach event when the device is ready for operation.

- If the Power-Up teach is successful, the new teach values are adopted if they are different from the previously stored teach values.
- If the Power-Up teach is not successful (e.g. object in the light path), the previously saved teach values are used.

NOTICE
Deactivate auto blanking during Power-Up Teach!
✇ Deactivate auto blanking if "Power-Up Teach" is activated.

NOTICE
No objects in the light path!
✇ During "Power-Up Teach", ensure that no beams are partially covered by an object.

4.8 Smoothing

With the smoothing function, interrupted beams are then only taken into account in the evaluation if the set minimum number of adjacent beams is reached at the same time.

Smoothing can be used, e.g., to suppress interference caused by spot soiling of the lens cover.

Smoothing "1" means that every interrupted beam is evaluated.
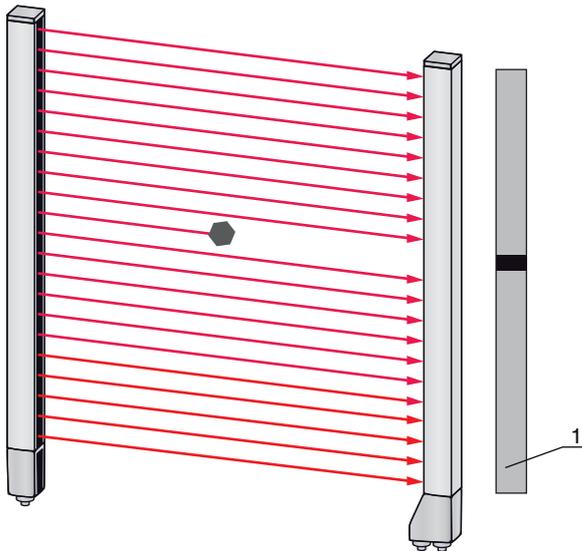
| 1 | Data output: beam number x interrupted |

Figure 4.7:   Smoothing configuration "1"

If smoothing is set to a value of "3", for example, data is only output if at least three adjacent beams are interrupted.
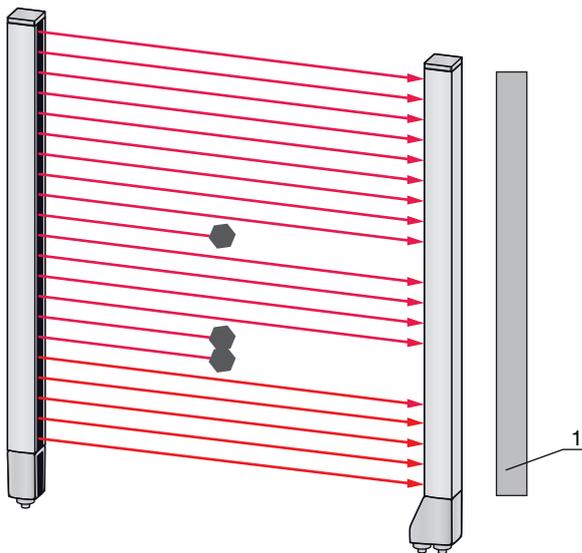
| 1 | Data output: 0 beams interrupted |

Figure 4.8:   Smoothing configuration "3", but no more than two adjacent beams interrupted
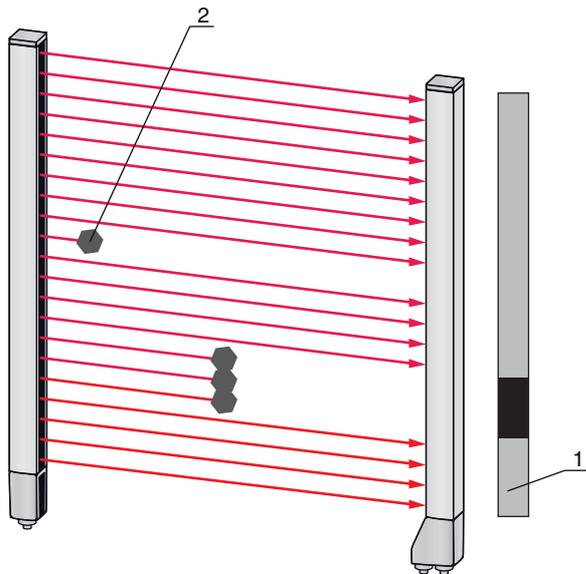
1	Data output: beam numbers from … to … interrupted
2	Interrupted beam is not taken into account

Figure 4.9:   Smoothing configuration "3", and three or more adjacent beams interrupted

NOTICE
Configuration values for smoothing!
✥ Values from 1 to 255 can be entered for smoothing.

Inverted smoothing

Inverted smoothing can suppress interference near the edges of objects, since uninterrupted beams are not evaluated until the set number is reached.

With inverted smoothing it is possible to detect, e.g., only successive openings of a certain minimum size within a web.

For an example configuration, see chapter 11.5.

4.9   Cascading/triggering

If the measurement field length of a light curtain is not sufficient for detecting a desired measurement path, multiple light curtains can be connected in series or cascaded. When doing so, it must be ensured that the light curtains do not mutually influence or interfere with one another. This is ensured by activating (triggering) with a time offset.

The following light curtain arrangements are possible in a cascade arrangement:

  • Multiple light curtains above one another, e.g., for height monitoring

1   Light curtain 1
2   Light curtain 2
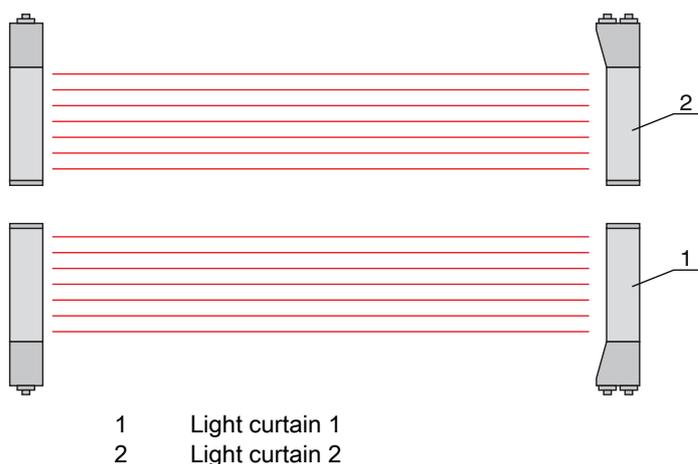
Figure 4.10: Simple cascading with two light curtains for height monitoring

- Multiple light curtains in a rectangular frame, e.g., for object measurement of height and width along a transport system.

1   Light curtain 1
2   Light curtain 2
3   Light curtain 3
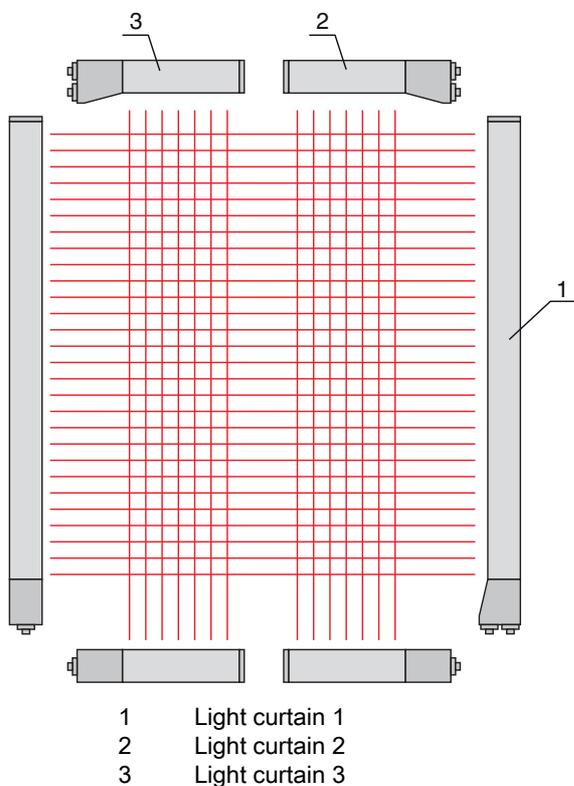
Figure 4.11: Simple cascading with three light curtains for object measurement

○
⫞⫞   The selection of activation via an internal or external trigger signal is made via the interface (see
      chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

NOTICE
⮑ Cascade light curtains for multiple-track transport systems.
⮑ Prevent mutual interference through sequential activation of the light curtains.
If the spatial configuration excludes mutual interference, multiple light curtains can also be activated simultaneously.

4.9.1 External triggering

Trigger input

For an exact time assignment, it is possible to start the measurement cycle of a light curtain in a targeted manner by means of a pulse at the trigger input. In this way, mutual interference can be prevented in applications with multiple light curtains. This trigger signal generated in the control must be wired at all cascaded light curtains.

The individual light curtains are configured so that the respective measurement is started with different delay times to the trigger pulse (see figure 4.12).

1	PLC
2	Light curtain 1, delay time = 0 ms
3	Light curtain 2, delay time = 11 ms (depending on the cycle time LC1)
4	Trigger signal (PLC)
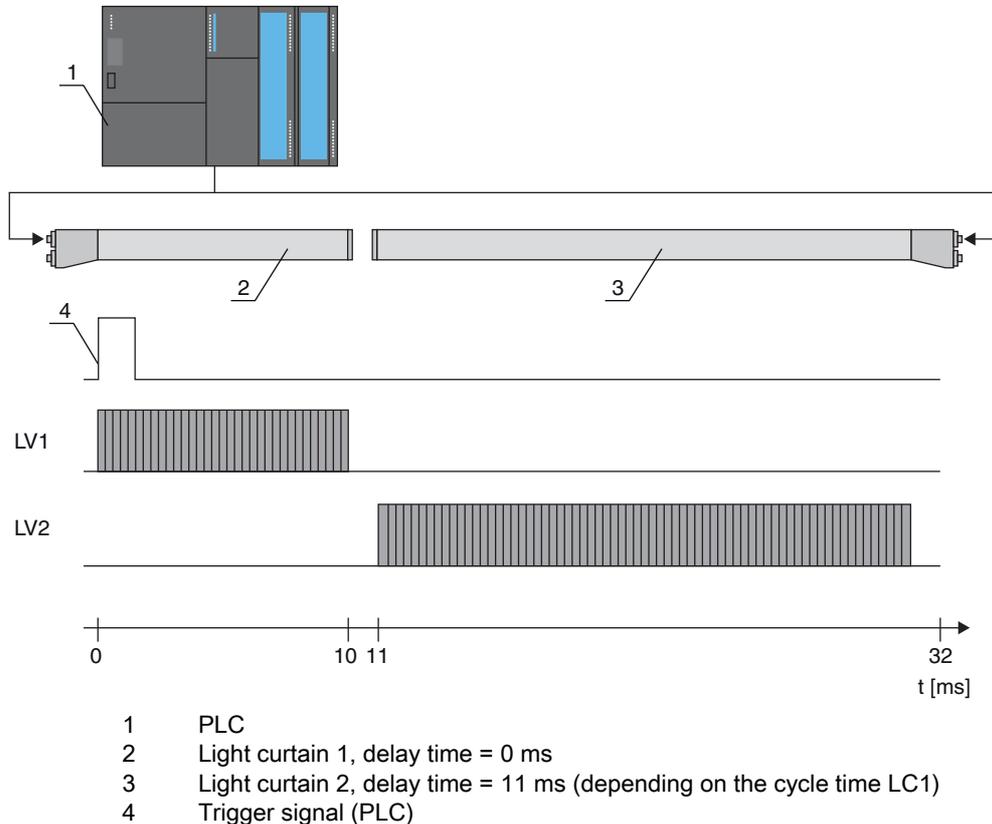
Figure 4.12: Activation via external trigger

4.9.2 Internal triggering

With internal trigger activation, a CML 700i configured as "master light curtain" generates the trigger pulse. This trigger pulse is continuous; this means that no further activation is required from a primary control.

Trigger output

The trigger output of the master light curtain makes available the trigger signal necessary for "cascading via internal trigger". The trigger output must be wired to the trigger inputs of the slave light curtains (see figure 4.13). This is used to start the measurement in the configured time sequence.

    The cycle time of the respective light curtain can be read out via the *Sensor Studio* configuration software (see chapter 12) or via the interface (see chapter 10).

    The selection of activation via an internal or external trigger signal is made via the interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

    For an example configuration, see chapter 11.6.

The following figure shows a wiring example for the cascading of three light curtains via internal trigger:

1	Trigger In (on X1, e.g. pin 5)
2	Slave light curtain 3
3	Slave light curtain 2
4	Master light curtain 1
5	Trigger Out (on X1, e.g. pin 5)
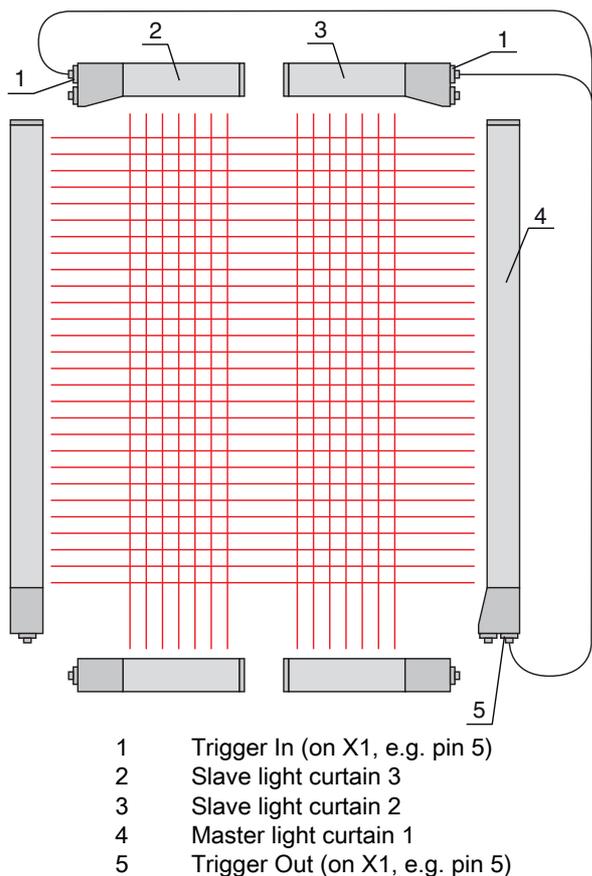
Figure 4.13: Wiring example of three light curtains via internal trigger

The following example shows a configuration of three light curtains via internal trigger.

1	Master light curtain LC1
2	Slave light curtain LC2
3	Slave light curtain LC3
4	Total cycle time
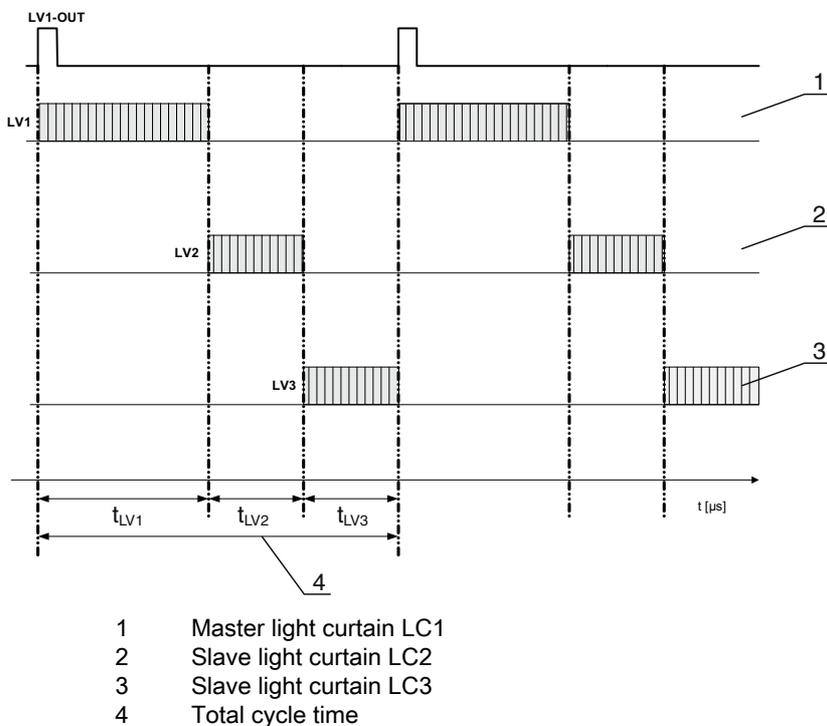
Figure 4.14: Example: cascading via internal trigger

4.10 Block evaluation of beam areas

With this function, the quantity of data to be transmitted can be reduced by restricting the imaging accuracy. The minimum resolution of the light curtain is still retained.

4.10.1 Defining beam area

To read out the beam states block-wise with a 16-bit or 32-bit telegram, the individual beams can be mapped to up to 32 areas independent of the maximum beam number. The individual beam information of grouped beams is linked to a logical bit, i.e., each area is represented as 1 bit.

The number of beams in an area can be freely defined. However, the beams must be adjacent to one another. The start beam and the end beam are to be defined as well as the conditions for switching of the area.

NOTICE
✎ The hold function (see chapter 4.5) also applies for the block evaluation of beam areas.

4.10.2 Autosplitting

The beams of the device are automatically divided into the selected number of areas of the same size. The states of the areas generated in this way can be read out in the process data by means of the "Area Out - HiWord" and "Area Out - LoWord" parameters.

Procedure:

- Select logic combination of the beams within the areas (logical AND / logical OR)
- Define the number of desired areas (e.g., 16 or 32)

The autosplitting configuration can be defined via the interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

4.10.3 Mapping beam area to switching output

If grouping individual beams or if creating a block, the beam state of any number of adjacent beams (area) can be signaled at a switching output.

The following options are possible here:

- To use a specific, single beam for the evaluation, e.g., as trigger signal for a primary control.
- To group the complete measurement field into one switching area and thereby signal at the switching output whether an object (at any position) is located in the measurement field.
- To configure up to 32 switching areas for a reference check or height monitoring; in many cases, this can make beam-data processing in the primary programmable logic control (PLC) unnecessary.

The switching conditions for the areas can be either AND or OR linked:

Logic function	Group bit (area status) [logic 1/0]	
AND	1	If all beams mapped to the area are interrupted
	0	If at least one beam is not interrupted in the selected area
OR	1	If at least one beam is interrupted in the selected area
	0	If none of the beams mapped to the area are interrupted

Areas may be sequential or overlapping. A maximum of 32 areas are available.

The switching behavior or the conditions for switching a beam area on and off can be defined via the interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

For an example configuration, see chapter 11.2.

Example for the configuration of an OR or AND link for a light curtain with 32 beams

	OR	AND
Start beam	1	1
End beam	32	32
Switch-on condition	1 beam interrupted	32 beams interrupted
Switch-off condition	0 beams interrupted	31 beams interrupted

The following figure shows how the beam areas can be arranged directly next to one another or freely over-lapping.

1	Beam area 1
2	Beam area 2
3	Beam area 3
4	Beam area 4
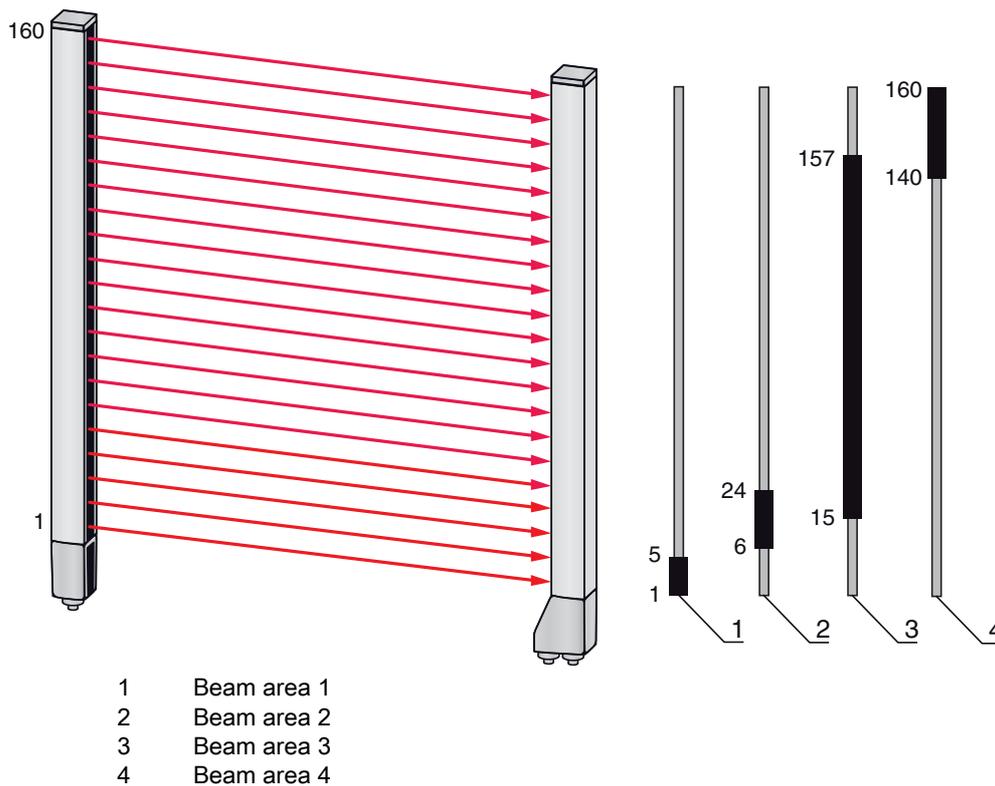
Figure 4.15: Beam areas

For a mapping of previously defined beam areas to, e.g., four switching outputs (Q1 to Q4), see chapter 11.2.

NOTICE
Increased number of logical beams for the diagonal- or crossed-beam function!
✎ Take into account the (increased) number of beams if the "diagonal"- or "crossed-beam" mode is activated (see chapter 4.1.2 or see chapter 4.1.3).

4.10.4 Teach height area

With the *Teach height area* function, it is possible to teach in up to four height areas, e.g. for height monitoring or sorting packets. In many cases, this saves time for programming.

- A maximum of four height areas are available.
- A height area is automatically defined using an object.
  When teaching a height area, all free beams above or below the object are combined into one height area. Therefore, the object cannot be located in the center of the measurement field length; the first or last beam must be interrupted.

1   Teaching height area 1
2   Teaching height area 2
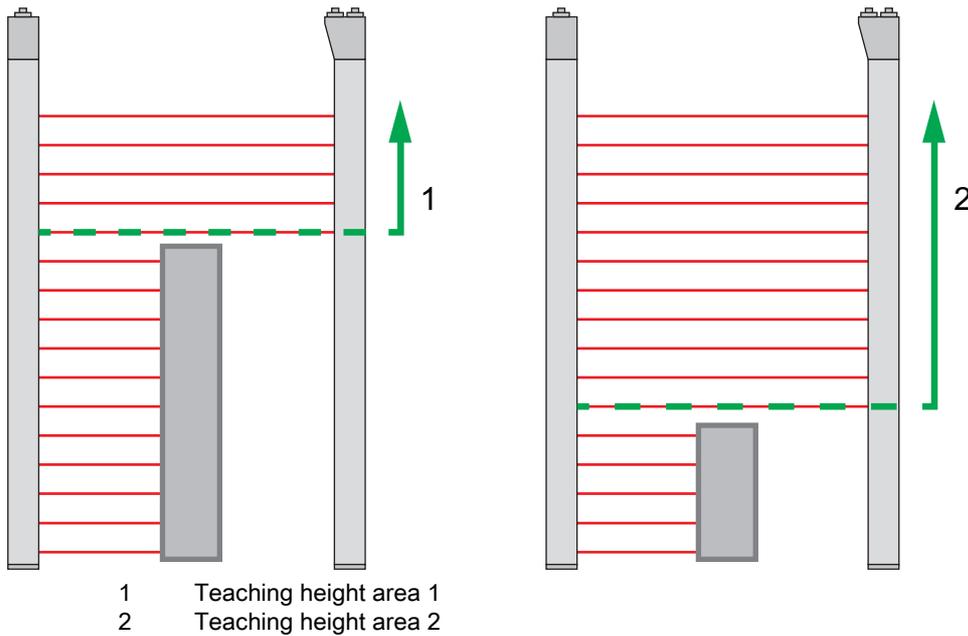
Figure 4.16: Teaching the height area with the *Teach in height area* function

• To define the entire beam area as a height area, teaching of the height area is performed without an object (all beams free).
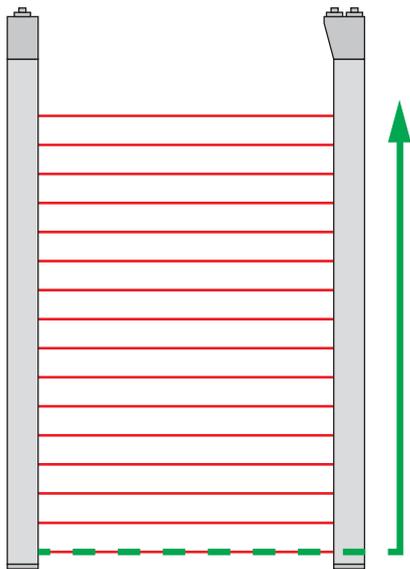
Figure 4.17: Teaching of the total beam area as height area without object

• The switching behavior or the conditions for switching the height area on or off via the *Teach height area* function is permanently defined as OR.
• Every IO pin can be assigned to a height area via the receiver control panel.
  Example: **Digital IOs > IO Pin 2 > Teach height > Execute**

  ◯   On the receiver control panel, the *Teach height area* function is activated via the **Teach height**
  ⓘ   menu item. Example: **Digital IOs > IO Pin 2 > Teach height > Execute**

        If the *Teach height area* function is activated via the receiver control panel, the IO pins are auto-
        matically assigned to the height areas.

Example configurations for the assignment of previously defined height areas to switching outputs Q1 to Q4:

• see chapter 11.2 "Example configuration - Mapping of beams 1 … 32 to output pin 2"

NOTICE
Error message during teach-in of the height area using the configuration software!
If the detection field of the light curtain is not free when the *Teach height area* function is executed using the *Sensor Studio* configuration software, an error message is displayed.
↳ Remove all objects located in the detection field of the light curtain.
↳ Restart the *Teach height area* function.

4.11 Switching outputs

4.11.1 Light/dark switching

The behavior of switching outputs Q1 to Q4 (or Q1 to Q2) can be configured with respect to light/dark switching. The setting ex works is "light switching", i.e., the outputs are activated if the light paths are free and become inactive if an object is detected in the measurement field.

○
⫴   A changeover to dark switching can be defined via the interface (see chapter 10), at the receiver control panel or using the *Sensor Studio* configuration software (see chapter 12).

4.11.2 Time functions

Each of the individual switching outputs can be assigned one of the time functions described in the following table.

○
⫴   The accuracy of the switching delay is dependent on the measurement frequency. Observe this especially in cascaded operation.

Time function	Selectable duration	Description
Start-up delay with re-trigger	0 … 65000 ms	Time that the sensor delays the start-up process after detecting an object. By means of a start-up delay, it is possible to suppress, e.g., upward-protruding packaging remnants (stretch wrap, etc.) during pallet height monitoring.
Switch-off delay with re-trigger	0 … 65000 ms	Time that the sensor delays the switching back of the output if the object leaves the detection range.
Pulse stretching	0 … 65000 ms	Minimum time that the state of the output is retained independent of what the sensor detects during this time. Pulse stretching is necessary for, e.g., hole recognition if the PLC cycle time does not register short pulses.
Pulse suppression with re-trigger	0 … 65000 ms	Minimum time that a measurement signal must be present in order for the output to switch. Short interference pulses are thereby suppressed.

○
⫴   The various time functions can be configured via the interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

4.12 Interference suppression (filter depth)

To suppress any faulty measurement values that may occur due to interference (ambient light, electromagnetic fields, …), the filter depth of the light curtain can be increased.

"Filter depth" means that an interrupted/free beam is not included in the further data evaluation until the same beam status is recorded for the set number of measurement cycles.

Filter depth "1" = the beam states of each measurement cycle are output.

Filter depth "3" = only those beam state changes that were stable over three measurement cycles are output.

⃝
⫿⫿   The configuration of the filter depth can be defined via the interface (see chapter 10) or via the
     Sensor Studio configuration software (see chapter 12).

4.13   Power setting

Functions for specific application scenarios:

- Detecting transparent films
  The sensitivity of the receiver can be increased so that the light curtain detects extremely thin transparent films in the measurement range.
  Configuration: see chapter 8.4 "Setting the function reserve"andsee chapter 11.7 "Example configuration – Detecting transparent films"

- Reliable beam penetration through opaque films
  The transmitter output power can be increased to such an extent that the light curtain can penetrate opaque, only semi-transparent objects.
  Configuration: see chapter 8.4 "Setting the function reserve"andsee chapter 11.8 "Example configuration – Reliable beam penetration through opaque films"

The desired power level can be preset as a target function reserve (function reserve mode *Target function reserve*). The automatic adjustment function of the light curtain then sets the appropriate transmitting power and receiving sensitivity.

Optionally, the transmitting power and receiving sensitivity can be adjusted separately in order to achieve an optimum result for the objects to be detected in a specific application (function reserve mode *Tx/Rx power*).

Function reserve mode *Target function reserve*

The light curtain adjusts automatically to a nominal value. The desired power level is set based on the nominal value for the light quantity which is to reach the receiver.

To reach the nominal value, the device first adjusts the transmitting power. If this is not enough, the receiving sensitivity is adjusted.

A target function reserve of "n" results in n times more power being used than would be necessary if the measurement field were free.

