Baumer
Passion for Sensors

Operating Manual

OM20/ OM30 RS485 with Modbus RTU

Laser distance sensor

EN-US

V4 | 11/29/2022

List of contents

1 About this document

1.1 Purpose

This operating manual (subsequently referred to as the *manual*) allows the safe and efficient handling of the product OM20/OM30.

The manual does not provide instructions on operating the machine in which the product is integrated. Information on this is found in the operating manual of the machine.

The manual is a constituent part of the product. It must be kept in the immediate vicinity of the product and must be accessible to personnel at all times.

Personnel must have carefully read and understood this manual before beginning any work. The basic prerequisite for safe working is compliance with all safety instructions and handling instructions given in this manual.

In addition, the local occupational health and safety regulations and general safety regulations apply.

The illustrations in this manual are examples only. Deviations are at the discretion of Baumer at all times.

1.2 Warnings in this manual

Warnings draw attention to injury or material damage. The warnings in this manual indicate different hazard levels:

Symbol	Warning term	Explanation
	**DANGER**	Indicates an immediate danger with high risk that will lead to death or serious injury if not avoided.
	WARNING	Indicates a possible danger with medium risk that may lead to death or (serious) injury if not avoided.
	CAUTION	Indicates a danger with low risk that could lead to slight or medium injury if not avoided.
	NOTE	Indicates a warning of material damage.
	**INFO**	Indicates practical information and tips that enable optimal use of the devices.

1.3 Labels in this manual

Identifier	Use	Example
Dialog element	Indicates dialog elements.	Click the ***OK*** button.
Unique name	Indicates the names of products, files, etc.	*Internet Explorer* is not supported in any version.
`Code`	Indicates entries.	Enter the following IP address: `192.168.0.250`

1.4 Liability limitation

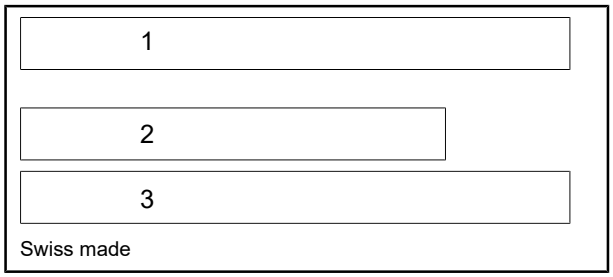
All information and notes in this manual have been compiled in accordance with the applicable standards and regulations, the state of the art, and our many years of knowledge and experience.

The manufacturer accepts no liability for damage due to the following reasons:

- Non-observance of the manual
- Improper use
- Use of unqualified personnel
- Unauthorized conversions

The obligations agreed in the delivery contract, the general terms and conditions and the delivery conditions of the manufacturer and its suppliers, as well as the legal regulations valid at the time of conclusion of the contract apply.

1.5 Name plate



Ill. 1: Name plate

1	Short item name (OMxx item number)	2	Production date
3	Serial number		

1.6 Scope of delivery

The scope of delivery includes:

- 1 x sensor
- 1 x quickstart
- 1 x General information leaflet

In addition, you can find