Adjustment ranges:

- Nominal value: 1 … 999
  Standard setting: 999

- Switching threshold: 5% … 98%

- Hysteresis: reactivation threshold after switching (5% … 80%)
  This smooths any bounce around a limit value.

Function reserve mode *Tx/Rx power*

Individual, separate adjustment of the amount of light that the transmitter emits (transmitting power, Tx) and of the gain in the input circuit at the receiver (receiving sensitivity, Rx).

⃝
⫿⫿   At maximum receiving sensitivity, the receiver reacts to extremely minor violations of the detection field.

Adjustment ranges:

- Transmitting power: 3 … 100 [%]

- Receiving sensitivity: 1 … 22

- Switching threshold: 5% … 98%

- Hysteresis: reactivation threshold after switching (5% … 80%)
  This smooths any bounce around a limit value.

The maximum function reserve is achieved with the following settings:
- Transmitting power: 100%
- Receiving sensitivity: 22
- Switching threshold: low value, e.g. 40%

4.14 Validation output

The light curtain can signal measurement readiness to the control via a digital output.

The light curtain does not deliver any stable measurement values e.g. during a teach event (teach-in).

> To debounce the validation signal, it is recommended to configure a waiting time of 100 ms in the control.

> After the device has been switched on, measurement readiness is **NOT** signaled when triggering is activated and the trigger-input signal is missing.

In the menu of the receiver control panel, configure an IO pin as a validation output.

↳ Select **Digital IOs > IO Pin > IO Function > Validation output**.

    You can configure IO Pin2, IO Pin5 or IO Pin6 as a validation output. Only one IO pin can be configured as a validation output.

4.15 Key lock

The *Key lock* function prevents entries and configuration changes from being made via the membrane keyboard on the receiver control panel.

The *Key lock* function can be activated via IO-Link or by means of a signal to an IO pin configured as a teach input. The two activation types are independent of each other.

Activating key lock via IO-Link

↳ Select **Display Key Lock** in the *Sensor Studio* configuration software (see chapter 12 "Connecting to a PC – Sensor Studio").

    Parameters > Global Settings > Display Key Lock

↳ Select the option *(1) Locked* or *(2) Volatile*.

Activating key lock by means of signal to IO pin configured as teach input

Signal at IO pin configured as teach input

↳ In the menu of the receiver control panel, configure an IO pin as a teach input.

    Select **Digital IOs > IO Pin > IO Function > Teach input**.

    You can configure IO Pin2, IO Pin5 or IO Pin6 as a teach input. Only one IO pin can be configured as a teach input at any one time.

↳ Apply a static signal to the IO pin which has been configured as a teach input.

- **IO Logic** "Positive PNP": +24 V
- **IO Logic** "Negative NPN": 0 V or "Open cable"

> The *Key lock* function cannot be enabled or disabled via the teach input.

Deactivating key lock

Deactivation of the key lock if the key lock was inadvertently activated during configuration at the receiver control panel.

Deactivating key lock via IO-Link

↳ Select **Display Key Lock** in the *Sensor Studio* configuration software (see chapter 12 "Connecting to a PC – Sensor Studio").

Parameters > Global Settings > Display Key Lock

↳ Select the option *(1) Locked* or *(2) Volatile*.

Deactivating key lock by means of signal to IO pin configured as teach input

↳ For the IO pin configured as a teach input, select an IO function other than *Teach input*.

Select **Digital IOs > IO Pin > IO Function**

5 Applications

The following typical applications with corresponding evaluation function (see chapter 4) exist for the measuring light curtain.

5.1 Height measurement
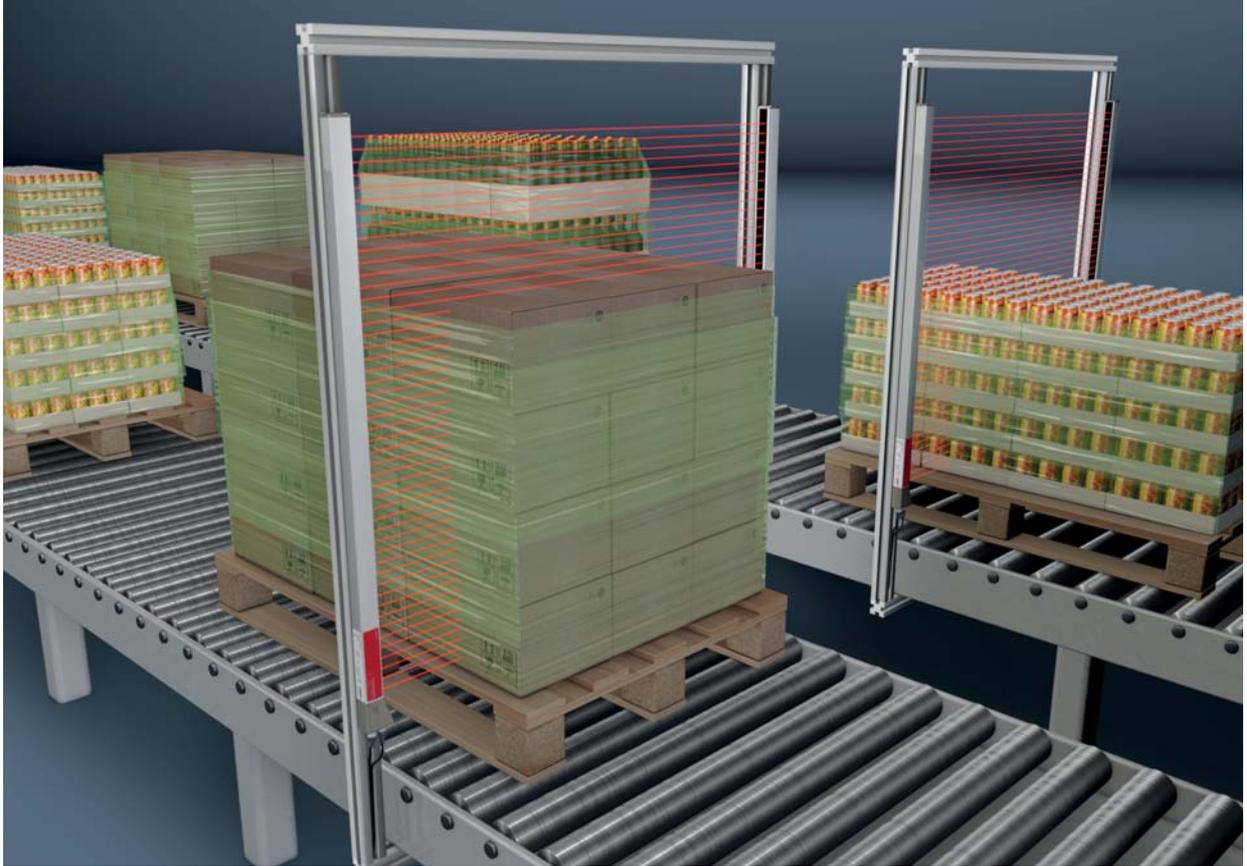
Figure 5.1:   Height measurement

↳ Evaluation function: *Last interrupted beam (LIB)*.

5.2   Object measurement
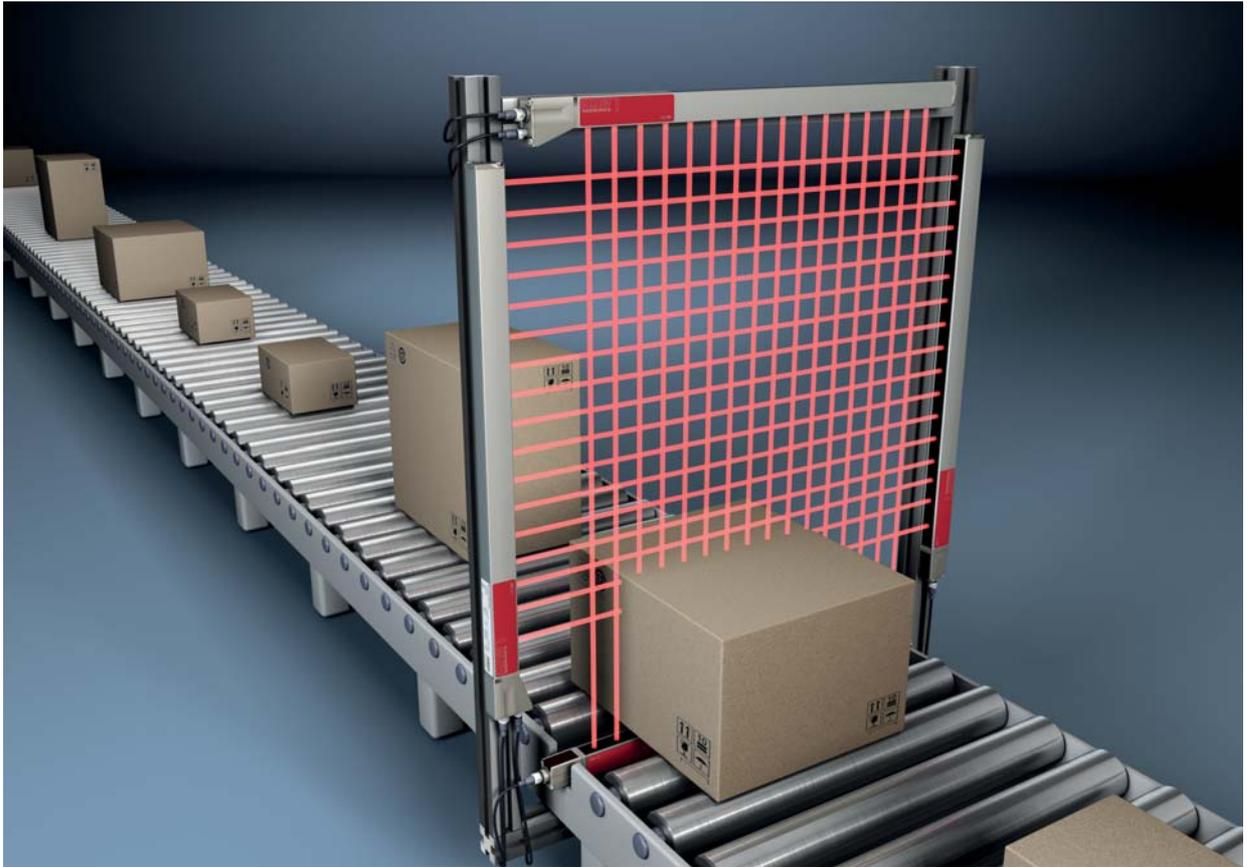
Figure 5.2:   Object measurement

↳ Height evaluation function: *Last interrupted beam (LIB)*.

↳ Width evaluation function: *Total of interrupted beams (TIB)*.

5.3   Width measurement, orientation detection

Figure 5.3:   Width measurement, orientation detection

✤ Evaluation function for width measurement: *Total of interrupted beams (TIB)*.

✤ Evaluation function for orientation detection: *Single-beam evaluation (beam-stream)* or *first/last interrupted beam (FIB/LIB)*.

5.4   Contour measurement
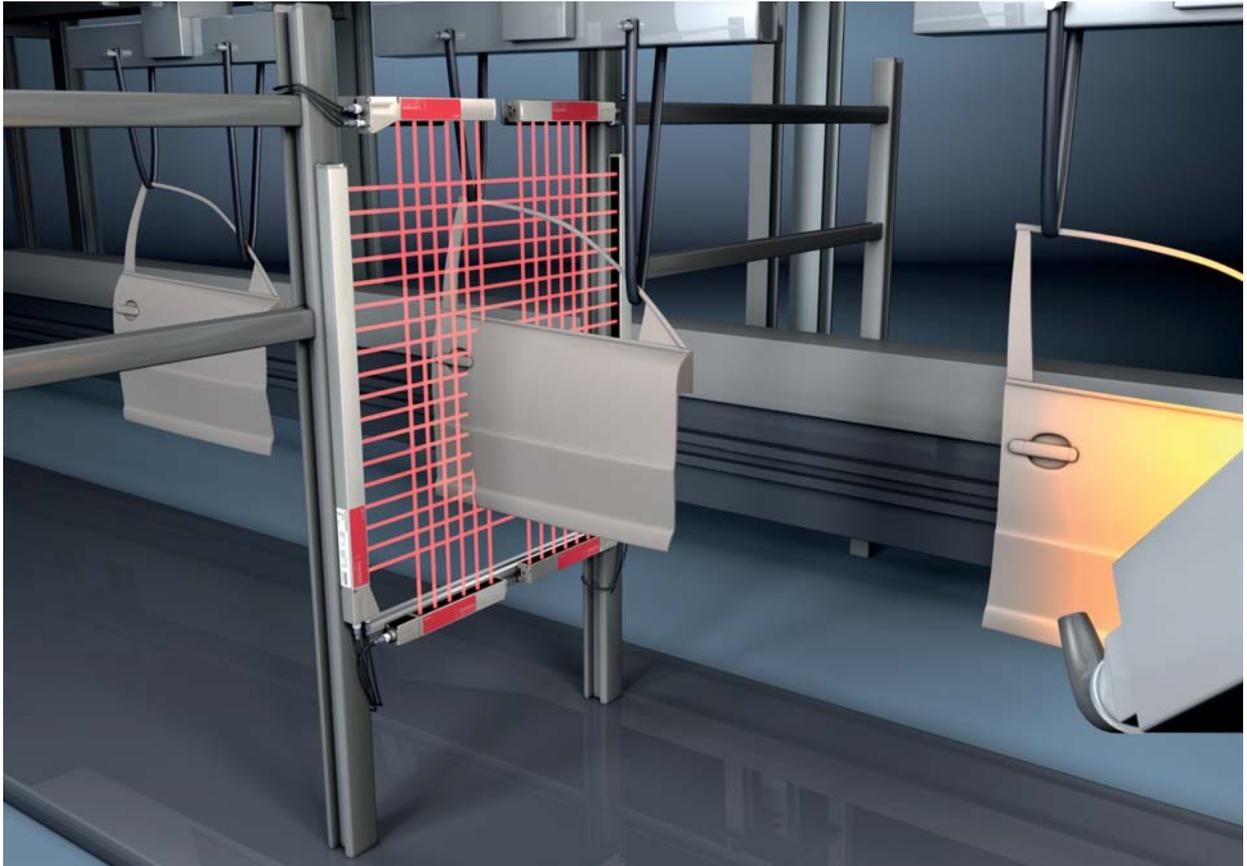
Figure 5.4:   Contour measurement

✎ Evaluation function: *Single-beam evaluation (beam-stream).*

5.5   Gap control/gap measurement
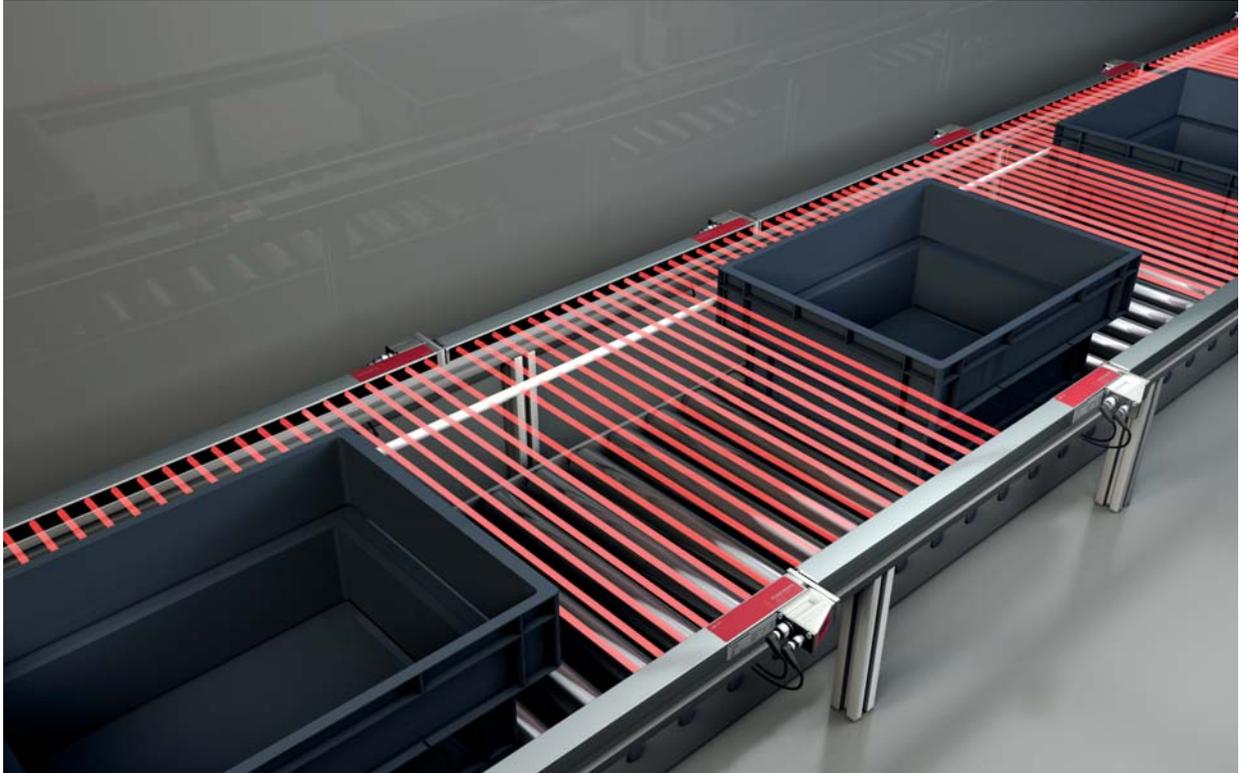
Figure 5.5:   Gap control/gap measurement

✎ Evaluation function: *Single-beam evaluation (beam-stream)*.

5.6   Hole recognition

For a detailed configuration example see chapter 11.3.
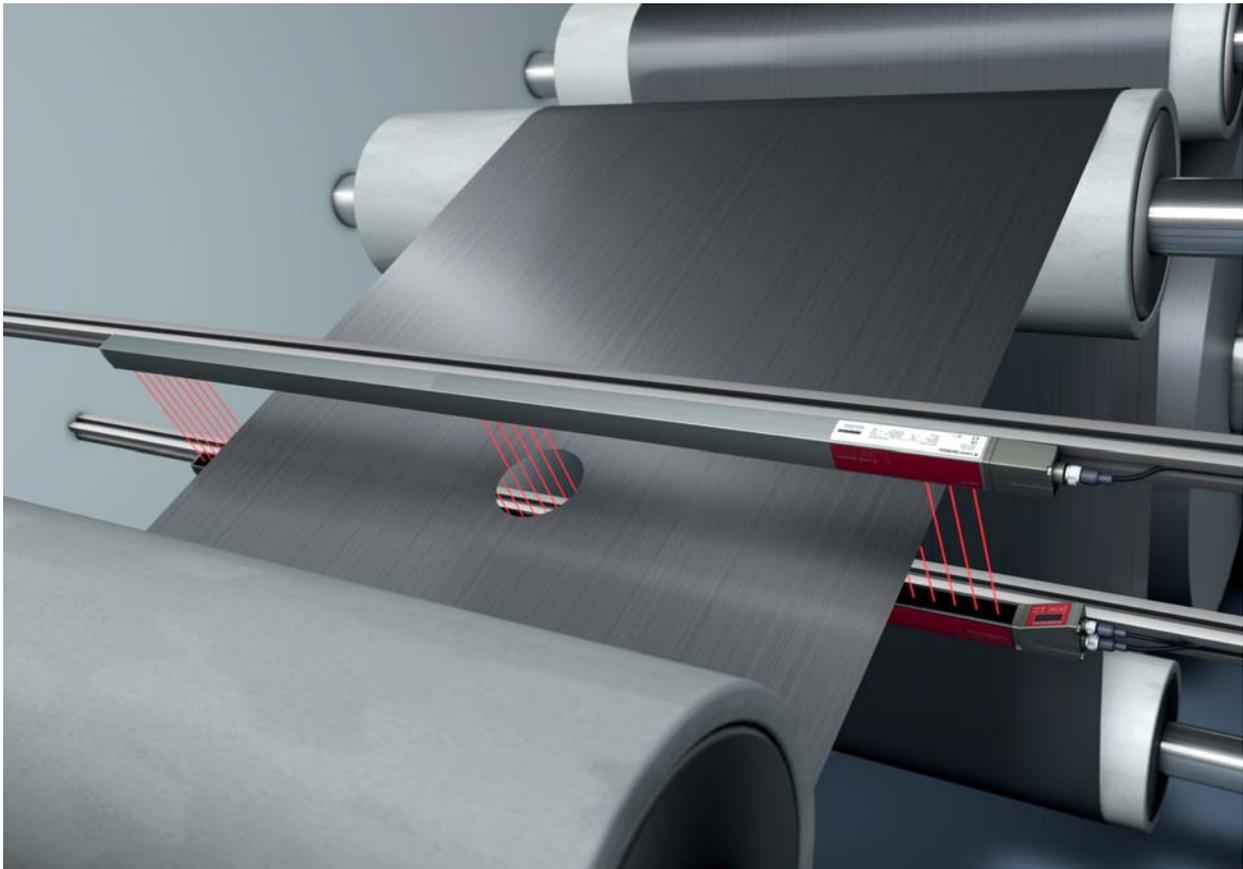
Figure 5.6:   Hole recognition

✤ For hole recognition within a web material, a beam area must be defined over the area to be monitored and mapped to an output. All beams in this area are interrupted. If a beam becomes "free" due to a flaw in the material, the output switches.

✤ If, for example, the web edge wanders slightly, the beam area can be dynamically adapted by "tracking" the start beam by selecting the *First interrupted beam (FIB)* evaluation function and the end beam by selecting the *Last interrupted beam (LIB)* evaluation function.

5.7   Power setting

• Detecting transparent films, see chapter 11.7 "Example configuration – Detecting transparent films"

• Reliable beam penetration through opaque films, see chapter 11.8 "Example configuration – Reliable beam penetration through opaque films"

• Detection of a film bag within a film bag, see chapter 11.9 "Example configuration – Double film detection"

6 Mounting and installation

6.1 Mounting the light curtain

NOTICE
No reflective surfaces, no mutual interference! ✋ Avoid reflective surfaces near the light curtains. Objects may otherwise not be precisely detected due to halation. ✋ Ensure sufficient distance, suitable positioning or partitioning. Optical sensors (e.g., other light curtains, photoelectric sensors, etc.) must not interfere with one another. ✋ Avoid interference from outside light (e.g., from flash lamps, direct sunlight) on the receiver.

Mount the transmitter and receiver as follows:

✋ Select the fastening type for transmitter and receiver.

    - Fastening via the T-groove on one side of the standard profile (see chapter 6.3).

    - Fastening via the rotating bracket on the ends of the profile (see chapter 6.4).

    - Fastening via the swiveling mounting brackets or parallel brackets (see chapter 6.5).

✋ Have a suitable tool at hand and mount the light curtain in accordance with the notices regarding the mounting locations.

✋ Mount the transmitter and receiver at the same height or with the same housing reference edge, free of tension and with the base in full contact with the mounting surface.

NOTICE
Must be observed! ✋ For horizontally mounted measuring light curtains with lengths of more than 2,000 mm, use an additional mounting bracket in the middle of the light curtain. ✋ The optical surfaces of transmitter and receiver must be parallel to and opposite one another. ✋ The transmitter and receiver connections must point in the same direction.

✋ Secure transmitter and receiver against turning or sliding.

1	Same height position / upper edge
2	Parallel alignment
3	Receiver
4	Transmitter
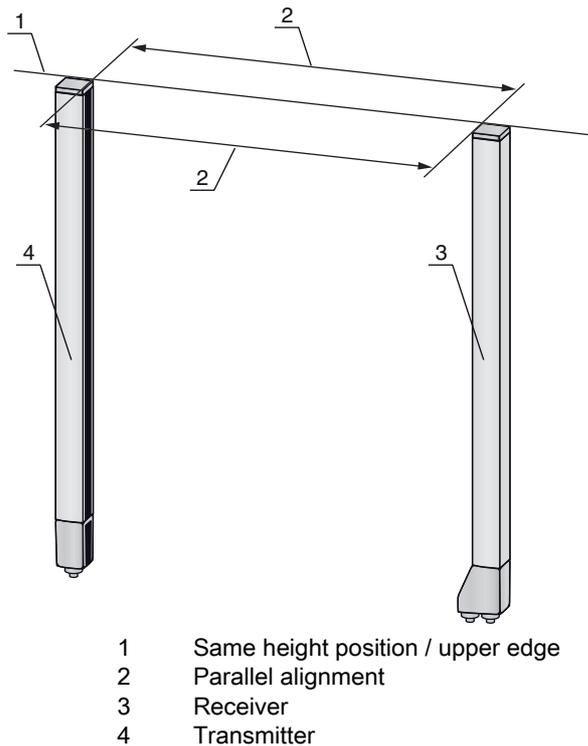
Figure 6.1:   Arrangement of transmitter and receiver

To achieve the maximum operating range limit, transmitter and receiver must be aligned with one another as accurately as possible.

After mounting, you can electrically connect (see chapter 7) and start up (see chapter 8) the light curtain.

6.2 Definition of directions of movement

The following terms for alignment movements of the light curtain around one of its individual beams are used:

a	Sliding: movement along the longitudinal axis
b	Turning: movement around the longitudinal axis
c	Tilting: lateral turning movement diagonal to the lens cover
d	Pitching: lateral turning movement in the direction of the lens cover
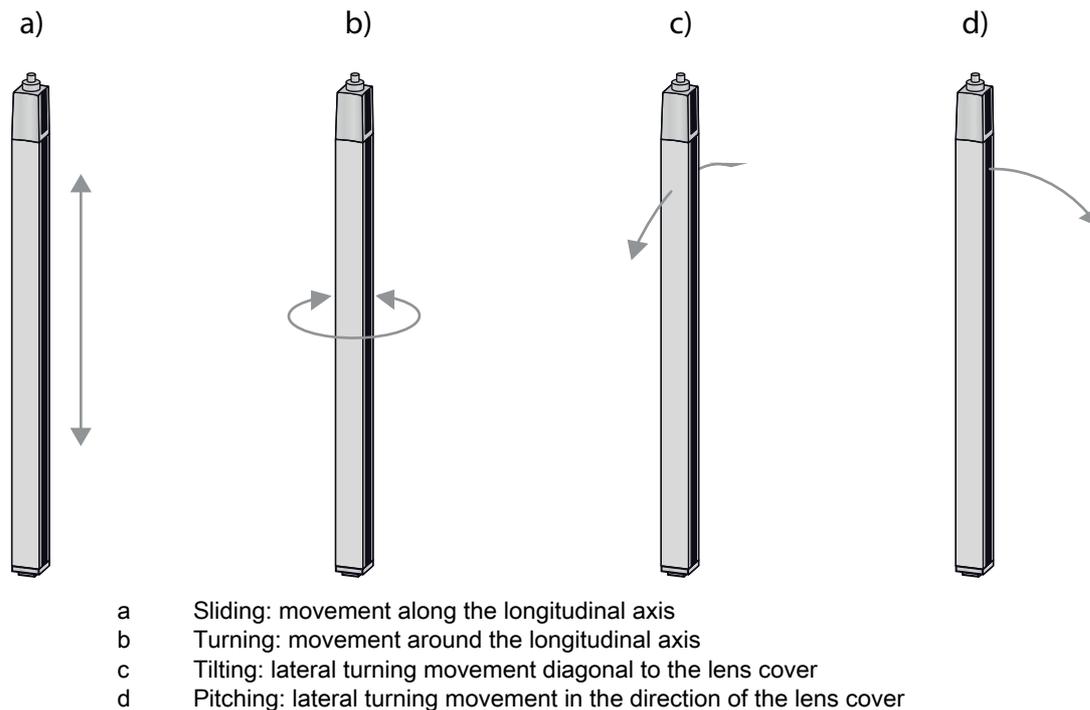
Figure 6.2:   Directions of movement during alignment of the light curtain

6.3 Fastening via sliding blocks

By default, transmitter and receiver are delivered with two sliding blocks (three sliding blocks for measurement field lengths of more than 2,000 mm) each in the side groove (see chapter 17).

↳ Fasten transmitter and receiver to the machine or system via the lateral T-groove with M6 screws.

ⓘ Sliding in the direction of the groove is possible, but turning, tilting and pitching is not.
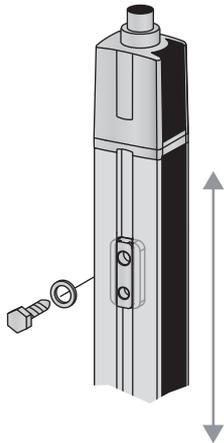
Figure 6.3:   Mounting via sliding blocks

6.4 Fastening via swivel mount

When mounting with the BT-2R1 swivel mount (See table 17.5), sold separately, the light curtain can be aligned as follows:

- Sliding through the vertical threaded holes in the wall plate of the swivel mount
- Turning by 360° around the longitudinal axis by fixing on the screw-on cone
- Tilting around main axis
- Pitching through horizontal threaded holes in the wall mounting

The wall mounting through threaded holes makes it possible to lift the mounting bracket after the screws have been loosened over the connection cap. Therefore, the mounting brackets do not need to be removed from the wall when exchanging the device. Loosening the screws is sufficient.
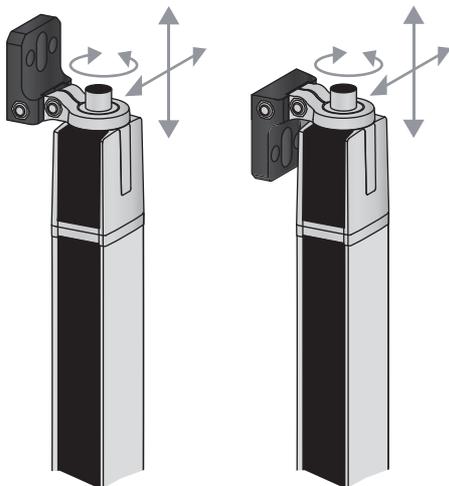
Figure 6.4:   Mounting via swivel mount

One-sided mounting on the machine table

The sensor can be mounted directly on the machine table via an M5 screw on the blind hole in the end cap. On the other end, a BT-2R1 swivel mount can be used, for example, so that turning movements for alignment are possible despite the fact that the sensor is mounted on one side.

NOTICE
Avoid reflection bypasses at the machine table!
↳ Make sure that reflections on the machine table and in the vicinity are prevented reliably.
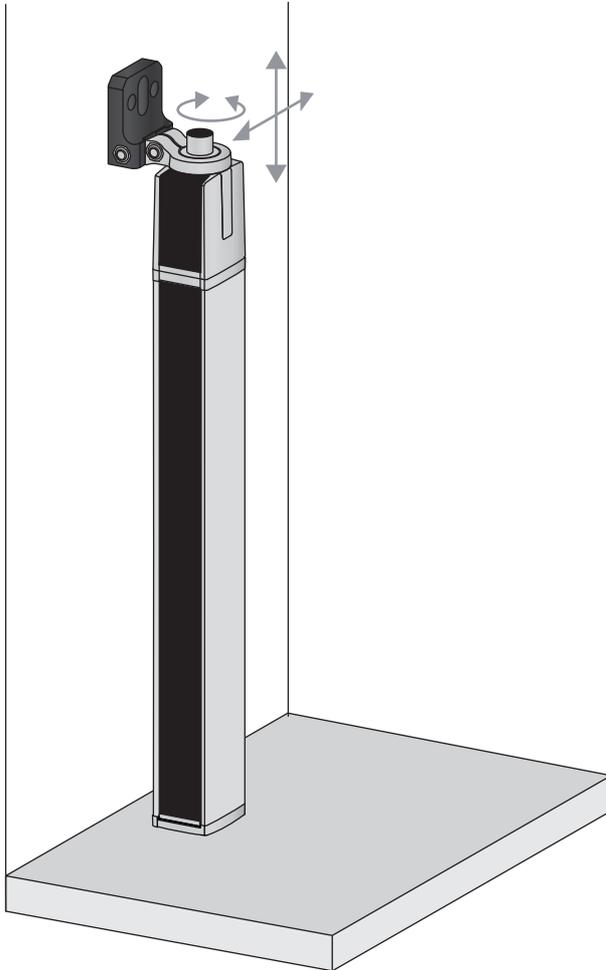
Figure 6.5:   Mounting directly on the machine table

6.5   Fastening via swiveling mounting brackets

When mounting with the BT-2SSD/BT-4SSD or BT-2SSD-270 swiveling mounting brackets (See table 17.5), sold separately, the light curtain can be aligned as follows:

- Sliding in the direction of slot
- Turning +/- 8° around the longitudinal axis

The BT-SSD (see figure 16.6) swiveling mounting brackets are also equipped with a vibration damper.

7 Electrical connection

7.1 Shielding and line lengths

The light curtains are equipped with modern electronics developed for industrial applications. In industrial environments, a number of sources of interference may affect the light curtains.

In the following, information is provided on the EMC-compliant wiring of the light curtains and the other components in the switch cabinet.

7.1.1 Shielding

NOTICE
General shielding information!
↳ Avoid interference emissions when using power components (frequency inverters, …).
The necessary specifications under which the power component satisfies its CE Declaration of Conformity can be found in the technical descriptions of the power components.
In practice, the following measures have proven effective:
Properly ground the total system.
Screw mains filter, frequency inverter, etc., flat to a galvanized mounting plate (thickness 3 mm) in the switch cabinet.
Keep cable between mains filter and inverter as short as possible and twist cables.
Shield both ends of the motor cable.
↳ Carefully ground all parts of the machine and of the switch cabinet using copper strips, ground rails or grounding cables with large cross section.
↳ Keep the length of the shieldless end of the cable as short as possible.
↳ Guide the shielding untwisted to a terminal (no "RF braid").

NOTICE
Separate power and control cables!
↳ Lay the cables for the power components (mains filter, frequency inverter, …) as far from the light curtain cables as possible (distance > 30 cm).
↳ Avoid laying power and light curtain cables parallel to one another.
↳ Cable crossings should be laid as perpendicular as possible.

NOTICE
Lay cables close to grounded metal surfaces!
↳ Lay the cables on grounded metal surfaces
This measure reduces interference coupling in the cables.

NOTICE
Avoid leakage currents in the cable shielding!
↳ Carefully ground all parts of the machine.
Leakage currents arise from incorrectly implemented equipotential bonding.
You can measure leakage currents with a clip-on ammeter.

NOTICE
Star-shaped cable connections!
↳ Ensure that the devices are connected in a star-shaped arrangement.
You thereby avoid mutual influences from various loads.
This prevents cable loops.

Grounding the light curtain housings

✎ Connect the transmitter housing **and** receiver housing of the light curtain to the protective conductor on the FE machine star point via the PE screw on the grounding slot nut (see figure 7.1).

The cable should have an impedance as low as possible for high-frequency signals, i.e., be as short as possible and have a large cross-sectional area (grounding strip, …).

✎ Use a lock washer and check the penetration of the anodized layer.

✎ Check the small Allen screw to ensure a secure connection between the grounding slot nut and housing.

The Allen screw is correctly tightened upon delivery from the factory.

If you have changed the position of the grounding slot nut or the PE screw, tighten the small Allen screw.
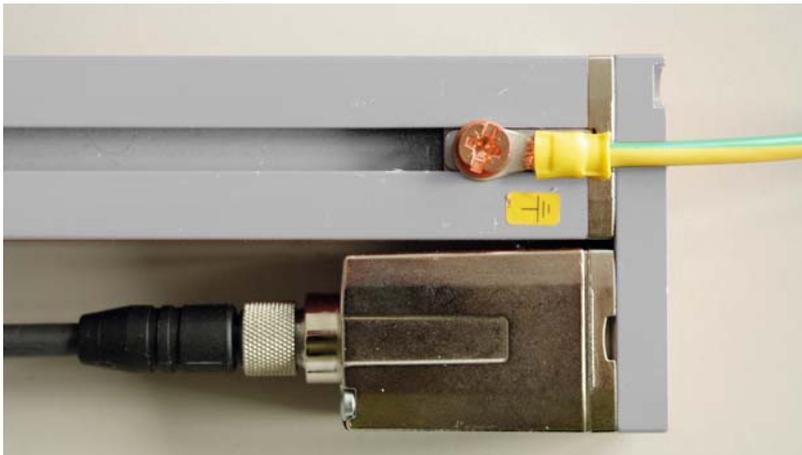
Figure 7.1:   Connecting the ground potential to the light curtain

Example for shielding both ends of the connection cables from the switch cabinet to the light curtain

✎ Ground the transmitter housing and receiver housing of the light curtain (see chapter "Grounding the light curtain housings").

✎ Clamp the shield in the switch cabinet flat to FE (see figure 7.2).

Use special shielding terminals (e.g., Wago, Weidmüller, …).
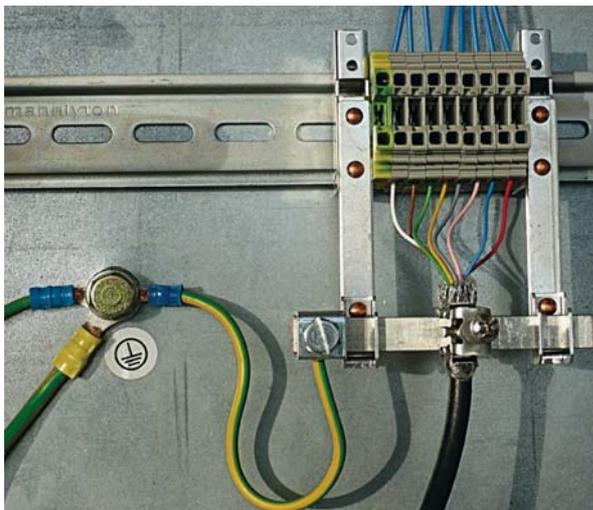
Figure 7.2:   Connecting the cable shielding in the switch cabinet

Depicted shielding components from Wago, series 790 …:

- 790 … 108 screen clamping saddle 11 mm

- 790 … 300 busbar holder for TS35

Example for shielding both ends of the connection cables from the PLC to the light curtain

↳ Ground the transmitter housing and receiver housing of the light curtain (see chapter "Grounding the light curtain housings").

↳ Only lay shielded light curtain cables to the PLC.

↳ Clamp the shield flat to FE in the PLC (see figure 7.3).

   Use special shielding terminals (e.g., Wago, Weidmüller, …).

↳ Make certain that the mounting rail is well grounded.
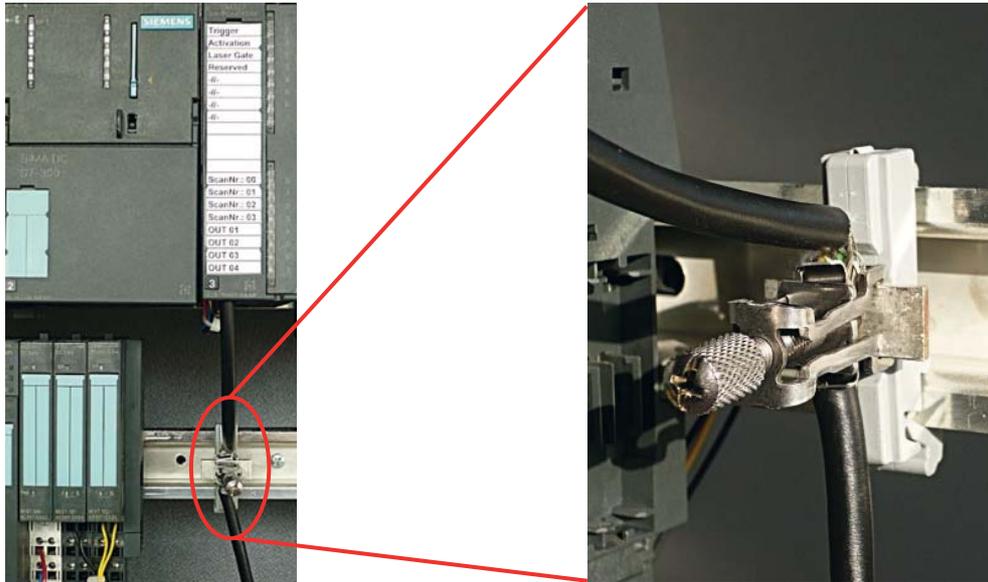
Figure 7.3:   Connecting the cable shielding to the PLC

Depicted shielding components from Wago, series 790 …:

- 790 … 108 screen clamping saddle 11 mm

- 790 … 112 carrier with grounding foot for TS35

7.1.2 Cable lengths for shielded cables

↳ Observe the maximum cable lengths for shielded cables.

Table 7.1:   Cable lengths for shielded cables

Connection to the CML 700i	Interface	Max. cable length	Shielding
PWR IN/digital IO, IO-Link, analog	X1	20 m	Required
PWR IN/digital IO (Y-connection cable and synchronization cable)	X1	20 m	Required
Synchronization cable analog/IO-Link	X2	20 m	Required

Designation of the interface connections: see chapter 7.3 "Device connections"

7.2 Connection and interconnection cables

NOTICE
Competent persons and approved purpose!
✋ Only allow competent persons to perform the electrical connection.
✋ Select the functions so that the light curtain can be used as intended (see chapter 2.1).

7.3 Device connections

The light curtain is provided with the following connections:

Device connection	Type	Function
X1 on receiver	M12 connector, 8-pin	Control interface and data interface: • Voltage supply • Switching outputs and control inputs • Configuration interface
X2 on receiver	M12 socket, 4-/5-pin	• Synchronization interface (for devices with analog output or IO-Link interface)
X3 on transmitter	M12 connector, 5-pin	Synchronization interface (for all controller types)

7.4 Digital inputs/outputs on connection X1
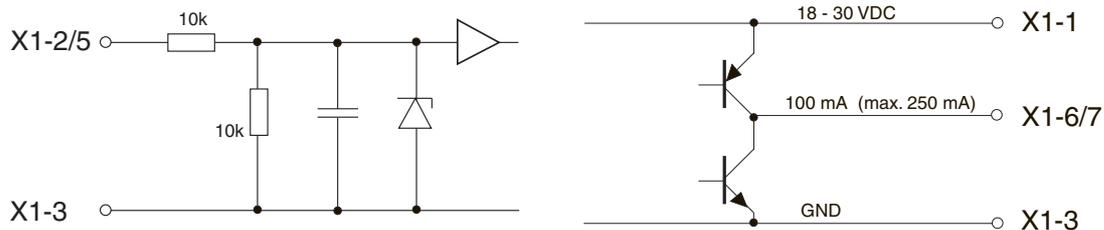
Figure 7.4:   Digital input/output schematic diagram

NOTICE
Single assignment of input functions!
✋ Each input function may only be used one time. If multiple inputs are assigned the same function, malfunctions may occur.

7.5 Electrical connection – CML 700i with IO-Link/analog interface

The electrical connection of devices with IO-Link and analog interfaces is established in the same way.

NOTICE
Light curtain grounding!
✋ Ground the light curtain before establishing an electrical connection or connecting the voltage supply (see chapter "Grounding the light curtain housings").
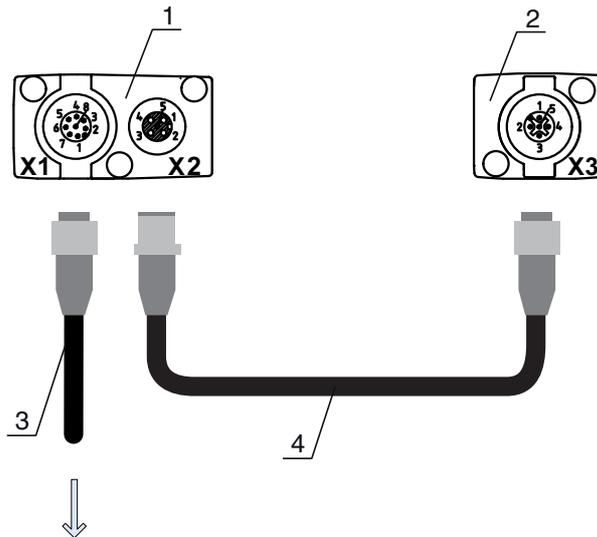
PWR IN/OUT

1 Receiver (R)
2 Transmitter (T)
3 Connection cable (M12 socket, 8-pin),see table 17.3
4 Synchronization cable (M12 plug/socket, 5-pin), see table 17.2.2

Figure 7.5: Electrical connection – CML 700i with IO-Link/analog interface

✧ Connect connection X2 to connection X3 using the appropriate synchronization cable.

✧ Connect connection X1 to the voltage supply and the control using the appropriate connection cable.

7.5.1 X1 pin assignment – CML 700i with analog interface

8-pin, M12 plug (A-coded) is used for connecting to PWR IN/digital IO and analog interface.
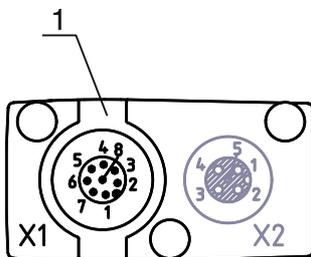
1 M12 plug (8-pin, A-coded)

Figure 7.6: X1 connection – CML 700i with analog interface

Table 7.2: X1 pin assignment – CML 700i with analog interface

Pin	X1 - Logic and power on the receiver
1	VIN: +24 V DC supply voltage
2	IO 1: input/output (configurable) Ex works: teach input
3	GND: ground (0 V)
4	C/Q: IO-Link communication
5	IO 2: input/output (configurable) Ex works: trigger input

Pin	X1 - Logic and power on the receiver
6	IO 3: input/output (configurable) Ex works: validation output
7	Toggling: • Analog voltage output (0 … 10 V) • Analog current output (4 … 20 mA)
8	AGND: analog output reference potential

Connection cables: see table 17.3.

NOTICE
Select either voltage output or current output (pin 7)!
� Voltage output and current output (pin 7) are not available simultaneously. The type of analog signal must be selected via the receiver control panel (see chapter 9). Alternatively, the analog signal can be configured via the *Sensor Studio* configuration software (see chapter 12).

NOTICE
Signal crosstalk in analog operation during simultaneous IO-Link communication!
If the simultaneous operation of IO-Link and analog signals is desired, perform the following measures:
✎ Wire a filter to the analog input of the control.
✎ Use shielded cables for the analog lines.

NOTICE
Permissible load resistance on the analog output!
When connecting the analog output, note the permissible load resistance.
✎ Voltage output 0 … 10 V DC / 0 … 11 V DC: R_L ≥ 2 k Ω
✎ Current output 4 … 20 mA DC / 0 … 24 mA DC: R_L ≤ 500 Ω

7.5.2 X2/X3 pin assignment – CML 700i with IO-Link/analog interface

5-pin, M12 socket/plug (A-coded) for the connection between transmitter and receiver.
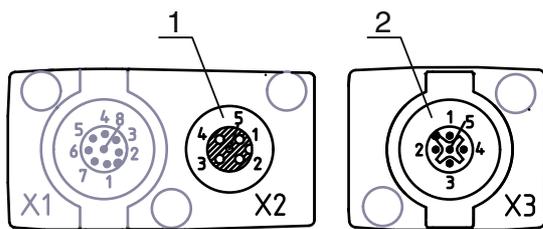
1   M12 socket X2 (5-pin, A-coded)
2   M12 plug X3 (5-pin, A-coded)

Figure 7.7:   X2/X3 connection – CML 700i with IO-Link/analog interface

Table 7.3:   X2/X3 pin assignment – CML 700i with IO-Link/analog interface

Pin	X2/X3 - Transmitter and receiver
1	SHD: FE functional earth, shield
2	VIN: +24 V DC supply voltage
3	GND: ground (0 V)
4	RS 485 Tx+: synchronization
5	RS 485 Tx-: synchronization

Interconnection cables: see table 17.2.2.

7.6   Electrical supply

With regard to the data for the electrical supply, see table 16.6.

8 Starting up the device - Basic configuration

The basic configuration includes the alignment of transmitter and receiver and the basic configuration steps via the receiver control panel.

The following optional basic functions for operation and configuration are available at the receiver control panel (see chapter 8.5 "Extended configurations on the receiver control panel menu"):

- Define digital inputs/outputs
- Inversion of the switching behavior
- Defining the filter depth
- Defining the display properties
- Changing the language
- Product information
- Resetting to factory settings

8.1 Aligning transmitter and receiver

NOTICE
Alignment during commissioning!
✋ The alignment performed during commissioning should only be performed by qualified personnel.
✋ Observe the data sheets and mounting instructions of the individual components.

Prerequisites:
- The light curtain has been mounted (see chapter 6) and connected (see chapter 7) correctly.

✋ Switch on the light curtain.

NOTICE
Alignment mode!
✋ When switched on for the first time ex works, the light curtain automatically starts in process mode.
✋ You can switch from process mode to alignment mode via the control panel.

✋ Check whether the green LEDs on the receiver control panel and transmitter illuminate continuously.

The display shows the alignment state of the first beam (FB) and last beam (LB) via two bar graph indicators.
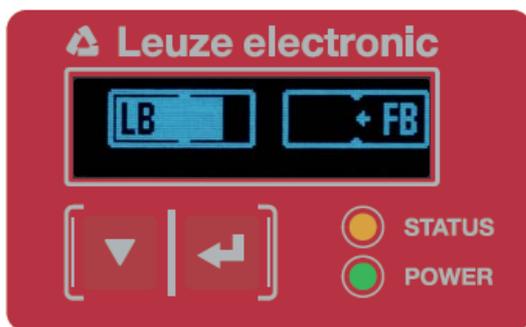
Figure 8.1:   Example: display showing an incorrectly aligned light curtain

✋ Loosen the fastening screws of the transmitter and receiver.

Loosen the screws only enough so that the devices can just be moved.

✋ Turn or slide the transmitter and receiver until the optimum position is reached and the bar graph indicators show the maximum values for the alignment.

NOTICE
Minimum sensitivity of the sensor!
✧ In order to perform a teach, a minimum level must be reached in the bar graph indicator (mark in the middle of the display).
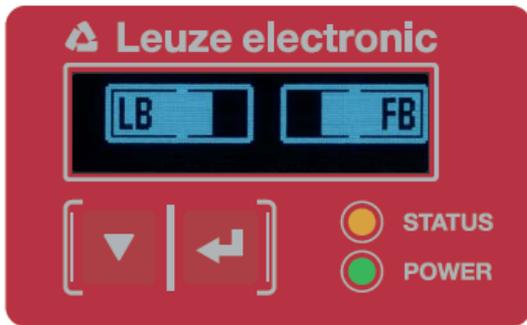
Figure 8.2:   Display showing an optimally aligned light curtain

✧ Tighten the fastening screws of the transmitter and receiver.

Transmitter and receiver are aligned.

Switching to process mode

After aligning, switch to process mode.

✧ Select **Display > Mode > Process mode**.

The display in the receiver of the light curtain shows the process mode states with the total of interrupted beams (TIB) and the logic states of the digital inputs/outputs (digital IOs).

Figure 8.3:   Display showing the process mode state of the light curtain

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description				
Display							
	Language		English	German	French	Spanish	Italian
	Mode		**Process Mode**	Alignment			

Switching to alignment mode

You can switch from process mode to alignment mode via the menu.

✧ Select **Display > Mode > Alignment**.

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description				
Display							
	Language		English	German	French	Spanish	Italian
	Mode		Process Mode	**Alignment**			

The next configuration step is teaching the environmental conditions (teach).

8.2 Teaching the environmental conditions

During teaching, the system checks whether the signals of all beams are within a certain corridor.

This means that a teach event generally regulates all beams to the preset function reserve (or sensitivity) for the current operating range. This ensures that all beams exhibit an identical switching behavior.

NOTICE
Conditions for performing a teach!
✋ When teaching without preconfigured blanking areas, the light path must always be completely free. A teaching error will otherwise occur.
✋ In this case, remove the obstacles and repeat the teach.
✋ If the light path is partially interrupted by structural elements, the permanently interrupted beams can be suppressed by means of blanking (*auto blanking* function). Interrupted beams are "deactivated" in this case.
✋ To automatically suppress the affected beams during teaching, configure the number of blanking areas via the configuration software *Sensor Studio* (see chapter 12).

> The configuration can be performed via the IO-Link interface (see chapter) or via the *Sensor Studio* configuration software (see chapter 12).

> You can choose whether the teach values are to be stored permanently or only temporarily (while the operating voltage is applied). The configuration ex works is for permanent (non-volatile) storage.

> A teach event can be performed both directly from process mode as well as from alignment mode.

NOTICE
Execute teach after changing the beam mode!
✋ Always perform a teach after changing the beam mode (parallel-/diagonal-/crossed-beam scanning) as well.

Prerequisites:
- The light curtain must be correctly aligned (see chapter 8.1).

✋ You can use one of the following teach types:

Teach via receiver control panel (see chapter 8.2.1).

Teach via teach input (see chapter 8.2.2).

Teach via IO-Link interface (IO-Link, see chapter).

Teach via *Sensor Studio* configuration software (see chapter 12).

8.2.1 Teach via receiver control panel

If blanking areas are configured via the configuration software interface, a teach event is performed that takes these blanking areas into account (blanking teach or auto blanking, see chapter 4.6).

> During a blanking teach or auto blanking, an "additional distance" is always added to the beams detected as interrupted. Safer operation is thereby achieved, e.g., in the case of vibrating guides, etc., in the "blanked" area.

> Optimization of the blanked beams is to be performed via a software interface configuration.

> A maximum of four adjacent areas of suppressed beams (blanking areas) can be configured.

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description		
Main Settings					
	Commands		**Teach**	Reset	Factory Settings

✎ Select **Main Settings > Command > Teach**.

✎ Press the ↵ button to execute the teach.

The display shows

Wait...

If the teach was started while in process mode, the display returns to the process mode display after a successful teach (see chapter 8.1).

If the teach was started from alignment mode, the display returns to the bar graph indicator following a successful teach and shows the received signal level of the first beam (FB) and the last beam (LB) (see chapter 8.1).

If teach is successful, both bars display the maximum value.
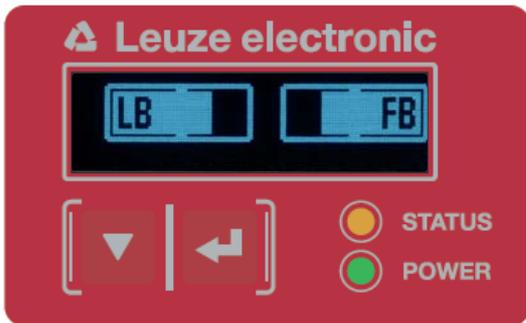
Figure 8.4: Display after successful teach

If no bars are visible in the bar graph indicator for the first beam (FB) and the last beam (LB), an error has occurred. It is possible, e.g., that the reception signal is too low. You can correct errors according to the error list (see chapter 13).

Power-Up Teach

After applying operating voltage, the "Power-Up Teach""

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description		
Main Settings					
	Commands		Teach	Reset	Factory Settings
	Operation Settings				
		Filter Depth			
		Beam Mode			
		Function Reserve			
		Blanking Teach			
		Power-Up Teach	Inactive	**Active**	

✎ Select **Main Settings > Operation Settings > Power-Up Teach > Active**.

8.2.2 Teaching via a control signal from the control

Teach input (Teach In)

This input can be used to perform a teach following initial commissioning, change of the alignment or during operation. During this procedure, the transmitter and receiver adjust themselves to the maximum function reserve according to the distance.

> Signal level for line teach with PNP configuration:
>
> Low: ≤ 2 V; High: ≥ (U$_B$-2 V
>
> With the PNP configuration, the signal levels are inverted.

To trigger a teach, a pulse must be applied on connection X1 on the receiver IO1 = pin 2 (factory setting) for longer than 20 ms … but less than 80 ms.

Depending on the configuration (PNP or NPN), this corresponds to the following signal response:

1   Teach is performed here
2   Function buttons on the receiver locked
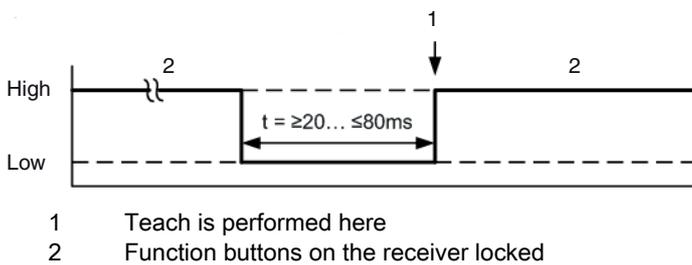
Figure 8.5:   Control signals for line teach with PNP configuration

1   Teach is performed here
2   Function buttons on the receiver locked
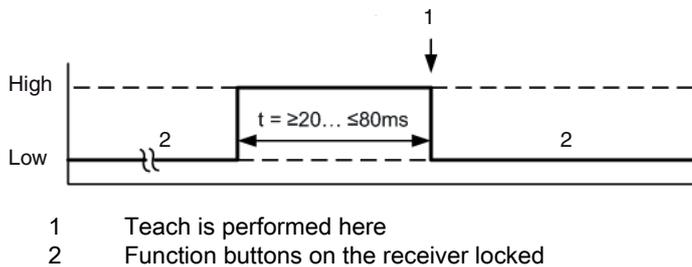
Figure 8.6:   Control signals for line teach with NPN configuration

Performing a teach via the line input

Prerequisites:

- The light curtain must be correctly aligned (see chapter 8.1).
- A connection must be established between PLC and the line input (teach-in).

✎ Send a teach signal to the teach input via the control (see chapter "Teach input (Teach In)" for the data) to trigger a teach.

The display on the receiver control panel shows

> Wait...

Following a successful teach, the display switches back to the bar graph (alignment mode).
If teach is successful, both bars display the maximum value.

Figure 8.7:   Display after successful teach

The next configuration step is to check the alignment.

8.3   Check alignment

Prerequisites:
- The light curtain must first be correctly aligned and a teach must be performed.

↳ Check whether the green LEDs on the receiver control panel and transmitter illuminate continuously.

↳ Use the bar graph indicator to check whether the light curtain is optimally aligned, i.e., whether the maximum is reached for both the first beam (FB) and the last beam (LB) in the bar graph indicator.

↳ Use the bar graph indicator to check the optimum alignment of the light curtain if you have corrected an error that occurred.

The next configuration steps:
- Perform extended configurations on the receiver control panel if necessary (see chapter 8.5)
- Start up CML 700i light curtains with analog output (see chapter 9)
- Start up CML 700i light curtains with IO-Link interface (see chapter 10)

8.4   Setting the function reserve

The function reserve can be set to the following levels:
- High: High function reserve for stable operation, low sensitivity
- Medium: Medium function reserve
- Low: Low function reserve, high sensitivity
- Transparent: Detection of transparent objects
- Target function reserve: Automatic adjustment of the transmitter power and the receiving sensitivity
- Tx/Rx power: Manual, separate adjustment of the transmitter power and the receiving sensitivity

The function reserve can be set via the receiver control panel, via the IO-Link interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

> The sensitivity levels (e.g., high function reserve for stable operation, medium function reserve and low function reserve) are configured ex works with "high function reserve for stable operation". The "low function reserve" configuration enables the detection of partially transparent objects.
>
> The switching threshold can be set for optimum operation for the detection of transparent objects in the "Transparent" configuration.

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description					
Main Settings								
	Commands							
	Operation Settings							
	Sensitivity Setting							
		Function Reserve	High	Medium	Low	Transparent	Target Func. Res.	Tx/Rx Power
		Switch Threshold	10 … 98					
		Hysteresis	5 … 80					

ꙮ Select **Main Settings > Sensitivity Setting > Function Reserve**

ꙮ For the switching threshold, enter a value between 10% (lowest sensitivity) and 98% (highest sensitivity). Factory setting: 75%

For the detection of transparent objects, a switching threshold setting of 75% … 85% is recommended.

ꙮ For the hysteresis, enter a value for the reactivation threshold after switching (5% … 80%). This smooths any bounce around a limit value.

> The adjustment options *Nominal value*, *Transmitting power* and *Receiver sensitivity* have no function in the function reserve modes *High*, *Medium*, *Low* and *Transparent*. These settings are only effective when configuring the function reserve modes *Target function reserve* and *Tx/Rx power*.

Target function reserve

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description					
Main Settings								
	Commands							
	Operation Settings							
	Sensitivity Setting							
		Function Reserve	High	Medium	Low	Transparent	**Target Func. Res.**	Tx/Rx Power
		Nominal Value	1 … 999					
		Switch Threshold	10 … 98					
		Hysteresis	5 … 80					

ꙮ Select **Main Settings > Sensitivity Setting > Function Reserve > Target Function Reserve**

ꙮ The nominal value describes the value of the light quantity which is to reach the receiver. Enter a value between 1 (smallest light quantity) and 999 (largest light quantity). Factory setting: 999

ꙮ For the switching threshold, enter a value between 10% (lowest sensitivity) and 98% (highest sensitivity). Factory setting: 75%

The upper switch-on threshold of the light curtain is defined using the switching threshold. The switch-off threshold is calculated as follows:

switch-off threshold = switching threshold - hysteresis

ꙮ For the hysteresis, enter a value for the reactivation threshold after switching (5% … 80%). This smooths any bounce around a limit value.

Example: Switching threshold: 75%; hysteresis: 10%. The light curtain switches off when 65% of the light quantity configured as the nominal value reaches the receiver. The light curtain switches on again when 75% of the light quantity configured as the nominal value reaches the receiver.

NOTICE
Switching the function reserve!
✋ If the function reserve is switched to *High*, *Medium*, *Low* or *Transparent*, the switching threshold and hysteresis are reset to a specific factory setting.

Tx/Rx power

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description					
Main Settings								
	Commands							
	Operation Settings							
	Sensitivity Setting							
		Function Reserve	High	Medium	Low	Transparent	Target Func. Res.	**Tx/Rx Power**
		Receiving Sensitivity	1 … 22					
		Transmitting Power	3 … 100					
		Switch Threshold	10 … 98					
		Hysteresis	5 … 80					

✋ Select **Main Settings > Sensitivity Setting > Function Reserve > Tx/Rx Power**

✋ For the receiving sensitivity (Rx), enter a value between 1 (lowest sensitivity) and 22 (highest sensitivity).

- Select maximum sensitivity for high beam penetration capacity.
  At maximum sensitivity, the light curtain may still be able to detect objects if a transparent medium allows almost no energy to pass through.
- If the receiver is set to an extremely high sensitivity, the light curtain switches even with extremely small objects which cause only very slight damping. In this case, the light curtain becomes e.g. more sensitive to dust if a low function reserve is set.
- Higher sensitivity of the receiver also means higher measurement value noise. The measurement value noise alone may cause pseudo switching of the light curtain if the hysteresis is set too low.

✋ For the transmitting power (Tx), enter a value between 3% (lowest transmitting power) and 100% (highest transmitting power).

✋ For the switching threshold, enter a value between 10% (lowest sensitivity) and 98% (highest sensitivity). Factory setting: 75%

✋ For the hysteresis, enter a value for the reactivation threshold after switching (5% … 80%). This smooths any bounce around a limit value.

Example: Switching threshold: 75%; hysteresis: 10%. The light curtain switches off when 65% of the light quantity configured using the transmitting power reaches the receiver. The light curtain switches on again when 75% of the light quantity configured using the transmitting power reaches the receiver.

NOTICE
Determine and note down the Tx/Rx setting!
✋ Determine by trial and error the *Tx/Rx power* settings with which the desired switching behavior is best reached in your application.
✋ Note down your *Tx/Rx power* settings so that you can restore the settings if necessary.

NOTICE
Incorrect Tx/Rx power setting!
If the *Tx/Rx power* parameters are incorrectly set, the light curtain may no longer be able to detect objects or pseudo switching may occur as a result of measurement value noise.
↳ Temporarily select a different function reserve mode (*High*, *Medium*, *Low*, *Transparent*). This resets the *Tx/Rx power* settings to the default values.
↳ Select the function reserve mode *Tx/Rx power* and set the *Tx/Rx power* parameters for the desired switching behavior in your application.

8.5   Extended configurations on the receiver control panel menu

It is not mandatory that extended configurations be performed on the receiver control panel menu in order to start up a light curtain.

8.5.1   Define digital inputs/outputs

The digital IO configurations (IO Pin 2, IO Pin 5 and IO Pin 6) are used to configure the parameters for the switching outputs:

- IO function: trigger input, teach input, command output, warning output, trigger output or validation output
- Inversion
- Area logic
- Start beam
- End beam

The individual configuration steps for the extended configuration combinations are not described separately.

When configuring start and end beam, you can configure values of up to 1774. Values above 1774 (to 1999) are not accepted and must be entered again.

The structure of these configurations in the receiver control panel menu is as follows (multiple configurations displayed simultaneously):

Examples

Configuration of pin 2 as PNP switching output

The following example shows a configuration of pin 2 as PNP switching output with additional configurations, such as area logic "OR" with a beam area of 1 … 32 and beam 1 as start beam according to the following table.

	OR
Start beam	1
End beam	32
Switch-on condition	1 beam interrupted
Switch-off condition	0 beams interrupted

Level 0	Level 1	Level 2	Description	
Digital IOs				
	IO Logic		**Positive PNP**	Negative NPN
	IO Pin 2			

Level 0	Level 1	Level 2	Description					
		IO Function	Trigger In	Teach In	**Area Out**	Warn Out	Trigger Out	Validation Out
		Inversion	Normal	**Inverted**				
		Teach height	Execute	Exit				
		Area Logic	AND	**OR**				
		Start Beam	001					
		End Beam	032					

↳ Select **Digital IOs > IO Logic > Positive PNP**.

↳ Select **Digital IOs > IO Pin 2 > IO Function > Area Output**.

↳ Select **Digital IOs > IO Pin 2 > Inversion > Inverted**.

↳ Select **Digital IOs > IO Pin 2 > Area Logic > OR**.

↳ Select **Digital IOs > IO Pin 2 > Start Beam > 001**.

↳ Select **Digital IOs > IO Pin 2 > End Beam > 032**.

Configuration of pin 2 as PNP warning output

The following example shows the configuration of pin 2 as PNP warning output.

Level 0	Level 1	Level 2	Description					
Digital IOs								
	IO Logic		**Positive PNP**	Negative NPN				
	IO Pin 2							
		IO Function	Trigger In	Teach In	Area Out	**Warn Out**	Trigger Out	Validation Out
		Inversion	Normal	Inverted				
		Teach height	Execute	Exit				
		Area Logic	AND	OR				
		Start Beam	(enter value)					
		End Beam	(enter value)					

↳ Select **Digital IOs > IO Logic > Positive PNP**.

↳ Select **Digital IOs > IO Pin 2 > IO Function > Warn Out**.

Configuration of pin 2 as PNP trigger input

The following example shows the configuration of pin 2 as PNP trigger input.

Level 0	Level 1	Level 2	Description					
Digital IOs								
	IO Logic		**Positive PNP**	Negative NPN				
	IO Pin 2							
		IO Function	**Trigger In**	Teach In	Area Out	Warn Out	Trigger Out	Validation Out
		Inversion	Normal	Inverted				
		Teach height	Execute	Exit				
		Area Logic	AND	OR				
		Start Beam	(enter value)					
		End Beam	(enter value)					

↳ Select **Digital IOs > IO Logic > Positive PNP**.

✎ Select **Digital IOs > IO Pin 2 > IO Function > Trigger In**.

ⓘ Trigger input and output are only active if cascading (triggered operation) was activated via the configuration interface or process interface.

A teach input is configured according to the same principle.

✎ Select **Digital IOs > IO Logic > Positive PNP**.

✎ Select **Digital IOs > IO Pin 2 > IO Function > Teach input**.

NOTICE
Configuration of the teach input can activate the key lock!
The setting of the teach input becomes effective immediately.
✎ Depending on the applied signal level, this can immediately activate the *Key lock* function (see chapter 4.15 "Key lock").

Configuration of pin 5 as PNP height area

The following example shows the configuration of pin 5 as PNP height area.

Level 0	Level 1	Level 2	Description					
Digital IOs								
	IO Logic		**Positive PNP**	Negative NPN				
	IO Pin 5							
		IO Function	Trigger In	Teach In	Area Out	Warn Out	Trigger Out	Validation Out
		Inversion	Normal	Inverted				
		Teach height	**Execute**	Exit				
		Area Logic	AND	OR				
		Start Beam	(enter value)					
		End Beam	(enter value)					

✎ Select **Digital IOs > IO Logic > Positive PNP**.

✎ Select **Digital IOs > IO pin 5 > Teach height > Execute**.

ⓘ The pin is automatically configured as an area output.

IO Function > Area Out must also be selected.

8.5.2 Inversion of the switching behavior (light/dark switching)

Light/dark switching is configured with this configuration.

ⓘ For all digital process interfaces, the configuration can also be performed via the IO-Link interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).

The following example shows how the switching output is switched from light switching (normal) to dark switching (inverted).

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description					
Digital IOs								
	IO Logic		Positive PNP	Negative NPN				
	IO Pin 2							
		IO Function	Trigger In	Teach In	Area Out	Warn Out	Trigger Out	Validation Out

Level 0	Level 1	Level 2	Description	
		Inversion	Normal	**Inverted**
		Teach height	Execute	Exit
		Area Logic	AND	OR
		Start Beam	(enter value)	
		End Beam	(enter value)	

✎ Select **Digital IOs > IO Pin 2 > Inversion > Inverted**.

8.5.3   Defining the filter depth

The filter depth is used to specify that an evaluation and output of the measurement values occurs only once the beam states are stable over multiple measurement cycles.

Example: with a filter depth of "5", five measurement cycles must be consistent before an evaluation is performed. For further information, see also the description of interference suppression (see chapter 4.12).

> For all digital process interfaces, the configuration can also be performed via the IO-Link interface (see chapter 10) or via the *Sensor Studio* configuration software (see chapter 12).
>
> When configuring the filter depth, you can enter values of up to 255. Values above 255 (to 299) are not accepted and must be entered again.

The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description		
Main Settings					
	Commands		Teach	Reset	Factory Settings
	Operation Settings				
		Filter Depth	(enter value) min = 1 max = 255		

✎ Select **Main Settings > Operational Settings > Filter Depth**.

8.5.4   Defining the display properties

With these configurations for the display, the brightness and a time unit for darkening the display are defined.

Visibility:

- Off: No display; the display remains dark until a button is pressed.
- Dark: Text is only slightly visible.
- Normal: Text is visible with good contrast.
- Bright: Text appears very bright.
- Dynamic: The display darkens gradually over the number of seconds configured under **Time Unit (s)**. During this time span, the display passes through all levels, from bright to off.

After approx. 5 minutes without button actuation, configuration mode is exited and the display changes to the previous mode.

When configuring the **Visibility** in the dark, normal and bright modes, the display is completely inverted after approx. 15 minutes to prevent the LEDs from burning in.

When configuring the **Time Unit (s)**, you can enter values of up to 240 seconds. Values above 240 (to 299) are not accepted and must be entered again.

The structure of these configurations in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description				
Display							
	Language		English	German	French	Italian	Spanish
	Mode		Process Mode	Alignment			
	Visibility		Off	Dark	Normal	Bright	**Dynamic**
	Time Unit (s)		**(enter value)** min = 1 max = 240				

✥ Select **Display > Visibility**.

✥ Select **Display > Time Unit (s)**.

8.5.5 Changing the language

The system language can be configured with this configuration.
The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description				
Display							
	Language		English	**German**	French	Italian	Spanish

✥ Select **Display > Language**.

8.5.6 Product information

With this configuration, you can read out product data (part number, type designation and other production-specific data) of the light curtain.
The structure of the configuration in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description
Information			
	Product Name		CML 730-PS
	Product ID		Receiver Part No. (e.g., 50119835)
	Serial Number		Receiver Serial No. (e.g., 01436000288)
	Transmitter ID		Transmitter Part No. (e.g., 50119407)
	Transmitter SN		Transmitter Serial No. (e.g., 01436000289)
	FW Version		e.g., 01.61
	HW Version		e.g., A001
	Kx Version		e.g., P01.30e

✥ Select **Information**.

8.5.7 Reset to factory settings

Factory settings can be restored with this configuration.
The structure of this menu item in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description		
Main Settings					
	Commands		Teach	Reset	Factory Settings

✤ Select **Main Settings > Command > Factory Settings**.

9 Starting up the device - Analog output

9.1 Analog output configuration on the receiver control panel

The configuration of the analog output involves the following steps on the receiver control panel.

> ○
> 〗 The configurations can be performed via the receiver control panel or the *Sensor Studio* config-uration software (see chapter 12). These configurations are stored in non-volatile memory so that they are retained the next time the device is switched on.
>
> It is always the last-made settings which are active.

General prerequisites:
- The measuring light curtain has been mounted (see chapter 6) and connected (see chapter 7 "Elec-trical connection") correctly.
- The basic configuration has been performed (see chapter 8).

Configuration of analog signal, analog function, characteristic curve (start beam / end beam)

The following example shows the configuration of an analog output to 4 … 20 mA. Current output pin 7 supplies an analog output signal depending on the first (FIB) interrupted beam. The measurement range goes from beam no. 1 … 32.

Structure of the analog signal, analog function, characteristic curve (start beam, end beam) settings in the receiver control panel menu (multiple settings shown simultaneously):

Level 0	Level 1	Level 2	Description						
Analog Output									
	Analog Signals		Off	U: 0 … 5 V	U: 0 … 10 V	U: 0 … 11 V	**I: 4 … 20 mA**	I: 0 … 20 mA	I: 0 … 24 mA
	Analog Function		Off	**FIB**	FNIB	LIB	LNIB	TIB	TNIB
	Start Beam		001						
	End Beam		032						

↳ Select the type of analog signal.

Off, or a defined voltage level and/or current level.

↳ Select the evaluation function whose result is to be depicted on the analog output.

Off, or FIB; FNIB; LIB; LNIB; TIB; TNIB.

↳ Set the start of the characteristic curve.

The start of the characteristic curve is defined by the start beam.

↳ Set the end of the characteristic curve.

The end of the characteristic curve is defined by the end beam.

> ○
> 〗 By entering End Beam < Start Beam, the characteristic curve of the analog output can be inverted.

The analog-device-specific configuration is concluded. The CML 700i is ready for process mode.

9.2 Analog output configuration via the *Sensor Studio* configuration software

The configuration of the analog output involves the following steps in the *Sensor Studio* configuration soft-ware (see chapter 12).

○
⫙   The configurations that are available in the IODD file via the *Sensor Studio* configuration software (see chapter 12) can, in part, also be performed via the receiver control panel. Both configuration types are stored in non-volatile memory so that they are retained the next time the device is switched on.

It is always the last set configurations which are active. If the last changes to the configuration were made via the receiver control panel, any settings changed via, e.g., the control or PC are overwritten.

General prerequisites:
- The measuring light curtain has been mounted (see chapter 6) and connected (see chapter 7) correctly.
- The measuring light curtain is connected to a PC via an IO-Link USB master (see chapter 12).
- *Sensor Studio* (incl. device-specific IODD file) is installed on the PC (see chapter 12).
- The basic configuration has been performed (see chapter 8).

○
⫙   The IO Device Description (IODD) can be used both with connected light curtain for direct configuration or without connected light curtain for creating device configurations.

The IODD file is supplied with the product CD. An updated version can also be downloaded from the Internet at **www.leuze.com**.

✎ Open the *Sensor Studio* configuration software on the PC (see chapter 12).

✎ Configure the following parameters:

- Smoothing (definition of a beam number for which no object detection is yet detected)

- Type of analog signal (off; or selection of defined voltage level or current level) (see chapter 9)

- Type of analog function (off; or FIB; FNIB; LIB; LNIB; TIB; TNIB) (see chapter 9)

- Characteristic curve configuration (start beam and end beam) (see chapter 9.3)

- Filter depth (definition of a minimum number of measurement cycles after which beam evaluation is performed)

✎ If necessary, configure additional parameter/process data with the aid of the process data table (see chapter 10.3).

✎ Save the configuration in the CML 700i.

The CML 700i is ready for process mode.

9.3   Behavior of the analog output

The output logic of the CML 700i returns the output signals to the programmable logic control (PLC). On interface X1, three pins can be assigned as output for the analog control of the PLC process interface.

The selected beam area (start beam/end beam) is mapped to the analog output of the CML 700i. The conversion is by means of a 12-bit D/A converter, whereby the 12-bit value (4096) is divided by the selected number of beams. The resulting values, mapped to the respective, configured analog values, yield the characteristic curve. If there are only a few beams, this results in an erratic characteristic curve.

○
⫙   The beams used for the measurement can be freely defined via the receiver control panel. It is also possible to specify that only a part of the beam area be used for the measurement.

1   Evaluation function
2   Start beam
3   End beam
4   Output signal
5   Standard characteristic curve
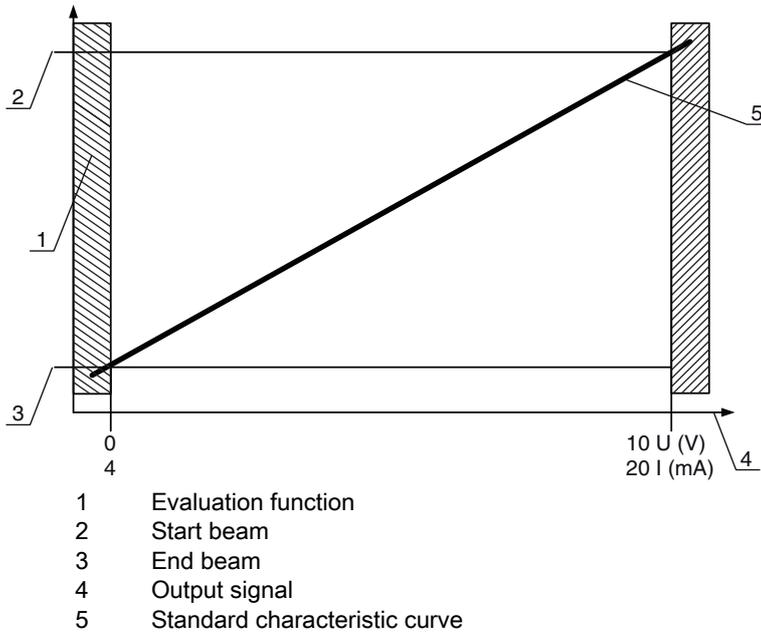
Figure 9.1:   Characteristic curve of analog output (default characteristic curve)

If a higher beam number is selected for the beginning of the measurement range than for the end of the measurement range, the characteristic curve is inverted.

1   Evaluation function
2   Start beam (for inverted characteristic curve)
3   End beam (for inverted characteristic curve)
4   Output signal
5   Inverted characteristic curve
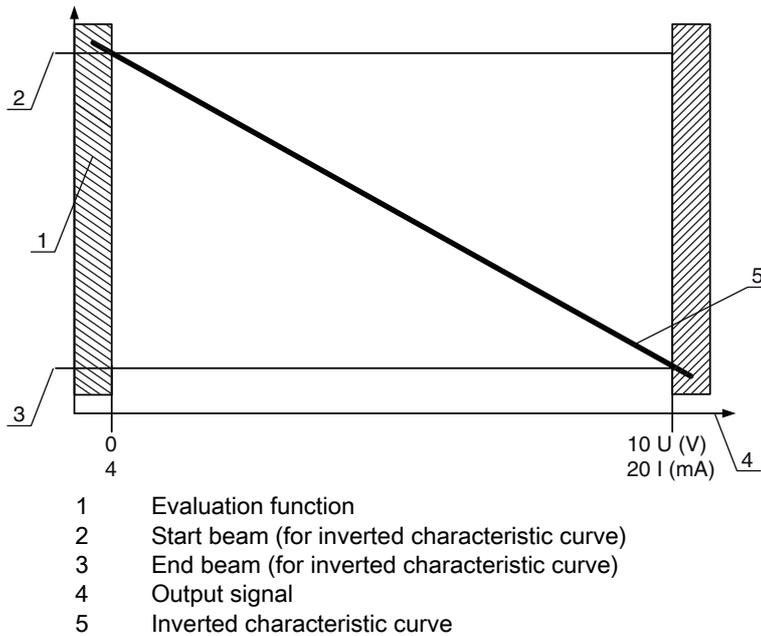
Figure 9.2:   Characteristic curve of analog output (inverted characteristic curve)

Overview: states of the analog output

Configuration for height and edge measurement			Analog value corresponding to the beam state	
			All free	All or end beam interrupted
Standard	Start beam	End beam	4 mA	20 (24) mA
			0 V	(5) 10 (11) V
Inverted	End beam	Start beam	20 (24) mA	4 mA
			(5) 10 (11) V	0 V

The rise time of the analog output from 0% to 100% can take up to 2 ms. To keep the control from evaluating the analog value of a rising edge, configure the control so that a value is detected as valid if it remains unchanged for a certain length of time.

10 Starting up the device - IO-Link interface

The configuration of an IO-Link interface involves the following steps on the receiver control panel and the IO-Link master module of the control-specific configuration software.

General prerequisites:

- The measuring light curtain has been mounted (see chapter 6) and connected (see chapter 7) correctly.
- The basic configuration has been performed (see chapter 8).

10.1 Defining IO-Link device configurations on the receiver control panel

The parameters for the IO-Link interface are configured with the process data length (PD length) and the data storage configurations. By changing the process data length, the light curtain receives a new IO-Link device ID and must be operated with the compatible IO Device Description (IODD).

NOTICE
Changes take effect immediately!
✏ The changes take effect immediately (without restarting).
✏ The IODD file is supplied with the device and is available for download at **www.leuze.com**.

Factory settings:

PD length: 8 bytes

Data storage: active

The structure of these configurations in the receiver control panel menu is as follows:

Level 0	Level 1	Level 2	Description
Main Settings			
	Commands		
	Operation Settings		
	IO-Link	**PD-Length**	**8 bytes** 32 bytes
		Data Storage	Inactive **Active** Event
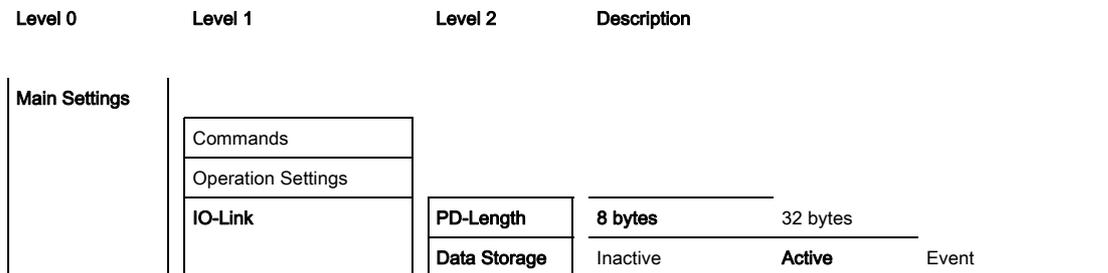
✏ Select **Main Settings > IO-Link > PD Length**.

The PD length is configured.

✏ Select **Main Settings > IO-Link > Data Storage**.

Event: The light curtain sends changes made to system-relevant parameters which can be transferred, directly to the IO-Link master module.

Other possible configuration steps are performed via the *Sensor Studio* configuration software (see chapter 12).
Process mode is configured via the IO-Link master module of the control-specific software.

10.2 Defining configurations via the IO-Link master module of the PLC-specific software

General prerequisites:

- The measuring light curtain has been mounted (see chapter 6) and connected (see chapter 7) correctly.
- The basic configuration has been performed (see chapter 8).
- The IO-Link-specific basic configurations have been performed.
  - IO-Link PD length selected

The IO Device Description (IODD) can be used both with connected light curtain for direct configuration or without connected light curtain for creating device configurations.

The IODD files are supplied with the product. The IODD can also be downloaded from the Internet at **www.leuze.com**.

↯ Open the configuration software of the IO-Link master module.

↯ Configure the following parameters:

- Beam mode (parallel-, diagonal-, crossed-beam)

- Blanking settings

- Teach settings

↯ Perform a teach. This is possible via the receiver control panel or the control group in the IO-Link process data (IO-Link object 2).

↯ If necessary, configure additional parameter/process data (see chapter 10.3).

↯ Save the configuration via the control group in the IO-Link process data (IO-Link object 2).

The IO-Link-specific configurations are performed and copied to the device. The device is prepared for process mode.

10.3 Parameter/process data for IO-Link

The parameter data and process data are described in the IO-Link Device Description (IODD) file.

Details on the parameters and on the structure of the process data can be found in the **.html** document, which is contained in the **IODD zip file**, and on the Internet at **www.leuze.com**.

Sub-index access is not supported.

Overview

Group	Group name
Group 1	System commands (see page 76)
Group 2	CML 700i status information (see page 76)
Group 3	Device description (see page 76)
Group 4	General configurations (see page 78)
Group 5	Additional settings (see page 78)
Group 6	Process data settings (see page 79)
Group 7	Cascading/trigger settings (see page 80)
Group 8	Blanking settings (see page 80)
Group 9	Teach settings (see page 82)
Group 10	Digital IO pin N settings (N = 2, 5, 6) (see page 82)
Group 12	Analog device settings (see page 83)
Group 13	Autosplitting (see page 84)
Group 14	Configuration for block evaluation of beam areas (see page 84)
Group 15	Evaluation functions (see page 86)

System commands (group 1)

ⓘ The system commands trigger a direct action in the device.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
System command	2		unsigned 8	WO	128, 130, 162, 163		128: Reset device 130: Factory reset 162: Perform teach 163: Save settings **Note**: Processing of the Save command takes up to 600 ms. During this time, no other data/telegrams are accepted.

CML 730-PS status information (group 2)

ⓘ The status information consists of operating state information or error messages.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation

CML operating state information	162	0	unsigned 16	RO			Bit
							0 … 11: measurement cycle number of a measurement
							12 … 13: reserved
							14: event
							  • is set to "1" if status changes.
							  • cause/reason for event: see index 2162
							15: 1 = valid measurement result exists

CML status information	163	0	unsigned 16	RO			Detailed device status code

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Teach status	69	0	unsigned 8	RO	0, 1, 128	0	Status information about teach operation 0: Teach ok 1: Teach busy 128: Teach error
Alignment	70	0	record 32 bit	RO			Information on the signal level of the first and last beam. The value changes depending on the selected function reserve.
Last beam intensity	70	1 (bit offset = 16)	unsigned 16	RO		0	
First beam intensity	70	2 (bit offset = 0)	unsigned 16	RO		0	

Device description (group 3)

ⓘ The device description specifies the device characteristics, e.g., beam spacing, the number of physical/logical individual beams, the number of cascades (16 individual beams) in the device and the cycle time.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Device access locks	12	1	boolean	RW			Write access lock
		2	boolean	RW			Data storage lock
		3	boolean	RW			Local configuration lock
		4	boolean	RW			Local user interface lock
Manufacturer name	16	0	string 32 bytes	RO			Leuze electronic GmbH + Co. KG
Manufacturer text	17	0	string 64 bytes	RO			Leuze electronic - the sensor people
Product name	18	0	string 64 bytes	RO			Receiver type designation
Product ID	19	0	string 20 bytes	RO			Receiver order number (8-digit)
Product text	20	0	string 64 bytes	RO			"Measuring light curtain CML 730-PS"
Serial number Receiver	21	0	string 16 bytes	RO			Receiver serial number for unique product identification
Hardware version	22	0	string 64 bytes	RO			
Firmware version	23	0	string 20 bytes	RO			
User-specific name	24	0	string 32 bytes	RW		***	Device designation defined by the user
Error counter	32	0	unsigned 16	RO			IO-Link error counter
Device status	36	0	unsigned 8	RO	0 … 4		Value: 0 device is OK Value: 1 maintenance required Value: 2 outside of specifications Value: 3 function test Value: 4 error
Detailed device status	37	0	array	RO			
Receiver part no.	64	0	string 20 bytes	RO			Receiver order number
Transmitter product designation	65	0	string 64 bytes	RO			Type designation
Transmitter part no.	66	0	string 20 bytes	RO			Transmitter order number
Transmitter serial number	67	0	string 16 bytes	RO			Transmitter serial number for unique product identification
Device characteristics	68	0	record 80 bit	RO			The device characteristics specify the beam spacing, the number of physical/logical individual beams, the number of cascades (16 individual beams) in the device and the cycle time.
Beam spacing	68	1 (bit offset = 64)	unsigned 16	RO	5, 10, 20, 40	5	Distance between two adjacent optical individual beams.
Number of physical individual beams	68	2 (bit offset = 48)	unsigned 16	RO		16	Number of axes

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Number of configured logical individual beams	68	3 (bit offset = 32)	unsigned 16	RO		16	The number of logical individual beams is dependent on the selected operating mode. The evaluation functions of the CML 700i are calculated on the basis of the logical individual beams.
Number of cascades	68	4 (bit offset = 16)	unsigned 16	RO		1	The CML 700i has a modular structure. 8, 16 or 32 individual beams are always grouped into a cascade.
Device cycle time	68	5 (bit offset = 0)	unsigned 16	RO		1000	The device cycle time defines the duration of a measurement cycle of the CML 700i.

General configurations (group 4)

Configured under group 4 "General configurations" are the type of scanning (parallel-/diagonal-/crossed-beam), counting direction and minimum object diameter for the evaluation (smoothing). The minimum hole size for the evaluation, e.g., with web material, is configured via inverted smoothing.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Global settings	71	0	record 32 bit	RW			
Beam mode	71	1 (bit offset = 24)	unsigned 8	RW	0 … 2	0	0: Parallel-beam scanning 1: Diagonal-beam scanning 2: Crossed-beam scanning
Counting direction	71	2 (bit offset = 16)	unsigned 8	RW	0 … 1	0	0: Normal - starting at the connector side 1: Inverted – starting opposite the connector site
Smoothing	71	3 (bit offset = 8)	unsigned 8	RW	1 … 255	1	Smoothing: Less than i interrupted beams are ignored.
Inverted smoothing	71	4 (bit offset = 0)	unsigned 8	RW	1 … 255	1	Inverted smoothing: Less than i free beams are ignored.

Additional settings (group 5)

The additional settings specify the filter depth, integration time (hold function) and key lock on the receiver control panel.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Additional settings	74	0	record 32 bit	RW			
Teach mode	74	1	unsigned 8	RW	0	0	0: Automatic teach
Filter depth	74	2 (bit offset = 16)	unsigned 8	RW	1 … 255	1	The filter depth indicates the necessary number of consistent beam states before the evaluation of the measurement values. The filter depth corresponds to the number of passes with interrupted beam so that the result leads to switching.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Integration time	74	3 (bit offset = 0)	unsigned 8	RW	0 … 65535	0	All measurement values are accumulated and retained over the duration of the integration time. Hold function in ms.
Key lock and display	78	0	unsigned 8	RW	0 … 2	0	Lock operational controls on the device. 0: Enabled 1: Locked 2: Volatile

Process data settings (group 6)

ℹ️ The process data settings describe the cyclically transmitted process data.

The process data setting permits the serial output of the individual pieces of beam data. Each individual beam can be processed and transferred as a bit independent of measurement field length, resolution and beam mode.

NOTICE

A maximum of 256 beams can be processed as a bit!

✧ The IO-Link specification only permits 32 bytes as process data; i.e., up to 256 beams can each be processed and transmitted as a bit.

✧ Through the limitation of the process data length, the beams, depending on the resolution, can only be processed and transmitted up to a certain measurement field length as a bit.

Example for the limitation of the measurement field length:
- Resolution of 5 mm: Measurement field length up to 1280 mm

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Process data settings	72	0	record 128 bit	RW			
Evaluation function module 01	72 (bit offset = 120)	1	unsigned 8	RW	1 … 111, 0, 200 … 205, 208 … 210, 212	204	1 … 111: Number of optical cascades for beam-stream evaluation (16 beams) 0: No function (NOP) 200: First interrupted beam (FIB) 201: First not interrupted beam (FNIB) 202: Last interrupted beam (LIB) 203: Last not interrupted beam (LNIB) 204: Total of interrupted beams (TIB) 205: Total of not interrupted beams (TNIB) 208: Switching state of areas 16 … 1 209: Switching state of areas 32 … 17 210: Switching state of the outputs mapped to the areas 212: CML 700i status information
Evaluation function module 02	72 (bit offset = 112)	2	unsigned 8	RW	1 … 111, 0, 200 … 205, 208 … 210, 212	202	1 … 111: Number of optical cascades for beam-stream evaluation (16 beams) 0: No function (NOP) 200: First interrupted beam (FIB) 201: First not interrupted beam (FNIB) 202: Last interrupted beam (LIB) 203: Last not interrupted beam (LNIB) 204: Total of interrupted beams (TIB) 205: Total of not interrupted beams (TNIB) 208: Switching state of areas 16 … 1 209: Switching state of areas 32 … 17 210: Switching state of the outputs mapped to the areas 212: CML 700i status information

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
......	....		....	..	..	..	....
......	....		....	..	..	..	....
Evaluation function module 16	72 (bit offset = 0)	1	unsigned 8	RW	1 … 111, 0, 200 … 205, 208 … 210, 212	0	1 … 111: Number of optical cascades for beam-stream evaluation (16 beams) 0: No function (NOP) 200: First interrupted beam (FIB) 201: First not interrupted beam (FNIB) 202: Last interrupted beam (LIB) 203: Last not interrupted beam (LNIB) 204: Total of interrupted beams (TIB) 205: Total of not interrupted beams (TNIB) 208: Switching state of areas 16 … 1 209: Switching state of areas 32 … 17 210: Switching state of the outputs mapped to the areas 212: CML 700i status information

Cascading/trigger settings (group 7)

To prevent mutual interference, multiple light curtains can be operated with a time offset with respect to one another (cascade). Here, the master generates the cyclical trigger signal; the slaves start their measurement after delay times, which are to be set to different values.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Trigger Settings	73	0	record 64 bit	RW			
Cascading	73	1 (bit offset = 56)	unsigned 8	RW	0 … 1	0	0: Not active (continuous scanning) 1: Active (sensor expects trigger signal)
Function mode	73	2 (bit offset = 48)	unsigned 8	RW	0 … 1	0	0: Slave (waiting for trigger signal) 1: Master (generating trigger signal)
Trigger delay time → Start measurement	73	3 (bit offset = 32)	unsigned 16	RW	500 … 65535	500	Unit: µs
Output pulse width	73	4	unsigned 16	RW		100	Width of output trigger pulse in µs **Note**: It is recommended not to change the value.
Master cycle time	73	5 (bit offset = 0)	unsigned 16	RW	1 … 6500	1	Unit: ms

Blanking settings (group 8)

Up to 4 beam areas can be deactivated. Deactivated beams can be assigned the logical values 0, 1 or the value of the adjacent beam. With auto blanking activated, up to 4 beam areas are automatically suppressed during teaching.

Auto blanking should only be activated during commissioning of the light curtain to suppress interfering objects. In process mode, auto blanking should be deactivated.

For details on this topic see chapter 11.4.

NOTICE
Perform teach after changing the blanking configuration!
✋ Perform a teach after changing the blanking configuration.
A teach can be performed via the receiver control panel or via the teach command.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Blanking settings	76	0	record 208 bit	RW			
Number of auto-blanking areas	76	1 (bit offset = 200)	unsigned 8	RW	0 … 4	0	Permissible number of auto blanking areas 0: 0 auto blanking areas 1: 1 auto blanking area 2: 2 auto blanking areas 3: 3 auto blanking areas 4: 4 auto blanking areas
Auto blanking (during teaching)	76	2 (bit offset = 192)	unsigned 8	RW	0 … 1	0	0: Not active (only manual configuration possible) 1: Active (blanking areas autom. configured by teach)
Logical value for blanking area 1	76	3 (bit offset = 176)	unsigned 16	RW	0 … 4	0	0: No beams blanked 1: Logical value 0 for blanked beams 2: Logical value 1 for blanked beams 3: Logical value = same as neighbor beam with lower beam number 4: Logical value = same as neighbor beam with higher beam number
Start beam of blanking area 1	76	4 (bit offset = 160)	unsigned 16	RW	1 … 1774	1	
End beam of blanking area 1	76	5 (bit offset = 160)	unsigned 16	RW	1 … 1774	1	
Logical value for blanking area 2	76	6 (bit offset = 128)	unsigned 16	RW	0 … 4	0	0: No beams blanked 1: Logical value 0 for blanked beams 2: Logical value 1 for blanked beams 3: Logical value = same as neighbor beam with lower beam number 4: Logical value = same as neighbor beam with higher beam number
Start beam of blanking area 2	76	7 (bit offset = 112)	unsigned 16	RW	1 … 1774	1	
End beam of blanking area 2	76	8 (bit offset = 96)	unsigned 16	RW	1 … 1774	1	
......	....		....	..	..	..	....
......	....		....	..	..	..	....
Logical value for blanking area 4	76	12 (bit offset = 32)	unsigned 16	RW	0 … 4	0	0: No beams blanked 1: Logical value 0 for blanked beams 2: Logical value 1 for blanked beams 3: Logical value = same as neighbor beam with lower beam number 4: Logical value = same as neighbor beam with higher beam number
Start beam of blanking area 4	76	13 (bit offset = 16)	unsigned 16	RW	1 … 1774	1	
End beam of blanking area 4	76	14 (bit offset = 0)	unsigned 16	RW	1 … 1774	1	

Teach settings (group 9)

In most applications, it is recommended that teach values be stored in non-volatile memory (remanent).

Depending on the function reserve selected for the teach event, the sensitivity is higher or lower (high function reserve = low sensitivity; low function reserve = high sensitivity).

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Function reserve mode	75	0	unsigned 8	RW	0 … 5	0	0: High 1: Medium 2: Low 3: Transparent 4: Target function reserve 5: Tx/Rx power
Teach settings	79	0	record 72 bit	RW			
Teach Count	79	1	unsigned 8	RW	1 … 255	10	Number of measurements required to determine minimum value **Note**: It is recommended not to change the value.
Type of storage for teach values	79	2 (bit offset = 16)	unsigned 8	RW	0 … 1	0	0: Non-volatile storage of teach values 1: Teach values only saved while voltage ON
Switching threshold	79	3 (bit offset = 0)	unsigned 8	RW	5 … 98	75	Threshold as percentage of teach threshold (50% = function reserve 2)
Switching hysteresis	79	4	unsigned 8	RW	5 … 80		Switching hysteresis as percentage of teach threshold
Transmitting power	79	5	unsigned 8	RW	3 … 100		Transmitting power in %
Receiving sensitivity	79	6	unsigned 8	RW	1 … 22		Receiver sensitivity
Function reserve nominal value	79	7	unsigned 8	RW	1 … 999	999	Nominal value of the function reserve
Power-Up teach	79	8	unsigned 8	RW	0 … 1		0: Deactivated 1: Activated

Digital IO pin N settings (N = 2, 5, 6) (group 10)

In this group, the inputs/outputs can be set to positive switching (PNP) or to negative switching (NPN). The switching behavior applies the same for all inputs/outputs.

This group can also be used to configure the inputs/outputs: pins 2, 5 and 6.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Digital IO switching level	77	0	unsigned 8	RW	0 … 1	1	0: Transistor, NPN 1: Transistor, PNP
Configuration pin 2, 5, 6							
Configuration Digital IO Pin 2 Digital IO Pin 5 Digital IO Pin 6	80 81 82	0	record 72 bit	RW			
Switching level	80 81 82	1	unsigned 8	RW	0 … 1	0	0: Normal - light switching 1: Inverted - dark switching

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
IO Function	80 81 82	2	unsigned 8	RW	0 … 6		0: Deactivated 1: Trigger input 2: Teach input 3: Area output 4: Warning output 5: Trigger output 6: Validation output
Operating mode of time module	80 81 82	3	unsigned 8	RW	0 … 4	0	0: Deactivated 1: Start-up delay 2: Switch-off delay 3: Pulse stretching 4: Pulse suppression
Time constant for selected function	80 81 82	4	unsigned 8	RW	0 … 65,000	0	Unit: ms
Area mapping 32 … 25	80 81 82	5	unsigned 8	RW		0	
Area mapping 24 … 17	80 81 82	6	unsigned 8	RW		0	
Area mapping 16 … 09	80 81 82	7	unsigned 8	RW		0	
Area mapping 08 … 01	80 81 82	8	unsigned 8	RW		0	

Analog device settings (group 12)

In this group, various parameters can be used to set the analog device configurations, e.g, the configuration of the analog output level and how the evaluation function that is represented on the analog output is selected.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Signal level	88	0	unsigned 8	RW	0 … 6	0	Configuration of the analog output level: voltage: 0 … 5 V voltage: 0 … 10 V voltage: 0 … 11 V current: 4 … 20 mA current: 0 … 20 mA current: 0 … 24 mA 0: Not active 1: Voltage: 0 … 5 V 2: Voltage: 0 … 10 V 3: Voltage: 0 … 11 V 4: Current: 4 … 20 mA 5: Current: 0 … 20 mA 6: Current: 0 … 24 mA
Evaluation function	89	0	record 48 bit, isolated access to sub-index not possible	RW			Selection of the evaluation function that is represented on the analog output: first interrupted/not interrupted beam (FIB/FNIB), last interrupted/not interrupted beam (LIB/LNIB), total of interrupted/not interrupted beams (TIB/TNIB)
Analog Function	89	1 (bit offset = 40)	unsigned 8	RW	0 … 6	0	0: No function (NOP) 1: First interrupted beam (FIB) 2: First not interrupted beam (FNIB) 3: Last interrupted beam (LIB) 4: Last not interrupted beam (LNIB) 5: Total of interrupted beams (TIB) 6: Total of not interrupted beams (TNIB)
Start beam of analog measuring area	89	2 (bit offset = 16)	unsigned 16	RW	1 … 1774	1	
End beam of analog measuring area	89	3 (bit offset = 16)	unsigned 16	RW	1 … 1774	1	

Autosplitting (group 13)

In this group, it is possible to split all logical beams into areas of identical size. The fields of areas 01 … 32 are thereby automatically configured.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Auto-Splitting	98	0	unsigned 16	WO	1 … 32 1: (active: all beams free - not active: = one beam inter-rupted) 257 … 288 2: (active: one beam free - not active: = all beams inter-rupted)	1: (active: all beams free - not active: = one beam inter-rupted)	Splitting of all logical beams into areas of identical size according to the number of areas set under "Number of areas". The fields of areas 01 … 32 are thereby automatically configured. 1: (active: all beams free – not active: ≥ one beam interrupted) 1: One area … 32: Thirty-two areas 2: (active: one beam free – not active: = all beams interrupted) 257: One area … 288: Thirty-two areas
Evaluation of the beams in the area	98	1 (bit offset = 8)	unsigned 8	WO	0 … 1	0	0: OR combined 1: AND combined
Number of Areas (equi-distant partitioning)	98	2 (bit offset = 0)	unsigned 8	WO	1 … 32	1	

Configuration for block evaluation of beam areas (group 14)

In this group, a detailed area configuration can be displayed and a beam area configured for the block evaluation.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
Show detailed area configuration	99	0	unsigned 8	RW	0 … 32	0	Choose the area (1..32) that requires detailed configuration. 0: Area 01 1: Area 02 2: Area 03 … 31: Area 32
Configuration of area 1							
Configuration area 01	100	0	record 112 bit	RW			Configuration of the area: definition of the status conditions so that the area takes on a logical 1 or 0. For diagonal- or crossed-beam scanning, the numbers of the logical beams are to be entered.
Area	100	1 (bit offset = 104)	unsigned 8	RW	0 … 1	0	0: Not active 1: Active
Active beam	100	2 (bit offset = 96)	unsigned 8	RW	0 … 1	0	0: Light switching (beam is active if light path is free) 1: Dark switching (beam is active if light path is interrupted)
Start beam of area	100	3 (bit offset = 80)	unsigned 8	RW	1 … 1774 65534 65533 65532 65531	1	65534: First interrupted beam (FIB) 65533: First not interrupted beam (FNIB) 65532: Last interrupted beam (LIB) 65531: Last not interrupted beam (LNIB)

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
End beam of area	100	4 (bit offset = 64)	unsigned 8	RW	1 … 1774 65534 65533 65532 65531	1	65534: First interrupted beam (FIB) 65533: First not interrupted beam (FNIB) 65532: Last interrupted beam (LIB) 65531: Last not interrupted beam (LNIB)
Number of active beams for area ON	100	5 (bit offset = 48)	unsigned 16	RW	0 … 1774	0	If more than or the same number of active beams are free or interrupted (see sub-index 2), the evaluation result of the area changes to "1".
Number of active beams for area OFF	100	6 (bit offset = 32)	unsigned 16	RW	0 … 1774	0	If less than or the same number of active beams are free or interrupted (see sub-index 2), the evaluation result of the area changes to "0".
Specified middle of the area	100	7 (bit offset = 16)	unsigned 16	RW	0 … 1774	0	
Specified width of the area	100	8 (bit offset = 0)	unsigned 16	RW	0 … 1774	0	
......	....		....	..	..	..	....
......	....		....	..	..	..	....
Configuration of area 32							
Configuration of area 32	131	0	record 112 bit	RW			Configuration of the area: definition of the status conditions so that the area takes on a logical 1 or 0. For diagonal- or crossed-beam scanning, the numbers of the logical beams are to be entered.
Area	131	1 (bit offset = 104)	unsigned 8	RW	0 … 1	0	0: Not active 1: Active
Active beam	131	2 (bit offset = 96)	unsigned 8	RW	0 … 1	0	0: Light switching (beam is active if light path is free) 1: Dark switching (beam is active if light path is interrupted)
Start beam of area	131	3 (bit offset = 80)	unsigned 8	RW	1 … 65534	1	
End beam of area	131	4 (bit offset = 64)	unsigned 16	RW	1 … 65534	1	
Number of active beams for area ON	131	5 (bit offset = 48)	unsigned 16	RW	1 … 1774	0	
Number of active beams for area OFF	131	6 (bit offset = 32)	unsigned 16	RW	1 … 1774	0	
Specified middle of the area	131	7 (bit offset = 16)	unsigned 16	RW	1 … 1774	0	
Specified width of the area	131	8 (bit offset = 0)	unsigned 16	RW	1 … 1774	0	

Evaluation functions (group 15)

ℹ In this group, all evaluation functions can be configured.

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
First interrupted beam (FIB)	150	0	unsigned 16	RO			Logical beam number of the first darkened individual beam. The logical beam numbers change to the "diagonal" or "crossed-beam" mode. Note any changed configuration of the counting direction!
First not interrupted beam (FNIB)	151	0	unsigned 16	RO			Logical beam number of the first undarkened individual beam. The logical beam numbers change to the "diagonal" or "crossed-beam" mode. Note any changed configuration of the counting direction!
Last interrupted beam (LIB)	152	0	unsigned 16	RO			Logical beam number of the last darkened individual beam. The logical beam numbers change in diagonal- or crossed-beam mode. Note any changed configuration of the counting direction!
Last not interrupted beam (LNIB)	153	0	unsigned 16	RO			Logical beam number of the last undarkened individual beam. The logical beam numbers change to the "diagonal" or "crossed-beam" mode. Note any changed configuration of the counting direction!
Total of interrupted beams (TIB)	154	0	unsigned 16	RO			Sum of all darkened individual beams. The sum changes to the "diagonal" or "crossed-beam" mode.
Total of not interrupted beams (TNIB)	155	0	unsigned 16	RO			Sum of all undarkened individual beams. The sum changes to the "diagonal" or "crossed-beam" mode.
Area output - LoWord	158	0	unsigned 16	RO			Status of areas 01 … 16 as 2 bytes of process data
Area output - HiWord	159	0	unsigned 16	RO			Status of areas 17 … 32 as 2 bytes of process data
Result of the area evaluation assigned to Pins	160	0	record 16 bit, isolated access to sub-index not possible	RO			Logical value of the area evaluation assigned to the output pin
Reserved	160	1 (bit offset = 4)	unsigned 16	RO			
Pin 7	160	2 (bit offset = 3)	boolean	RO			Reserved
Pin 6	160	3 (bit offset = 2)	boolean	RO			
Pin 5	160	4 (bit offset = 1)	boolean	RO			
Pin 2	160	5 (bit offset = 1)	boolean	RO			
HW analog (HWA)	161	0	unsigned 16	RO			
PD beam-stream	171	0	array	RO			8 bytes

Parameter	Index	Sub-index	Data type	Access	Value range	Default	Explanation
PD beam-stream	172	0	array	RO			16 bytes
PD beam-stream	173	0	array	RO			32 bytes
PD beam-stream	174	0	array	RO			64 bytes
PD beam-stream	175	0	array	RO			128 bytes
PD beam-stream	176	0	array	RO			222 bytes
Beam-stream mask	177	0	array	RO			222 bytes
PD collection	178	0	record 208 bit	RO			Aggregation of all key process data
FIB	178	1	unsigned 16	RO			First interrupted beam
FNIB	178	2	unsigned 16	RO			First not interrupted beam
LIB	178	3	unsigned 16	RO			Last interrupted beam
LNIB	178	4	unsigned 16	RO			Last not interrupted beam
TIB	178	5	unsigned 16	RO			Number of interrupted beams
TNIB	178	6	unsigned 16	RO			Total of not interrupted beams
TNIB	178	7	unsigned 16	RO			Reserved
TNIB	178	8	unsigned 16	RO			Reserved
	178	9	unsigned 16	RO			Status beam area 16 … 09
	178	10	unsigned 16	RO			Status beam area 08 … 01
	178	11	unsigned 16	RO			Status beam area 32 … 25
	178	12	unsigned 16	RO			Status beam area 24 … 17
	178	13	unsigned 16	RO			Result of the area evaluation assigned to Pins
	178	14	unsigned 16	RO			Result of the area evaluation assigned to Pins
HWA	178	15	unsigned 16	RO			HW analog
Measurement running	178	16	boolean	RO			Process data valid?
Event flag	178	17	boolean	RO			Device status change performed?
	178	18	unsigned 8 2 bit	RO			Reserved
Measurement counter	178	19	unsigned 8 12 bit	RO			Measurement counter (modulo 4096)

11   Example configurations

11.1   Example configuration - Reading out 64 beams (beam-stream)

The beam-stream evaluation function is used, e.g., for evaluating the size and position of objects on a transport system.

11.1.1   Configuration of beam-stream process data via IO-Link interface

✎ Map the beam states of the individual optical cascades in the CML 700i to the process data as follows.

Evaluation function 01 (group 6)	Index 72, bit offset 120 = 1	The first optical cascade (beams 1 … 16) is transmitted in process data module 01
Evaluation function 02 (group 6)	Index 72, bit offset 112 = 2	The second optical cascade (beams 17 … 32) is transmitted in process data module 02
Evaluation function 03 (group 6)	Index 72, bit offset 104 = 3	The third optical cascade (beams 33 … 48) is transmitted in process data module 03
Evaluation function 04 (group 6)	Index 72, bit offset 96 = 4	The fourth optical cascade (beams 49 … 64) is transmitted in process data module 04

11.2   Example configuration - Mapping of beams 1 … 32 to output pin 2

11.2.1   Configuration of area/output mapping (general)

The following table shows an example configuration for an area mapping to an output. In this example, beams 1 … 32 are to be applied to output pin 2 on interface X1.

✎ Map beams 1 … 32 to area 01.

Description / variables				
Display detailed area configuration Value: 0 = area 01				
Configuration of area 01				
Area Value: 1 = active				
Logical behavior of the area	Value: 0 Normal - light switching (i.e., switching if beams are free)	Value: 1 Inverted - dark switching (i.e., switching if beams are interrupted)	Value: 0 Normal - light switching	Value: 1 Inverted - dark switching
Start beam of area Value:	1	1	1	1
End beam of area Value:	32	32	32	32
Number of active beams for area ON Value:	32	32	1	1
Number of active beams for area OFF Value:	31	31	0	0
Switching behavior Value: 0 = normal - light switching (i.e., switching if beams are free)	Output 1 if all beams are free. Output 0 if a beam is interrupted or if more than a beam are interrupted.	Output 0 if all beams are free or 1 … 31 beams are free. Output 1 only if 32 beams are interrupted.	Output 1 if all beams are free or as long as 1 … 31 beams are free. Output 0 if 32 beams are interrupted.	Output 0 if all beams are free. Output 1 as soon as a beam is interrupted.
Switching behavior Value: 1 = inverted - dark switching (i.e., switching if beams are interrupted)	Output 0 if all beams are free. Output 1 if one or more beams are interrupted. OR function	Output 1 if all beams are free or 1 … 31 beams are free. Output 0 only if 32 beams are interrupted. AND function	Output 0 if all beams are free or as long as 1 … 31 beams are free. Output 1 if 32 beams are interrupted.	Output 1 if all beams are free. Output 0 as soon as a beam is interrupted.

✎ Configure pin 2 as area output.

Description / variables		
Configuration of digital inputs/outputs		
Input/output selection	Value: 0 = output	Pin 2 functions as digital output
Function of the switching output	Value: 1 = switching output (area 1 … 32)	The switching output signals the logical states of beam areas 1 … 32

✤ Map pin 2 to configured area 1.

Digital Output 2 Settings		
Area mapping 32 … 1 (OR combination)	0b00000000000000000000000000000001	Every area is displayed as a bit.

Possible additional area-to-pin configurations:

✤ Map pin 2 to configured area 8.

Digital Output 2 Settings	
Area mapping 32 … 1 (OR combination)	0b00000000000000000000000010000000

✤ Map the configured areas 1 and 8 (OR-linked) to the corresponding switching output.

Digital Output 2 Settings	

11.2.2 Configuration of an area/output mapping via IO-Link interface

✤ Map the beams to output pin 2 as follows.

Configuration of area 01 (group 14)	Index 100, bit offset 104:	= 1	Area 01 active
	Index 100, bit offset 96:	= 0	Light switching
	Index 100, bit offset 80:	= 1	Start beam of area
	Index 100, bit offset 64:	= 32	End beam of area
	Index 100, bit offset 48:	= 32	Number of active beams for area ON
	Index 100, bit offset 32:	= 31	Number of active beams for area OFF
Digital IO Pin 2 Settings (group 10)	Index 80, bit offset 24:	= 0	Pin 2 as output
	Index 80, bit offset 16:	= 1	Switching behavior inverted
	Index 80, bit offset 0:	= 1	Switching output area 32 … 1
	Index 84, bit offset 0:	= 1	Bit mapping of area 01 to pin 2

11.3 Example configuration - Hole recognition

The following table shows an example configuration for hole recognition for web material with signaling of a hole at output pin 2. Example of detection beginning with a free beam with fixed/dynamic web position.

✤ First activate and configure a beam area (e.g., area 01).

✤ Map the area to the corresponding switching output.

Description / variables		
Configuration of pin 2		
Input/output selection	Value: 0 = output	Pin 2 functions as digital output
Function of the switching output	Value: 1 = switching output area 1 … 32	The switching output signals the logical states of beam areas 1 … 32
Switching behavior	Switching behavior Value: 0 = normal - light switching Value: 1 = inverted - dark switching	Configuration according to the necessary switching behavior of the output

✤ Map configured area 1 to pin 2.

11.3.1 Configuration of hole recognition via IO-Link interface

✎ For hole recognition for web material map hole indication to output pin 2.

Configuration of area 01 (group 14)	Index 00, bit offset 104:	= 1	Area 01 active
	Index 100, bit offset 96:	= 0	Light switching
	Index 100, bit offset 80:	= 65534	Start beam of the area dynamic: on 65534 (start beam = FIB)
	Index 100, bit offset 64:	= 65532	End beam of the area dynamic: on 65532 (start beam = LIB)
	Index 100, bit offset 48:	= 1	Number of active beams for area ON
	Index 100, bit offset 32:	= 0	Number of active beams for area OFF
Digital IO Pin 2 Settings (group 10)	Index 80, bit offset 24:	= 0	Pin 2 as output
	Index 80, bit offset 16:	= 1	Switching behavior inverted
	Index 80, bit offset 0:	= 1	Switching output area 32 … 1
	Index 84, bit offset 0:	= 1	Bit mapping of area 01 to pin 2

11.4 Example configuration - Activating and deactivating blanking areas

11.4.1 Configuration of blanking areas (general)

✎ Perform the following settings to activate or deactivate blanking areas.

Example: automatic blanking of two areas during teaching

Blanking settings	Parameter *Number of auto blanking areas*:	= 2	Two blanking areas permitted
	Parameter *Auto blanking (during teaching)*:	= 1	Automatic blanking-area configuration active
System commands	Parameter *Teach command*:	= 1	Execute teach command

Example: Deactivation/resetting of auto blanking

Blanking settings	Parameter *Number of auto blanking areas*:	= 0	No blanking areas permitted
	Parameter *Auto blanking (during teaching)*:	= 0	Automatic blanking area configuration not active

Blanking settings	Parameter *Function for blanking area/logical value for blanking area 1*:	= 0	No beams blanked
	Parameter Function for blanking area/logical value for blanking area 2:	= 0	No beams blanked
System commands	Parameter *Teach command*:	= 1	Execute teach command

11.4.2 Configuration of blanking areas via IO-Link interface

✎ Perform blanking area activation and deactivation.

Example: automatic blanking of two areas during teaching

Blanking settings (group 8)	Index 76, bit offset 200:	= 2	Two blanking areas permitted
	Index 76, bit offset 192:	= 1	Automatic blanking-area configuration active
System commands (group 1)	Index 2	= 162	Execute teach

In the background, the values of objects INDEX 76 sub-index 3 et seq. are calculated and stored in non-volatile memory. Upon successful teach completion, all other objects of index 76 are stored in non-volatile memory if index 79, sub-index 2 is set to value 0 = non-volatile storage of teach values.

Example: Deactivation/resetting of auto blanking

Blanking settings (group 8)	Index 76, bit offset 200:	= 0	No blanking areas permitted
	Index 76, bit offset 192:	= 0	Automatic blanking area configuration not active

Blanking settings (group 8)	Index 76, bit offset 176:	= 0	No beams blanked
	Index 76, bit offset 176:	= 0	No beams blanked
System commands (group 1)	Index 2:	= 162	Execute teach

11.5 Example configuration – smoothing

11.5.1 Smoothing configuration (general)

✧ Make the following settings for smoothing.

Example: Smoothing of four interrupted beams

Smoothing settings	Parameter *Smoothing -– less than i interrupted beams are ignored:*	= 4	Beams are taken into account in the evaluation once there are four or more interrupted beams

Example: Inverted smoothing of four interrupted beams

Smoothing settings	Parameter *Inverted smoothing - less than i free beams are ignored:*	= 4	Beams are taken into account in the evaluation once there are four or more free beams

> If the set configuration of the light curtain is running stably in your application and the measurement field resolution can be reduced, e.g. in the case of objects to be detected which are considerably larger than 10 mm, it is recommended to set *Smoothing* and *Inverted smoothing* to a value > 1.

11.5.2 Configuration of smoothing via IO-Link interface

✧ Assign the desired value for smoothing.

Example: Smoothing of four interrupted beams

General configuration (group 4)	Index 71, bit offset 8:	= 4	Beams are taken into account in the evaluation once there are four or more interrupted beams

Example: Inverted smoothing of four interrupted beams

General configuration (group 4)	Index 71, bit offset 0:	= 4	Beams are taken into account in the evaluation once there are four or more free beams

11.6 Example configuration - Cascading

11.6.1 Configuration of a cascading arrangement (general)

The following figure shows an example for a timing sequence of a cascading arrangement with three light curtains.
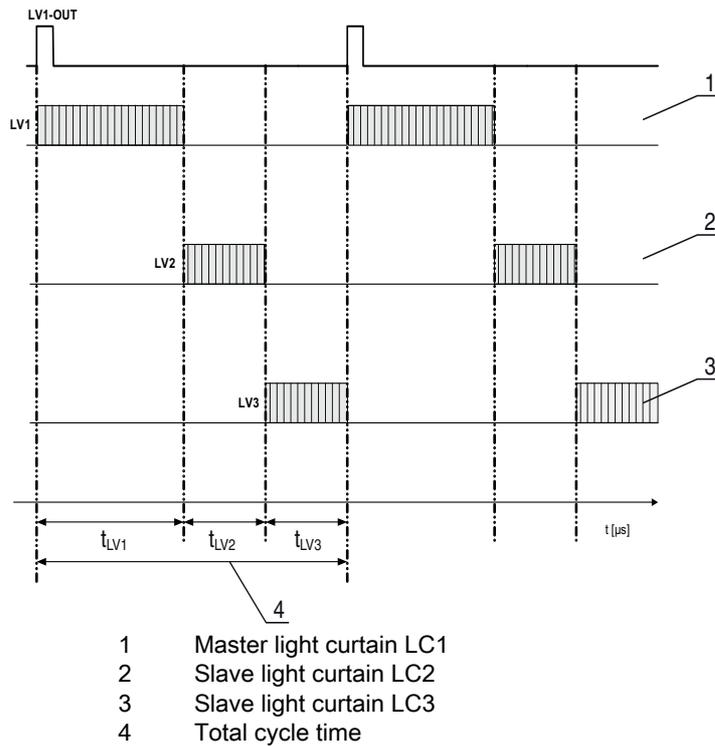
1 Master light curtain LC1
2 Slave light curtain LC2
3 Slave light curtain LC3
4 Total cycle time

Figure 11.1: Example: cascading with three light curtains

Configuring light curtain 1:

✏ Configure the trigger settings (triggered, master, total cycle time).

Cascading configuration	
Cascading	1: Active **Note:** With cascading operation, the master must also be set to 1 (active)!
Function type	1: Master (sends trigger signal)
Master cycle time	Total cycle time (= sum of cycle times of the light curtains LC1+LC2+LC3) Duration of a TRIGGER cycle in ms

✏ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings	
Pin 5 - Input/output selection	1: Output
Pin 5 - Switching behavior	0: Light switching
Pin 5 - Output function	3: Trigger output

Configuring light curtain 2:

✏ Configure the trigger settings (triggered, slave, delay time).

Cascading configuration	
Cascading	1: Active **Note:** With cascading operation, the master must also be set to 1 (active)!
Function type	0: Slave (expects trigger signal)
Trigger delay time → Scan [us]	Enter cycle time of light curtain 1 (LC1)

✏ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings	

Pin 5 - Input/output selection	1: Input
Pin 5 - Switching behavior	0: Light switching
Pin 5 - Output function	1: Trigger input

Configuring light curtain 3:

↳ Configure the trigger settings (triggered, slave, delay time).

Cascading configuration	
Cascading	1: Active **Note:** With cascading operation, the master must also be set to 1 (active)!
Function type	0: Slave (expects trigger signal)
Trigger delay time → Scan [us]	Enter cycle time of light curtain 1 and light curtain 2 (= sum of cycle times of light curtains LC1+LC2)

↳ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings	
Pin 5 - Input/output selection	1: Input
Pin 5 - Switching behavior	0: Light switching
Pin 5 - Output function	1: Trigger input

11.6.2 Configuration of a cascading arrangement via IO-Link interface

CML700i frame arrangement for cascading with IO-Link interface wiring
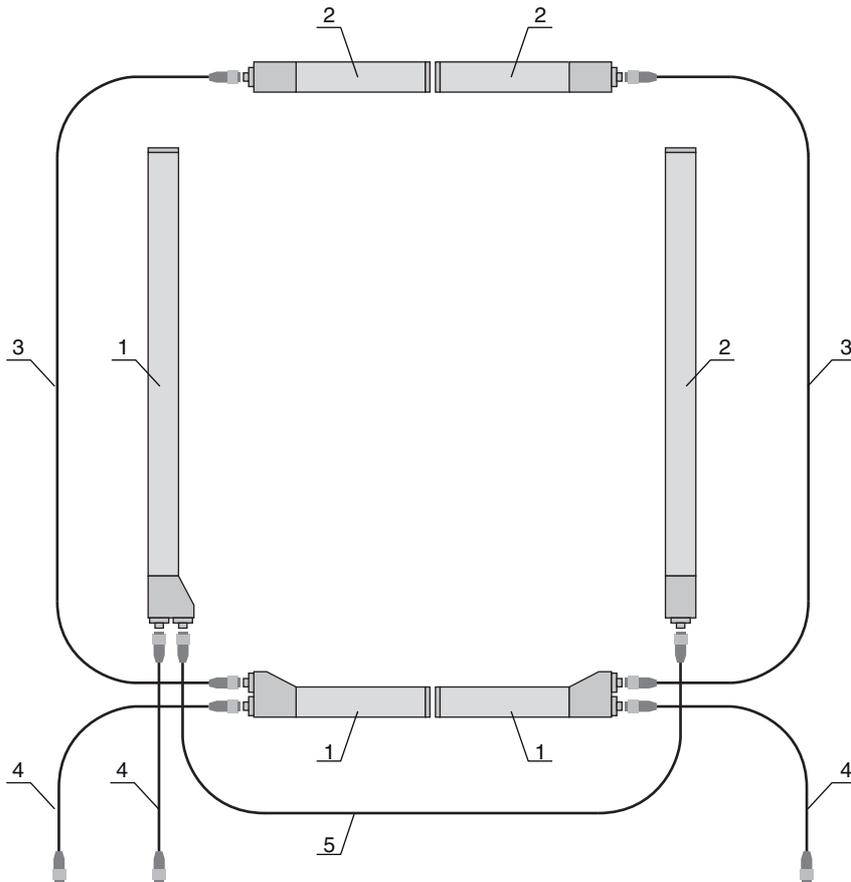
1	Receiver
2	Transmitter
3	Interconnection cable 5 m (See table 0.20)
3	Interconnection cable 5 m (See table 0.12)
4	Connection cable 5 m (See table 17.3)
4	Connection cable 5 m (See table 0.13)
5	Interconnection cable 2 m (See table 0.22)
5	Interconnection cable 2 m (See table 0.12)

Configuring light curtain 1:

✎ Configure the trigger settings (triggered, master, total cycle time).

Cascading configuration (group 7)	Index 73, bit offset 56	= 1	Cascading: active **Note:** With cascading operation, the master must also be set to 1 (active)!
	Index 73, bit offset 48	= 1	Function type: master - sends trigger signal
	Index 73, bit offset 32		Master cycle time: total cycle time of all light curtains (LC1+LC2+LC3) Duration of a TRIGGER cycle in ms

✎ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings (group 10)	Index 81, bit offset 24	= 0	Pin 5 - input/output selection: output
	Index 81, bit offset 16	= 0	Pin 5 - switching behavior: light switching
	Index 81, bit offset 00	= 3	Pin 5 - output function: trigger output

Configuring light curtain 2:

✎ Configure the trigger settings (triggered, slave, delay time).

Cascading configuration (group 7)	Index 73, bit offset 56	= 1	Cascading: active **Note:** With cascading operation, the master must also be set to 1 (active)!
	Index 73, bit offset 48	= 0	Function type: slave - expects trigger signal
	Index 73, bit offset 00		Delay time Trigger → Scan [µs]: enter cycle time of light curtain 1 (LC1)

✎ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings (group 10)	Index 81, bit offset 24	= 1	Pin 5 - input/output selection: input
	Index 81, bit offset 16	= 0	Pin 5 - switching behavior: light switching
	Index 81, bit offset 08	= 1	Pin 5 - output function: trigger input

Configuring light curtain 3:

✎ Configure the trigger settings (triggered, slave, delay time).

Cascading configuration (group 7)	Index 73, bit offset 56	= 1	Cascading: active **Note:** With cascading operation, the master must also be set to 1 (active)!
	Index 73, bit offset 48	= 0	Function type: slave - expects trigger signal
	Index 73, bit offset 32		Delay time Trigger → Scan [µs]: enter cycle time of light curtain 1 and light curtain 2 (= sum of the cycle times of light curtains LC1+LC2)

✎ Configure the digital IOs (pin 5) settings.

Digital IO1 (pin 5) settings (group 10)	Index 81, bit offset 24	= 1	Pin 5 - input/output selection: input
	Index 81, bit offset 16	= 0	Pin 5 - switching behavior: light switching
	Index 81, bit offset 08	= 1	Pin 5 - output function: trigger input

11.7 Example configuration – Detecting transparent films

✎ Select **Main Settings > Sensitivity Setting > Function Reserve > Transparent**

✎ Set the following configuration:

Switching threshold: 90% (possibly lower if the film allows this)

Hysteresis: 10% (at least 5% if the distance between the transmitter and receiver is small)
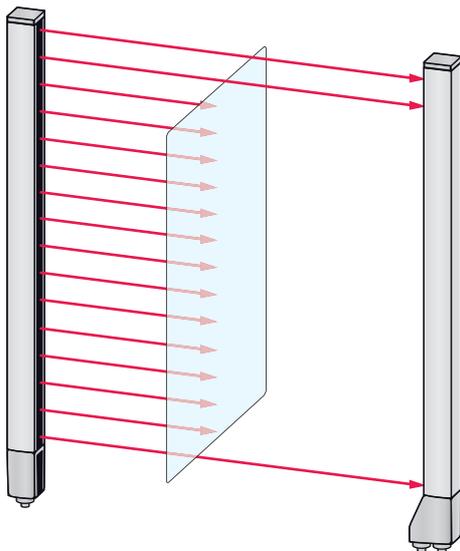

Figure 11.2: Detecting transparent films

The minimum damping for the detection of objects is calculated according to the following formula:

$$\text{Minimum damping} = (100\% - \text{threshold}) + \text{hysteresis}$$

11.8   Example configuration – Reliable beam penetration through opaque films

Function reserve mode *Target function reserve*

✎ Select **Main Settings > Sensitivity Setting > Function Reserve > Target Function Reserve**

✎ Set the following configuration:

Nominal value: 999 (maximum value)

Switching threshold: 40% (at least 30%; the smaller the switching threshold is, the higher the beam penetration power will be)

Hysteresis: 20% (at least 10%; the smaller the switching hysteresis is, the higher the beam penetration power will be)
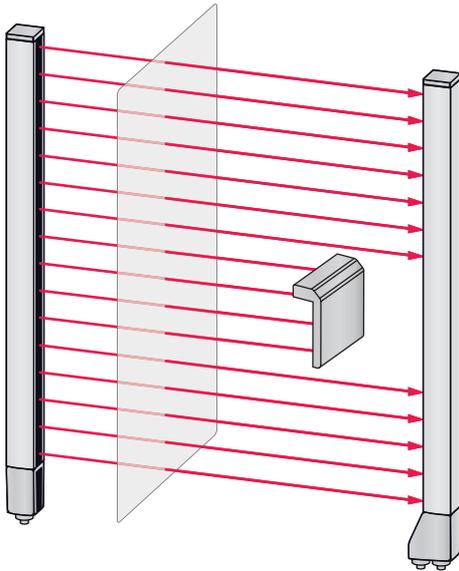

Figure 11.3:   Reliable beam penetration through opaque films

Objects behind the film are detected reliably if they are 10 mm or larger in size.

Function reserve mode *Tx/Rx power*

✎ Select **Main Settings > Sensitivity Setting > Function Reserve > Tx/Rx Power**

The optimum parameter settings can only be determined directly in the application.

✎ Determine the settings by trial and error in your application.

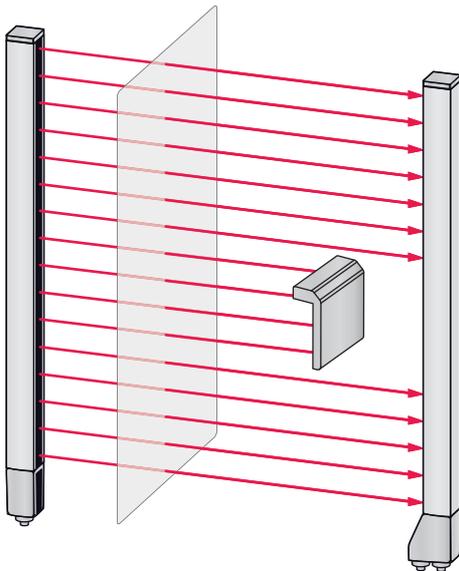| NOTICE |
|---|
| **Halation effects can influence the measurement!** |
| Halation effects may be a hindrance depending on the position of the film and of the objects to be detected. |
| ✎ Reduce the transmitting power while maintaining the same receiving sensitivity setting. |

Figure 11.4: Reliable beam penetration through opaque films

11.9   Example configuration – Double film detection

Detection of a film bag within a film bag

✎ Select **Main Settings > Sensitivity Setting > Function Reserve > Target Function Reserve**, or

✎ Select **Main Settings > Sensitivity Setting > Function Reserve > Tx/Rx Power**

The optimum parameter settings can only be determined directly in the application.

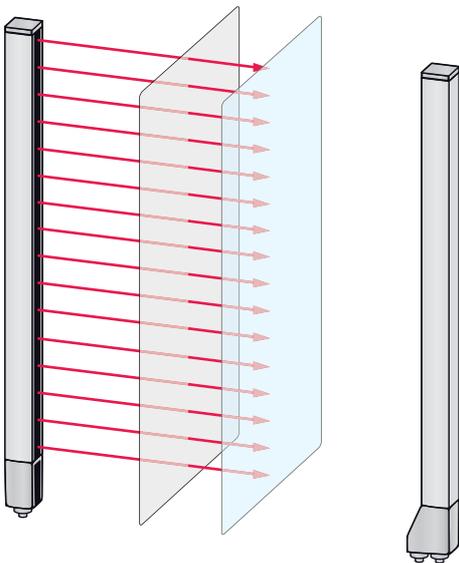✎ Determine the settings by trial and error in your application.

Figure 11.5: Double film detection

✎ If the enveloping film is transparent, you could select **Main Settings > Sensitivity Setting > Function Reserve > Tx/Rx Power**.

Reduce the switching threshold gradually until the light curtain no longer detects the outer film bag and reliably detects the inner film bag.

12   Connecting to a PC – *Sensor Studio*

The *Sensor Studio* configuration software – in combination with an IO-Link USB master – provides a graphical user interface for the operation, configuration and diagnosis of sensors with IO-Link configuration interface (IO-Link devices), independent of the selected process interface.

Each IO-Link device is described by a corresponding IO Device Description (IODD file). After importing the IODD file into the configuration software, the IO-Link device connected to the IO-Link USB master can be operated, configured and checked – conveniently and in multiple languages. An IO-Link device that is not connected to the PC can be configured offline.

Configurations can be saved and reopened as projects for transferring back to the IO-Link device at a later time.

> Only use the *Sensor Studio* configuration software for products manufactured by **Leuze electronic.**
>
> The *Sensor Studio* configuration software is offered in the following languages: German, English, French, Italian and Spanish.
>
> The FDT frame application of the *Sensor Studio* supports all languages; all languages may not be supported in the IO-Link device DTM (Device Type Manager).

The *Sensor Studio* configuration software is designed according to the FDT/DTM concept:

- Make individual configuration settings for the light curtain in the Device Type Manager (DTM).
- The individual DTM configurations of a project can be called up via the frame application of the Field Device Tool (FDT).
- Communication DTM: IO-Link USB master
- Device DTM: IO-Link device/IODD for CML 700i

Procedure for the installation of the software and hardware:

✤ Install the *Sensor Studio* configuration software on the PC.

✤ Install the driver for the IO-Link USB master on the PC.

✤ Connect the IO-Link USB master to the PC.

✤ Connect the CML 700i (IO-Link device) to the IO-Link USB master.

✤ Install IO-Link device DTM with IODD file for CML 700i in the *Sensor Studio* FDT frame.

12.1   System requirements

To use the *Sensor Studio* configuration software, you need a PC or laptop with the following specifications:

Table 12.1:   *System requirements for Sensor Studio* installation

Operating system	Windows 7 Windows 8
Computer	• Processor type: 1 GHz or higher • USB interface • CD-ROM drive • Main memory • 1 GB RAM (32-bit operating system) • 2 GB RAM (64-bit operating system) • Keyboard and mouse or touchpad
Graphics card	DirectX 9 graphic device with WDDM 1.0 or higher driver
Additionally required capacity for *Sensor Studio* and IO-Link device DTM	350 MB hard drive memory 64 MB main memory

> Administrator privileges on the PC are necessary for installing *Sensor Studio*.

12.2   Installing *Sensor Studio* configuration software and IO-Link USB master

> The installation of the *Sensor Studio* configuration software is done via supplied data carrier **Sensor Studio & IO-Link USB master**.
>
> For subsequent updates, you can find the most recent version of the *Sensor Studio* configuration software on the Internet at **www.leuze.com**

12.2.1   Installing the *Sensor Studio* FDT frame

NOTICE
First install the software!
✎ Do not yet connect the IO-Link USB master to the PC.
First install the software.

> If FDT frame software is already installed on your PC, you do not need the *Sensor Studio* installation.
>
> You can install the communication DTM (IO-Link USB master) and the device DTM (IO-Link device CML 700i) in the existing FDT frame.

✎ Start the PC and insert the **Sensor Studio & IO-Link USB Master** data carrier.

The language selection menu starts automatically.

If the language selection menu does not start automatically, double-click the *start.exe* file.

✎ Select a language for the interface text in the Installation Wizard and software.

The installation options are displayed.

✎ Select **Leuze electronic Sensor Studio** and follow the instructions on the screen.

The Installation Wizard installs the software and places a shortcut on the desktop (![icon]).

12.2.2   Installing drivers for IO-Link USB master

✎ Select the **IO-Link USB Master** installation option and follow the instruction on the screen.

The Installation Wizard installs the software and places a shortcut on the desktop (![icon]).

12.2.3   Connecting IO-Link USB master to the PC

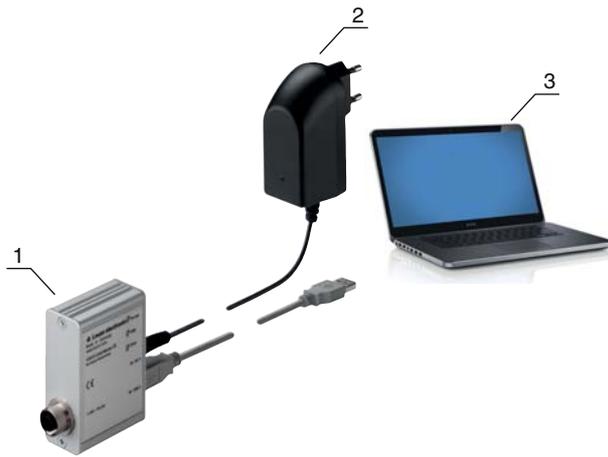The light curtain is connected to the PC via the IO-Link USB master (see table 17.6).

✎ Connect the IO-Link USB master to the plug-in power supply unit or the mains supply.

> Included in the delivery contents of the IO-Link USB master is a USB interconnection cable for connecting the PC to the IO-Link USB master as well as a plug-in power supply unit and a short description.
>
> The mains supply of the IO-Link USB master via the plug-in power supply unit is only activated if IO-Link USB master and PC are connected via the USB interconnection cable.

✎ Connect the PC to the IO-Link USB master.

        1   IO-Link USB master
        2   Plug-in power supply unit
        3   PC

Figure 12.1: PC connection via the IO-Link USB master

↳ The **wizard for searching for new hardware** starts and installs the driver for the IO-Link USB master on the PC.

12.2.4 Connect the IO-Link USB master to the light curtain

Prerequisites:

- IO-Link USB master and PC are connected via the USB interconnection cable.
- IO-Link USB master is connected to the mains supply with the plug-in power supply unit.

NOTICE
Connect the plug-in power supply unit for IO-Link USB master!
↳ To connect a light curtain, the plug-in power supply unit must be connected to the IO-Link USB master and the mains supply.
The voltage supply via the USB interface of the PC is permissible only for IO-devices with a current consumption of up to 40 mA at 24 V.

ⓘ   Included in the delivery contents of the IO-Link USB master is a USB interconnection cable for connecting the PC to the IO-Link USB master as well as a plug-in power supply unit and a short description.

Included in the delivery contents of the IO-Link USB master is a USB interconnection cable for connecting the PC to the IO-Link USB master as well as a plug-in power supply unit and a short description.

The voltage supply of the IO-Link USB master and the light curtain via the plug-in power supply unit is only activated if IO-Link USB master and PC are connected via the USB interconnection cable.

↳ Connect the IO-Link USB master to the receiver.

↳ CML 700i with analog output or IO-Link interface:

   Connect the IO-Link USB master to interface X1 on the receiver with the connection cable (see figure 12.2).
The connection cable is not included in the delivery contents and must be ordered separately if needed
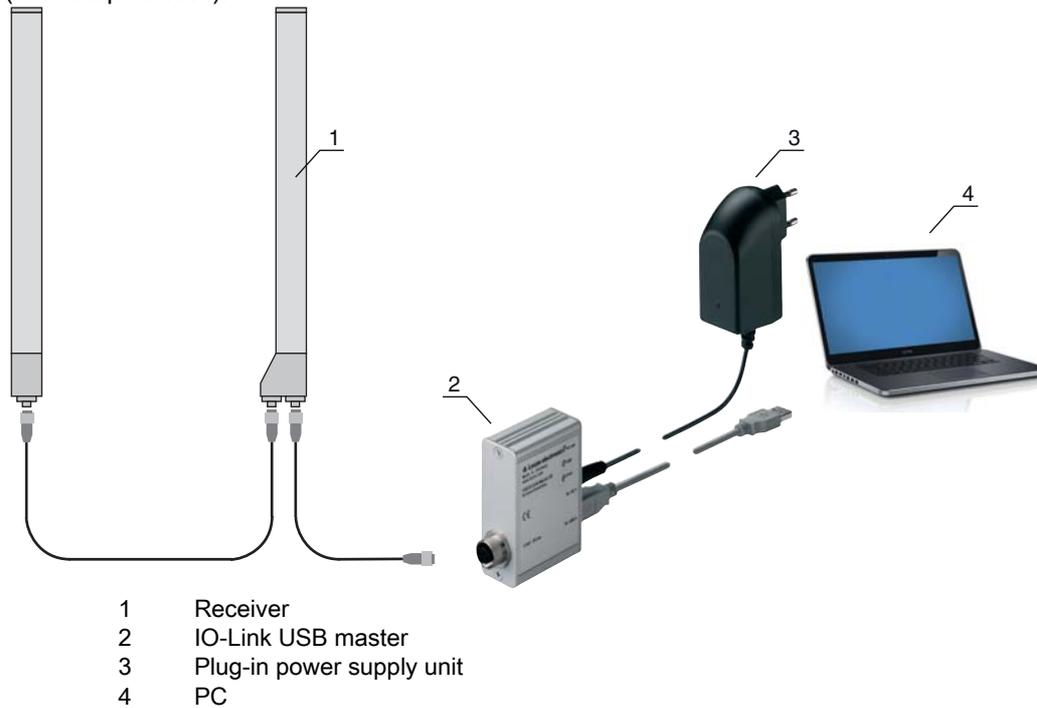
(see chapter 17.4).

1 Receiver
2 IO-Link USB master
3 Plug-in power supply unit
4 PC

Figure 12.2: CML 700i (analog/IO-Link) connection to the IO-Link USB master

12.2.5 Installing the DTM and IODD

Prerequisites:
- The light curtain is connected to the PC via the IO-Link USB master.
- FDT frame and driver for IO-Link USB master are installed on the PC.

✎ Select the **IO-Link device DTM (User Interface)** installation option and follow the instructions on the screen.

The Installation Wizard installs the DTM and the IO Device Description (IODD) for the light curtain.

ℹ DTM and IODD for all IO-Link devices currently available from Leuze electronic are installed.

NOTICE
IO Device Description (IODD) not up-to-date!
The values in the IODD file supplied with the device may no longer be up-to-date.
✎ Download the up-to-date IODD file from the Internet at **www.leuze.com**.

12.3 Starting the *Sensor Studio* configuration software

Prerequisites:
- The light curtain has been mounted (see chapter 6) and connected (see chapter 7) correctly.
- The *Sensor Studio* configuration software is installed on the PC (see chapter 12.2 "Installing Sensor Studio configuration software and IO-Link USB master").
- The light curtain is connected to the PC via the IO-Link USB master (see chapter 12.2 "Installing Sensor Studio configuration software and IO-Link USB master").

✎ Start the *Sensor Studio* configuration software by double-clicking the *Sensor Studio* icon ( ).

The **Mode selection** of the Project Wizard is displayed automatically or under the **File** menu item.

✎ Select the **Device selection without communication connection (offline)** configuration mode and click on [Next].

The **Project Wizard** displays the **device selection** list of the configurable devices.
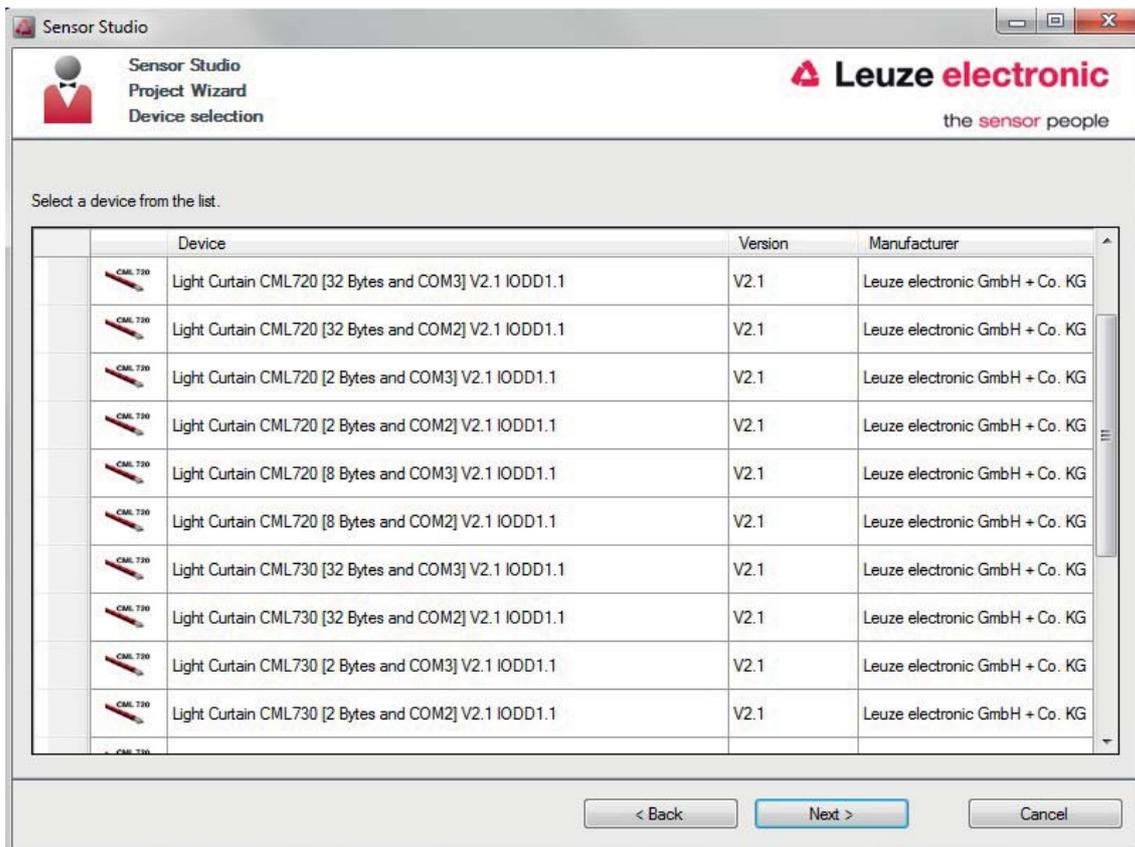
Figure 12.3: Device selection for CML 700i measuring light curtain

✋ Select the connected light curtain according to the configuration in the **Device Selection** and click on [Next].

The device manager (DTM) of the connected light curtain starts with the offline view for the *Sensor Studio* configuration project.

✋ Establish the online connection to the connected light curtain.

In the *Sensor Studio* FDT frame, click on the [Establish connection with device] button (▷).

In the *Sensor Studio* FDT frame, click on the [Online parameters] button (P_{o}).

The IO-Link USB master synchronizes with the connected light curtain and the current configuration data and process data are displayed in the device manager (DTM).
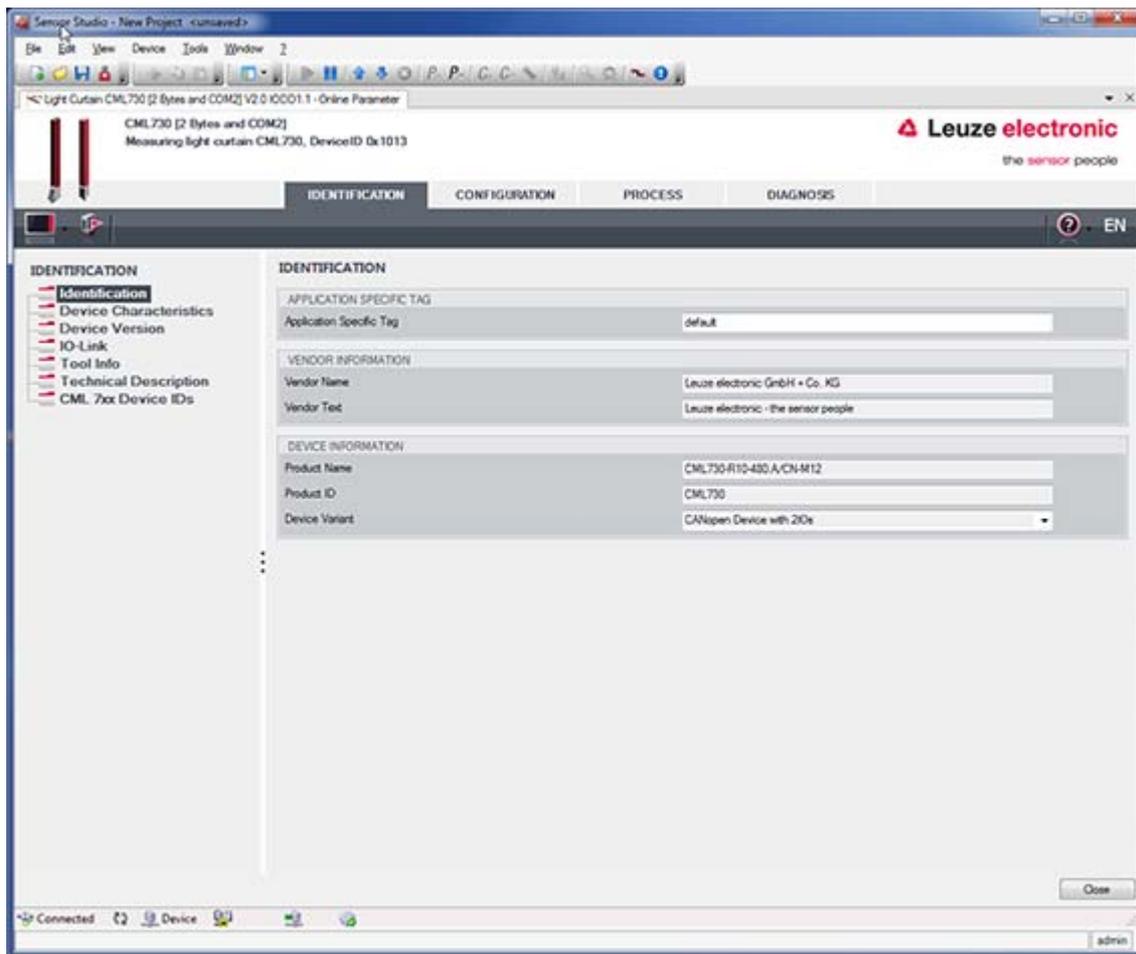
Figure 12.4: Configuration project: *Sensor Studio* device manager (DTM) for CML 700i

↳ The menus of the *Sensor Studio* device manager (DTM) can be used to change or read out the config-
uration of the connected light curtain.

The user interface of the *Sensor Studio* device manager (DTM) is largely self-explanatory.

The online help system provides information on the menu items and adjustment parameters. Select the
Help menu item in the menu [?].

Error message when [establishing connection with the device]

If the device selected in the **Device selection** list of the *Sensor Studio* Project Wizard does not match the
configuration (bit rate and PD length) of the connected light curtain, an error message is displayed.

Under **IDENTIFICATION > CxL-7XX Device IDs**, you will find a list with the assignment of the device IDs
displayed in the error message to the **device** description in the **device selection** list.

↳ Change the device selection in the **device selection** list according to the configuration (bit rate and
PD length) of the connected light curtain.

Alternatively, you can set the configuration (bit rate and PD-length) of the light curtain in the receiver
control panel corresponding to the device selection in the **Device selection** list.

↳ In the *Sensor Studio* FDT frame, click on the [Establish connection with device] button (▶).

12.4   Short description of the *Sensor Studio* configuration software

This chapter contains information and explanations on the individual menu items and adjustment param-
eters of the *Sensor Studio* configuration software and the device manager (DTM) for CML 700i measuring
light curtains.

This chapter does not include a complete description of the *Sensor Studio* configuration software.

Complete information on the FDT frame menu and on the functions in the device manager (DTM) can be found in the online help system.

The device managers (DTM) for light curtains of the *Sensor Studio* configuration software have the following main menus and functions:
- *IDENTIFICATION* (see chapter 12.4.2)
- *CONFIGURATION* (see chapter 12.4.3)
- *PROCESS* (see chapter 12.4.4)
- *DIAGNOSTICS* (see chapter 12.4.5)

The online help system displays information on the menu items and adjustment parameters for each function. Select the **Help** menu item in the menu [?]

12.4.1 FDT frame menu

You can find complete information on the FDT frame menu in the online help system. Select the **Help** menu item in the menu [?].

12.4.2 *IDENTIFICATION* function
- *Operating information*: Information on operating the device manager (DTM)
- *Technical description*: The available original operating instructions of the device in pdf format
- *CML-7XX*: Table with the assignment of device IDs to the **device**description in the **device selection** list in the *Sensor Studio* Project Wizard.
  The information is needed if an error message is displayed when connecting with the device.

12.4.3 *CONFIGURATION* function
- *Save permanently*: Configuration changes via *Sensor Studio* are effective immediately but are lost if the device is de-energized.
  With *Save permanently*, the configuration set via *Sensor Studio* is stored in non-volatile memory in the device.

NOTICE
Configuration for process mode only via the control!
✎ **Always** configure process mode via the control and, if applicable, the fieldbus interface.
In process mode, only the configuration conveyed via the control is active. The configuration changes made via *Sensor Studio* are only active in process mode if they were previously transmitted 1:1 to the control.

- *Teach*: The sensitivity of the teach event (see chapter 8.2 "Teaching the environmental conditions") can only be set via the *Sensor Studio* configuration software.
- *Upload device data set from device* ( ): The configuration is uploaded from the device to the device manager (DTM), e.g., to update the online view in *Sensor Studio* after the configuration was changed via the receiver control panel.
- *Upload device data set from device* ( ) / *Synchronize with device* ( ):
  - If the [Upload device data set from device] button ( ) is displayed in the device manager (DTM), the *Sensor Studio* display shows the current configuration of the light curtain.
  - If the [Synchronize with device] button ( ) is displayed in the device manager (DTM), the *Sensor Studio* display is not consistent with the current configuration of the light curtain.

If parameters are changed in the device manager (DTM) that affect other parameters (e.g., if changing the beam mode causes the configured logical beams to change), the changes to these parameters are configured in the device – but are not yet displayed in the *Sensor Studio* display. Click on the [Synchronize with device] button ([⊘]) to synchronize the *Sensor Studio* display with the current configuration of the light curtain. Following successful synchronization, the [Upload device data set from device] button ([⬆]) is displayed in the device manager (DTM).

12.4.4 *PROCESS* function

- The *Process* function offers graphical visualizations of the process data of the connected light curtain.

- [Cyclical refresh] button ([▶]): Starts the cyclical acquisition of the process data, which are graphically depicted under *Numerical display*, *Beam-stream display* and Areas and outputs. Each graphical display covers up to 300 seconds.

- *Beam-stream display*: Using the [Show or hide the graphical cursor] button ([⊞]), you can move the graphical cursor in the visualization, e.g., to evaluate the time difference between two events.
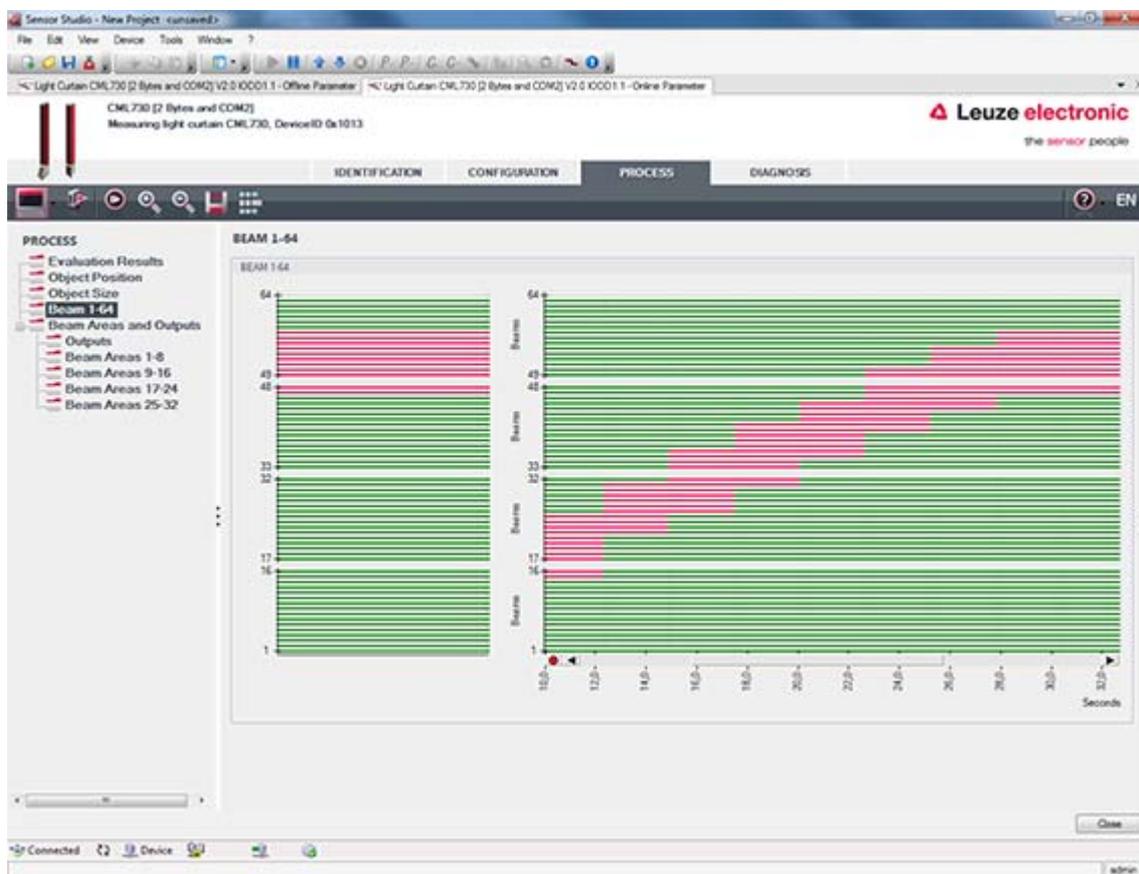
Figure 12.5: Graphical visualization: Beam-stream display

12.4.5 *DIAGNOSTICS* function

The *DIAGNOSTICS* function offers the following commands.

- Reset device, i.e., restart the connected light curtain
- Store configuration in non-volatile memory (see chapter 12.4.3)

12.4.6 Exiting *Sensor Studio*

After completing the configuration settings, close the *Sensor Studio* configuration software

✎ Exit the program via **File > Exit**.

✎ Save the configuration settings as a configuration project on the PC.

You can open the configuration project again at later time via **File > Open** or via the *Sensor Studio* **Project Wizard** ( ).

13 Troubleshooting

13.1 What to do in case of failure?

After switching on the light curtain, display elements (see chapter 3.4) assist in checking the proper function and troubleshooting.

In case of error, you can determine the error from the LED displays. With the error message you can determine the cause of the error and initiate measures to rectify it.

NOTICE
If the light curtain responds with an error display, you will often be able to eliminate the cause yourself!
✎ Switch off the system and leave it switched off.
✎ Analyze and eliminate the cause of the error using the following table.
✎ If you are unable to rectify the error, contact the Leuze electronic branch responsible for you or call the Leuze electronic customer service (see chapter 15 "Service and support").

13.2 Operating indicators of the LEDs

Table 13.1:   Receiver LED displays - state and causes

LED green	LED yellow	State	Possible cause
ON (continuous light)	-	Sensor ready	
OFF	OFF	Sensor not ready	Interruption of the operating voltage; Light curtain in start-up phase
OFF	Flashing (15 Hz)	Missing function reserve	Soiling of the lens covers Misalignment of transmitter or receiver Operating range exceeded
Flashing synchronously (3 Hz)		Teach running	
Flashing synchronously (9 Hz)		Teach error	Soiling of the lens covers Operating range exceeded
Flashing alternately (9 Hz)		System error	No connection between transmitter and receiver Operating voltage too low Receiver is not compatible with the transmitter

Table 13.2:   LED displays - causes and measures

Error	Possible cause	Measure
Teach error	Soiling of the lens covers Poor alignment of transmitter and receiver	Clean the lens cover on the receiver and on the transmitter. Check alignment.
Function reserve too low	Poor alignment of transmitter and receiver Soiling of the lens covers	Adjust alignment. Test with shorter distance between transmitter and receiver. Clean the lens cover on the receiver and on the transmitter.
Alignment signal too low	Poor alignment of transmitter and receiver Soiling of the lens covers	Adjust alignment. Test with shorter distance between transmitter and receiver. Clean the lens cover on the receiver and on the transmitter.
Outputs are not active or change their state without a contour change in the measurement field	Configuration data is read or written	End configuration communication.

    During teaching, the system checks whether the signals of all beams are within a certain corridor. If there are considerable deviations in the signal strength, this results in a teaching error and is indicated on the LEDs. The cause may be partial soiling of the lens cover.

    Measure: clean the lens covers on the transmitter and receiver!

    Soiling of the lens cover is indicated by the LEDs if the function reserve mode *High*, *Medium* or *Low* is set (see chapter 8.4 "Setting the function reserve").

13.3 Error codes in the display

The following error messages can be output in the form of status codes in the device display.

Table 13.3:   Normal operation

Status code	Description
RxS 0x0100	CxL in normal mode, start-up phase still running
RxS 0x0180	CxL reconfigures itself after a configuration. Process data is invalid.
RxS 0x0190	The measurement system is not active (after a stop command or if the first trigger pulse is missing).
RxS 0x0200	The "Leuze AutoControl ACON function" has detected soiling.
RxS 0x0300	Teach parameters have been changed (teaching must be done) or default values are active.
RxS 0x0FFF	CxL shuts down. Process data is invalid.

Table 13.4:   Warnings

Error code	Description	Possible cause (s)
RxS 0x1000	Device in teach mode, no new process data available	• Distance between transmitter and receiver too large or too small • Poor alignment • Soiling • Extraneous light, especially mutual interference • Beams are interrupted, but blanking is deactivated • The maximum number of blanking areas is not sufficient • The number of beams to be blanked is greater than or equal to the number of all logical beams
RxS 0x1100 RxS 0x1001 RxS 0x11xy	Teaching error Trigger frequency too high The device could not end teach, no new process data available	
RxS 0x111x	Blanking error	
RxS 0x112x	Error due to weak signal Individual beams do not reach the minimum reception level	
RxS 0x113x	Internal error Device has reached the power limit	

Table 13.5:   Errors (can be corrected)

Error code	Description	Measures
RxS 0x2000	No communication possible between transmitter and receiver.	Check cable.
RxS 0x2001	Receiver/transmitter inconsistency. The receiver is not compatible with the transmitter.	Replace transmitter.
RxS 0x2100	The supply voltage is not sufficient.	Check voltage supply.
RxS 0x2200	EEPROM data corrupt.	Reset device to factory settings.
RxS 0x23xy	Configuration error. xy gives information on the type of configuration error.	Contact service (see chapter 15). Reset device to factory settings. Check parameters and parameter relation.
RxS 0x23F1	Configuration error – function reserve. Hysteresis ≥ switching threshold.	Check the configuration of the function reserve parameters (see chapter 8.4). Reset device to factory settings.
RxS 0x23F2	Configuration error – digital IOs. More than one line input exists.	Check the configuration of the Digital IO parameters (see chapter 8.5). Reset device to factory settings.
RxS 0x23F3	Configuration error – beam evaluation areas. The switch-on and switch-off conditions must differ if they are unequal to zero and the area is active.	Check the configuration of the beam evaluation areas. Reset device to factory settings.

Error code	Description	Measures
RxS 0x23F4	Configuration error - blanking. Upper adjacent beam selected for beam "i" and lower adjacent beam selected for beam "i+1".	Check the configuration of the blanking parameters (see chapter 10.3). Reset device to factory settings.
RxS 0x23F5	Configuration error - blanking. Upper adjacent beam selected for beam "i" and no adjacent beam exists.	Check the configuration of the blanking parameters (see chapter 10.3). Reset device to factory settings.
RxS 0x23F6	Configuration error - blanking. Lower adjacent beam selected for beam "i" and no adjacent beam exists.	Check the configuration of the blanking parameters (see chapter 10.3). Reset device to factory settings.
RxS 0x23F7	Configuration error - blanking. Overlapping of the blanking areas.	Check the configuration of the blanking parameters (see chapter 10.3). Reset device to factory settings.
RxS 0x23F8	Configuration error - blanking. Start beam > end beam.	Check the configuration of the blanking parameters (see chapter 10.3). Reset device to factory settings.
RxS 0x23FA	Configuration error – time behavior. The delay time is greater than the trigger cycle time/measurement cycle time.	Check the time behavior setting (see chapter 16.2). Reset device to factory settings.
RxS 0x23FB	Configuration error – time behavior. The pulse width is greater than the trigger cycle time.	Check the time behavior setting (see chapter 16.2). Reset device to factory settings.
RxS 0x23FC	Configuration error – time behavior. The measurement cycle time is greater than the trigger cycle time.	Check the time behavior setting (see chapter 16.2). Reset device to factory settings.

Table 13.6:   Serious errors (cannot be corrected)

Error	Description	Measures
RxS 0x3000	Hardware error, no details available	Return device following consultation with Service department (see chapter 15)
RxS 0x3001	Hardware error, transmitter 9V supply	
RxS 0x3002	Hardware error, transmitter 5V supply	
RxS 0x3003	Hardware error, receiver 5V supply	
RxS 0x3005	Hardware error, receiver cascade No receiver cascade or different LED number of transmitter and receiver	
RxS 0x3006	Hardware error, transmitter	
RxS 0x3007	Hardware error, inter-controller communication is interrupted	
RxS 0x3008	Hardware error, different number of diodes at transmitter and receiver	
RxS 0x3009 RxS 0x300A	Hardware error, no Rx cascades Hardware error, no Tx cascades	
RxS 0x3100 RxS 0x3101	Error in the factory settings. Can only be rectified by reprogramming the device firmware.	

14 Care, maintenance and disposal

14.1 Cleaning

In the event of dust build-up on the sensor:

✎ Clean the sensor with a soft cloth; use a cleaning agent (commercially available glass cleaner) if necessary.

NOTICE
Do not use aggressive cleaning agents!
✎ Do not use aggressive cleaning agents such as thinner or acetone for cleaning the light curtains.   Use of improper cleaning agents can damage the lens cover.

14.2 Servicing

Usually, the light curtain does not require any maintenance by the operator.

Repairs to the device must only be carried out by the manufacturer.

✎ For repairs, contact your responsible Leuze electronic subsidiary or Leuze electronic customer service (see chapter 15).

14.2.1 Firmware update

A firmware update can only be performed by Leuze electronic customer service on-site or at the company headquarters.

✎ For firmware updates, contact your responsible Leuze electronic subsidiary or Leuze electronic customer service (see chapter 15).

14.3 Disposing

For disposal observe the applicable national regulations regarding electronic components.

15   Service and support

Defective devices are repaired in our service center competently and quickly. Leuze electronic offers you an extensive service packet to keep any necessary system downtimes to a minimum.

Our service center requires the following information:

- Customer number
- Part designation or part number
- Serial number or batch number
- Reason for return with description

24-hour on-call service at:
+49 (0) 7021 573-0

Service hotline:
+49 (0) 7021 573-123
Monday to Thursday, 8.00 a.m. to 5.00 p.m. (UTC+1)
Friday, 8.00 a.m. to 4.00 p.m. (UTC+1)

E-mail:
service.detect@leuze.de

Repair service and returns:
Procedure and Internet form can be found at
www.leuze.com/repair
Return address for repairs:
Service center
Leuze electronic GmbH + Co. KG
In der Braike 1
D-73277 Owen / Germany

16   Technical data

16.1   General specifications

Table 16.1:   Optical data

Light source	LED (modulated light)
Wavelength	850 nm (infrared light)

Table 16.2:   Measurement field data: Operating range limit and measurement field length of the CML 730-PS

Beam spacing [mm]	Typ. op. range limit [a] [m]		Measurement field length [b] [mm]	
	min.	max.	min.	max.
5	0.1	5.0	160	1280

a) Typ. operating range limit: min./max. attainable range without function reserve for parallel-beam scanning.

b) Measurement field lengths and beam spacings specified in fixed rasters, see ordering table.

Table 16.3:   CML 730-PS operating ranges

Beam spacing [mm]	Operating range [m] Parallel-beam		Operating range [m] Diagonal-beam		Operating range [m] Crossed-beam	
	min.	max.	min.	max.	min.	max.
5	0.1	4.0	0.2	3.0	0.2	2.5

NOTICE
Reduced operating range with sensitivity setting "Transparent"
✎ If the sensitivity is set for the detection of transparent media, the operating range is reduced:
0.1 m … 1.75 m with beam spacing 5 mm and parallel-beam operation

Table 16.4:   CML 730-PS profile and measurement field lengths

Measurement field length B [mm] with beam spacing A: 5 mm	Profile length L [mm]
160	168
240	248
320	328
400	408
480	488
560	568
640	648
720	728
800	808

Measurement field length B [mm] with beam spacing A: 5 mm	Profile length L [mm]
880	888
960	968
1040	1048
1120	1128
1200	1208
1280	1288

Table 16.5:   Data on the time behavior of the CML 730-PS

Response time per beam [a]	10 µs
Readiness delay	≤ 1.5 s

a)   Cycle time = number of beams x 0.01 ms + 0.15 ms. The minimum cycle time is 1 ms.

Table 16.6:   Electrical data

Operating voltage U_B	18 … 30 VDC (incl. residual ripple)
Residual ripple	≤ 15 % within the limits of U_B
Open-circuit current	See table 16.7

Table 16.7:   CML 730-PS open-circuit current

Measurement field length [mm]	Current consumption [mA] (without load at switching output)		
	at U_B 24 VDC	at U_B 18 VDC	at U_B 30 VDC
160	135	165	125
320	165	200	145
640	215	275	190
960	270	345	235
1440	350	455	300

Table 16.8:   Interface data

Inputs/outputs	3 pins can be configured as input or output
Switching output current	Max. 100 mA
Signal voltage active/not active	≥ 8 V / ≤ 2 V
Activation delay	≤ 1 ms
Input resistance	Approx. 6 k Ω
Analog interfaces	0 … 10(11) V and 0(4) … 20(24) mA
Digital interfaces	IO-Link (230.4 kbit/s; 38.4 kbit/s)

Table 16.9:   Mechanical data

Housing	Continuous-cast aluminum
Optics cover	PMMA plastic
Connection technology	M12 connectors (8-pin / 5-pin)

Table 16.10:   Environmental data

Ambient temperature (operation)	-30 °C … +60 °C Dry cold, non-condensing Detection of transparent media to -20 °C
Ambient temperature (storage)	-40 °C … +70 °C
Protective circuit	Transient protection Polarity reversal protection Short circuit protection for all outputs (provide external protective circuit for inductive load for this purpose!)

Table 16.11:   Certifications

Degree of protection	IP 65
Protection class	III
Certifications	UL 508, CSA C22.2 No.14 Light source: exempt group (in acc. with EN 62471)
Standards applied	IEC 60947-5-2
Electromagnetic compatibility	IEC 61000-6-2 and EN 1000-6-4 Industrial interference emission This is a Class A product. In a domestic environment, this product may cause radio interference. In this case the operator may be required to take appropriate measures.

16.2 Timing

In principle, the individual beams are always processed sequentially for light curtains. The internal controller starts transmitter 1 and then activates only the corresponding receiver 1 to measure the received light power. If the measured value exceeds the switch-on threshold, this first beam is evaluated as an uninterrupted/free beam.

The time between activation of the transmitter and evaluation in the receiver is referred to as the response time per beam.

In the CML 730-PS the response time per beam is = 10 µs.

The total cycle time for the evaluation of all beams and transmission to the interface is calculated as follows:

Cycle time = number of beams x response time per beam + constant

○
∏   The minimum cycle time is 1 ms, i.e., the cycle time is never less than 1 ms, even with very short light curtains with a small number of beams.

Table 16.12:   Profile and measurement field lengths, cycle times for CML 730-PS

Measurement field length B [mm] with beam spacing A: 5 mm	Cycle time [ms]	Profile length L [mm]
160	1.00	168
240	1.00	248
320	1.00	328
400	1.00	408
480	1.16	488
560	1.36	568
640	1.48	648
720	1.68	728
800	1.80	808
880	1.96	888
960	2.12	968
1040	2.28	1048
1120	2.40	1128
1200	2.60	1208
1280	2.76	1288

Limits for detecting objects

The detection of objects and the evaluation of the data depend on the following factors:
- Beam resolution and cycle time of the light curtain
- Movement speed of the objects
- Transmission rate of the data bytes
- Cycle time of the control

Minimum object diameter for detection perpendicular to beam plane

For a moving object, the cycle time of the light curtain must be shorter than the period of time that the object to be detected is located in the beam plane.

For an object that moves vertically to the beam plane, the following apply:

$$v_{max} = (L - 10mm)/(t_z)$$

v_{max}	[m/s]	= Maximum object speed
L	[m]	= Length of the object in the direction of movement
t_z	[s]	= Cycle time of the light curtain

or

$$L_{min} = v \cdot t_z + 10mm$$

L_{min}	[m]	= Length of the object in the direction of movement (minimum length)
v	[m/s]	= Object speed
t_z	[s]	= Cycle time of the light curtain

NOTICE

Minimum length of the gap between two successive objects!

✍ The gap between two successive objects must be greater than the minimum object diameter.

16.3 Minimum object diameter for stationary objects

The minimum object diameter of a stationary object is determined by the beam spacing and optic diameter.

Minimum object diameter for "parallel"-beam mode:

The minimum object diameter depends on the beam spacing because objects also need to be reliably detected in the transition area between two beams.
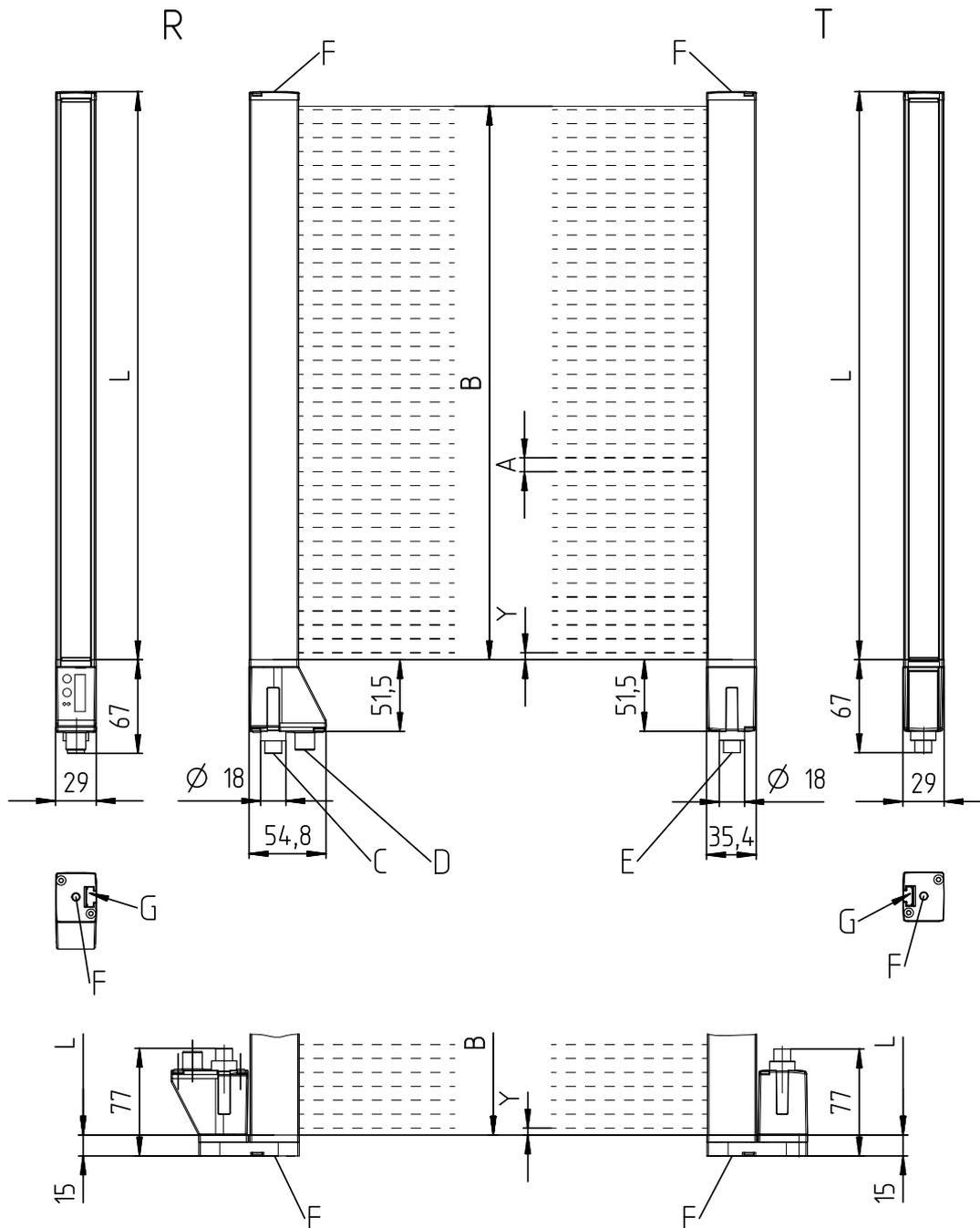
Beam spacing	Minimum object diameter	
5 mm	Beam spacing + 5 mm	= 10 mm
10 mm / 20 mm / 40 mm	Beam spacing + 10 mm	= 20 mm / 30 mm / 50 mm

NOTICE
Minimum object diameter for "crossed beam" mode!
✋ In "crossed beam" mode, the object diameter in the center area is reduced to 1/2 x beam spacing.

16.4   Dimensioned drawings

all dimensions in mm

A   Beam spacing (see chapter 16.1)
B   Measurement field length
C   IO-Link / analog devices: Power In/Out
C   PROFIBUS/ CANopen / RS485 devices: Power In/Out + transmitter connection (Y-cable)
D   IO-Link / analog devices: connection to transmitter
E   Connection to receiver
F   M6 thread
G   Fastening groove
L   Profile length (See table 16.4)
R   Receiver
T   Transmitter
Y   Devices with beam spacing 5 mm: Y = 2.5 mm
Y   Devices with beam spacing 10, 20, 40 mm: Y = 5 mm

Figure 16.1: CML 700i with axial or with rear connector outlet

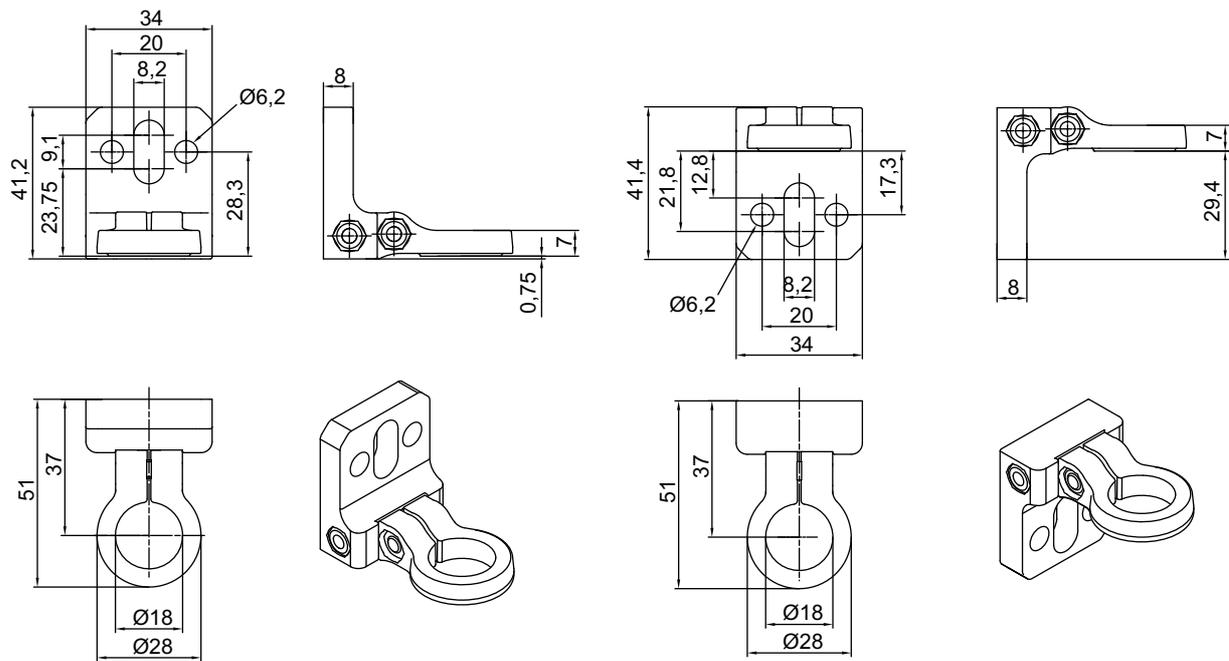## 16.5   Dimensioned drawings: Accessories
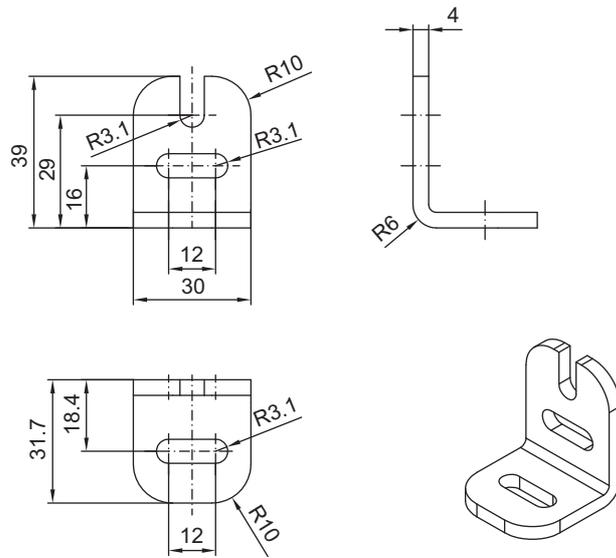
all dimensions in mm
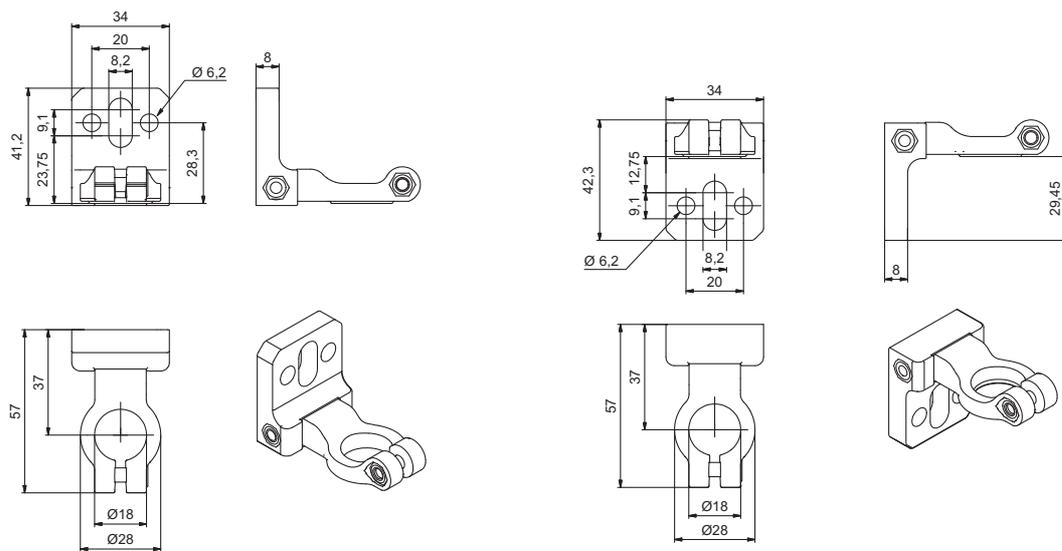
Figure 16.2:   BT-2L mounting bracket
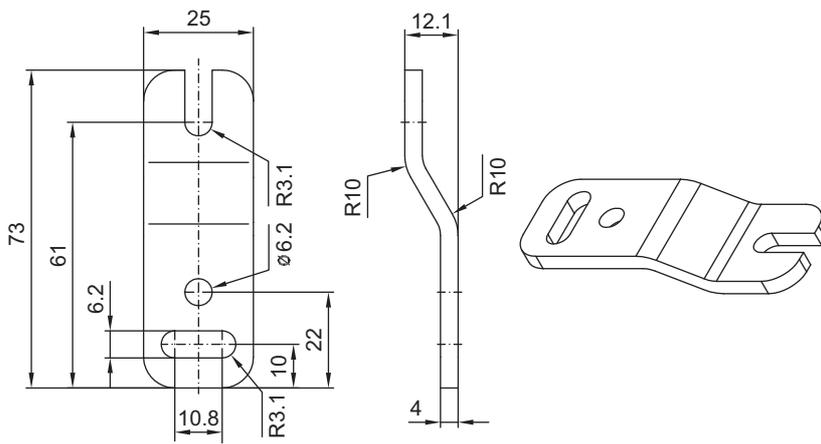
all dimensions in mm

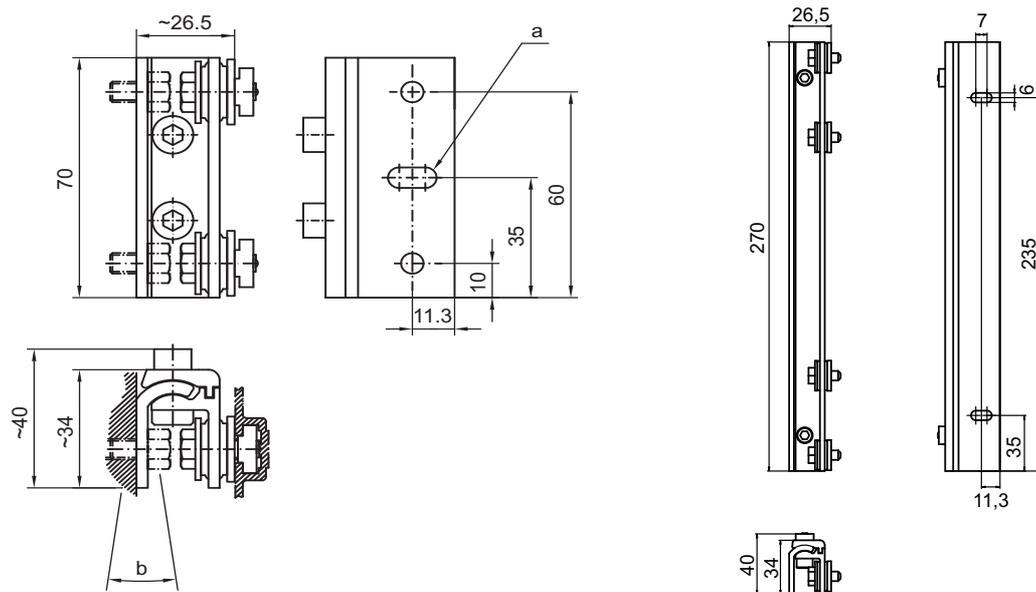Figure 16.3:   BT-2Z parallel bracket

all dimensions in mm

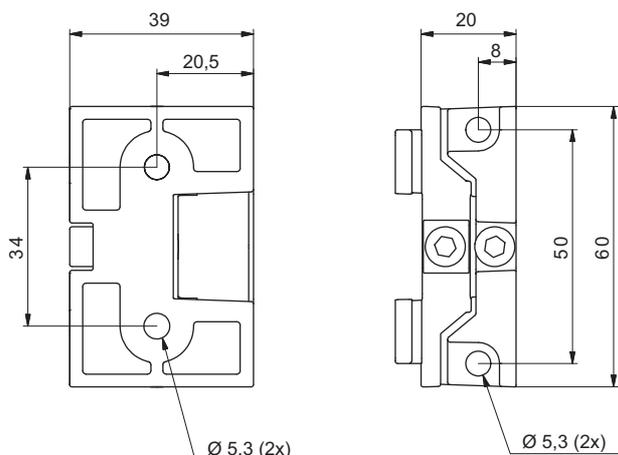Figure 16.4: BT-2R1 swivel mount (shown in two mounting views)
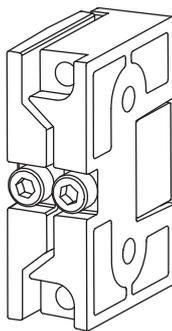
all dimensions in mm

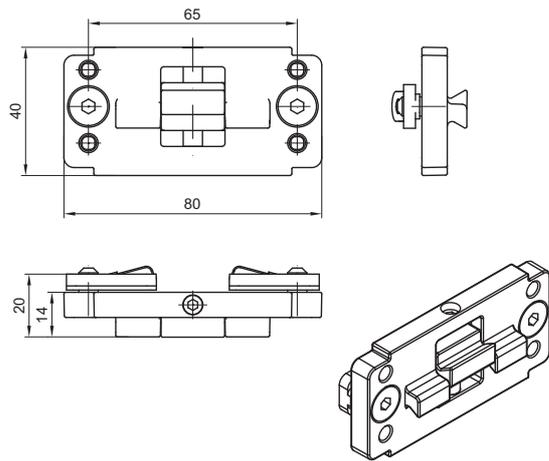Figure 16.5: Swivel mount BT-2HF

all dimensions in mm

Figure 16.6:   BT-2SSD and BT-2SSD-270 swiveling mounting
              brackets

all dimensions in mm

Figure 16.7:   BT-2SB10/BT-2SB10-S swiveling mounting brackets

all dimensions in mm

Figure 16.8: BT-2P40 clamp bracket

17 Ordering information and accessories

17.1 Nomenclature

Part designation:

CMLbbbi- fss-xxxx.a/ii-eee-ooo

Table 17.1:   Part number code

CML	Operating principle: measuring light curtain
bbbi	Series: 720i for CML 720i Series: 730i for CML 730i** Series: 730 for CML 730-PS**
f	Function classes: T: Transmitter R: Receiver
ss	Beam spacing: 05: 5 mm 10: 10 mm 20: 20 mm 40: 40 mm
xxxx	Measurement field length [mm], dependent on beam spacing: For values see tables
a	Equipment: A: Axial connector outlet R: Rear connector outlet
ii	Interface: L: IO-Link CN: CANopen PB: PROFIBUS PN: PROFINET CV: Analog current and voltage output D3: RS 485 Modbus
eee	Electrical connection: M12: M12 connector
ooo	Option: EX: Explosion protection PS: Power Setting
**: Not available in the design with explosion protection.	

Table 17.2:   Part descriptions, examples

Part designation	Properties
CML720i-T10-1580.A/ CN-M12-EX	CML 720i, transmitter, beam spacing 10 mm, measurement field length 1580 mm, axial connector outlet, CANopen interface, M12 connector, explosion protection (zones 2 + 22)
CML720i-T05-1920.A/ CN-M12	CML 720i, transmitter, beam spacing 5 mm, measurement field length 1920 mm, axial connector outlet, CANopen interface, M12 connector
CML720i-T05-1920.A/ D3-M12	CML 720i, transmitter, beam spacing 5 mm, measurement field length 1920 mm, axial connector outlet, RS 485 Modbus interface, M12 connector

Part designation	Properties
CML730i-T20-2720.A-M12	CML 730i, transmitter, beam spacing 20 mm, measurement field length 2720 mm, axial connector outlet, M12 connector
CML730i-R20-2720.R/PB-M12	CML 730i, receiver, beam spacing 20 mm, measurement field length 2720 mm, rear connector outlet, PROFIBUS interface, M12 connector
CML730i-R20-2720.R/D3-M12	CML 730i, transmitter, beam spacing 20 mm, measurement field length 2720 mm, rear connector outlet, RS 485 Modbus interface, M12 connector
CML730-R05-1280.R/CV-PS-M12-M12	CML 730-PS, receiver, beam spacing 5 mm, measurement field length 1280 mm, rear connector outlet, analog interface, M12 connector

17.2   Accessories – CML 700i with IO-Link/analog interface
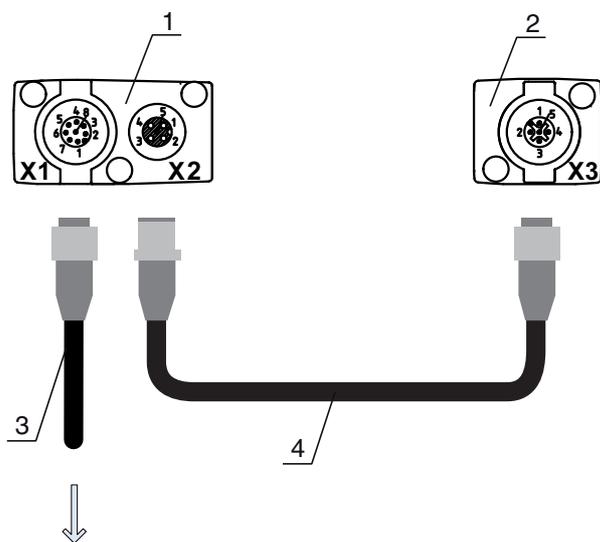
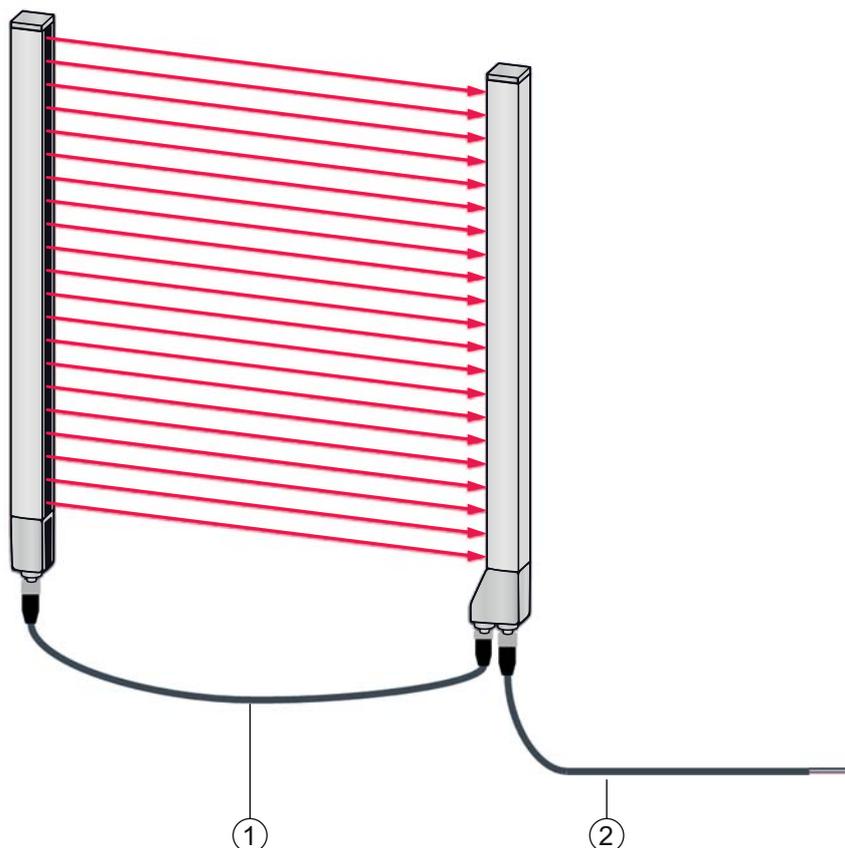**PWR IN/OUT**

1	Receiver (R)
2	Transmitter (T)
3	Connection cable (M12 socket, 8-pin)
4	Synchronization cable (M12 plug/socket, 5-pin)

Figure 17.1: Electrical connection – CML 700i with IO-Link/analog interface

17.2.1 IO-Link analog interface (connection in the switch cabinet: screw terminals)

1   X2/X3 interconnection cable (transmitter – receiver synchronization), See table 17.2.2
2   X1 connection cable (IO-Link/analog signal, digital IO, power for connection to control in switch cabinet), See table 17.3

Figure 17.2: IO-Link interface (analog)

Table 17.3:   X1 cable accessories – CML 700i with IO-Link/analog interface

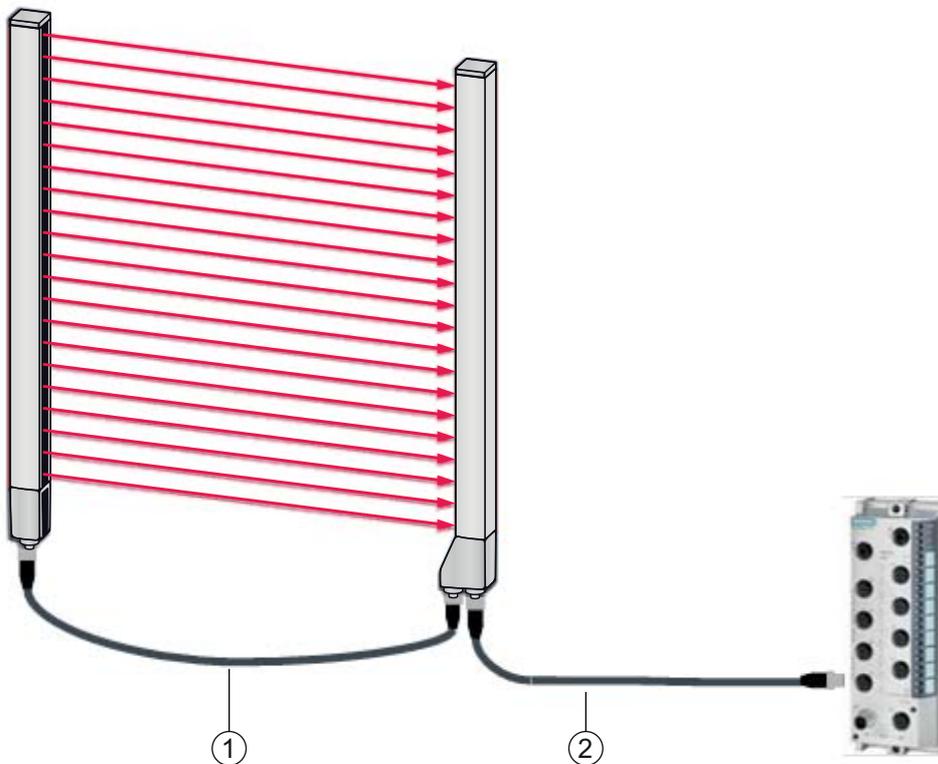| Part no.	Part designation	Description
X1 connection cables for CML 700i (IO-Link/analog signal, digital IO, power for connection to control in switch cabinet); see figure 17.2		
50104591	K-D M12A-8P-2m-PUR	Connection cable, M12 socket, axial, 8-pin, length 2,000 mm, shielded PUR cable, open cable end
50104590	K-D M12A-8P-5m-PUR	Connection cable, M12 socket, 8-pin, length 5,000 mm, shielded PUR cable, open cable end
50106882	K-D M12A-8P-10m-PUR	Connection cable, M12 socket, 8-pin, length 10,000 mm, shielded PUR cable, open cable end
429178	CB-M12-8GF	M12 socket, axial, 8-pin, user configurable

X1 cable (IO-Link/analog): core colors

- Pin1 = white
- Pin2 = brown
- Pin3 = green
- Pin4 = yellow
- Pin5 = gray
- Pin6 = pink
- Pin7 = blue
- Pin8 = red

The specified core colors apply only if the cables from Leuze electronic are used.

17.2.2 IO-Link interface (connection to IO-Link master)

Part no.	Part designation	Description
X2/X3 interconnection cables for CML 700i (transmitter – receiver synchronization); see figure 17.2		
50129779	KDS DN-M12-5A-M12-5A-P3-010	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 1,000 mm, shielded, PUR
50129780	KDS DN-M12-5A-M12-5A-P3-020	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 2,000 mm, shielded, PUR
50129781	KDS DN-M12-5A-M12-5A-P3-050	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 5,000 mm, shielded, PUR
50129782	KDS DN-M12-5A-M12-5A-P3-100	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 10,000 mm, shielded, PUR
50129783	KDS DN-M12-5A-M12-5A-P3-200	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 20,000 mm, shielded, PUR

1   X2/X3 interconnection cables (transmitter – receiver synchronization), See table
2   X1 connection cable (IO-Link, power to IO-Link master with M12 connections), See table 17.4

Figure 17.3: IO-Link interface (connection to IO-Link master)

Table 17.4:	X1 cable accessories – CML 700i with IO-Link interface

Part no.	Part designation	Description
X1 interconnection cables for CML 700i (IO-Link, power to IO-Link master with M12 connections); see figure 17.3		
50120999	K-DS M12A-8P-4P-2m-L-PUR	Interconnection cable: M12 socket, 8-pin, A-coded; shielded PUR cable, length 2,000 mm; M12 plug, 4-pin, A-coded
50121000	K-DS M12A-8P-4P-5m-L-PUR	Interconnection cable: M12 socket, 8-pin, A-coded; shielded PUR cable, length 5,000 mm; M12 plug, 4-pin, A-coded

X2/X3 cable accessories – CML 700i with IO-Link interface

Part no.	Part designation	Description
X2/X3 interconnection cables for CML 700i (transmitter – receiver synchronization); see figure 17.3		
50129779	KDS DN-M12-5A-M12-5A-P3-010	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 1,000 mm, shielded, PUR
50129780	KDS DN-M12-5A-M12-5A-P3-020	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 2,000 mm, shielded, PUR
50129781	KDS DN-M12-5A-M12-5A-P3-050	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 5,000 mm, shielded, PUR
50129782	KDS DN-M12-5A-M12-5A-P3-100	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 10,000 mm, shielded, PUR
50129783	KDS DN-M12-5A-M12-5A-P3-200	Interconnection cable, M12 plug/socket, axial, 5-pin, A-coded, length 20,000 mm, shielded, PUR

## 17.3	Accessories – fastening technology

Table 17.5:	Mounting technology accessories

Part no.	Part designation	Description
Mounting technology		
429056	BT-2L	L mounting bracket (angled), 2 x
429057	BT-2Z	Z mounting bracket (parallel), 2 x
429046	BT-2R1	360° swivel mount, 2 x incl. 1 MLC cylinder
429058	BT-2SSD	Swiveling mounting bracket with vibration damper, ± 8°, 70 mm long, 2x
429059	BT-4SSD	Swiveling mounting bracket with vibration damper, ± 8°, 70 mm long, 4x
429049	BT-2SSD-270	Swiveling mounting bracket with vibration damper, ± 8°, 270 mm long, 2x
424422	BT-2SB10	Swiveling mounting bracket, ± 8°, 2x
424423	BT-2SB10-S	Swiveling mounting bracket with vibration damper, ±8°, 2x
429393	BT-2HF	360° swivel mount, 2 x incl. 1 CML cylinder

Part no.	Part designation	Description
429394	BT-2HF-S	360° swivel mount, 2 x, with vibration damper, incl. 1 CML cylinder
424417	BT-2P40	Clamp bracket
425740	BT-10NC60	Sliding block with M6 thread, 10 x
425741	BT-10NC64	Sliding block with M6 and M4 thread, 10 x
425742	BT-10NC65	Sliding block with M6 and M5 thread, 10 x

17.4 Accessories – PC connection

Table 17.6: Accessories - PC connection configuration

Part no.	Part designation	Description
IO-Link USB master V2.0		
50121098	SET MD12-US2-IL1.1 + accessories	IO-Link USB master V2.0 Plug-in power supply unit (24 V/24 W) with international adapters High-speed USB 2.0 connection cable; USB A to Mini-USB Data carrier with software, drivers and documentation
Adapter cables for CML 700i (IO-Link, analog)		
50120999	K-DS M12A-8P-4P-2m L-PUR	Adapter cable: M12 socket, 8-pin, B-coded; PUR cable, length 2,000 mm; M12 plug, 5-pin, B-coded
50121000	K-DS M12A-8P-4P-5m L-PUR	Adapter cable: M12 socket, 8-pin, B-coded; PUR cable, length 5,000 mm; M12 plug, 5-pin, B-coded

17.5 Accessories - Device columns

For devices with axial connector outlet only

Table 17.7: Accessories - Device columns

Part no.	Part designation	Description
549881	UDC-1000-S2-R	Device column, U-shaped, profile height 1000 mm
549882	UDC-1300-S2-R	Device column, U-shaped, profile height 1300 mm
549883	UDC-1600-S2-R	Device column, U-shaped, profile height 1600 mm
549884	UDC-1900-S2-R	Device column, U-shaped, profile height 1900 mm
549885	UDC-2500-S2-R	Device column, U-shaped, profile height 2500 mm
549886	UDC-3100-S2-R	Device column, U-shaped, profile height 3100 mm

17.6 Scope of delivery

- 1 transmitter incl. 2 sliding blocks (profile length from 2 m: 3 sliding blocks; profile length from 2.5 m: 4 sliding blocks)
- 1 receiver incl. 2 sliding blocks, (profile length from 2 m: 3 sliding blocks; profile length from 2.5 m: 4 sliding blocks)
- 1 set of operating instructions (PDF file on data carrier)

Connection and interconnection cables, mounting brackets, IO-Link USB master (incl. *Sensor Studio* configuration software), etc., are not included in the delivery contents but must rather be ordered separately.

Devices with rear connector outlet are also delivered with a cylinder and a screw. These extra parts are needed for mounting with the BT-2R1 swivel mount (See table 17.5).

18   EC Declaration of Conformity

The measuring light curtains of the CML series have been developed and manufactured in accordance with the applicable European standards and directives.

The manufacturer of the product, Leuze electronic GmbH + Co. KG in D-73277 Owen, possesses a certified quality assurance system in accordance with ISO 9001.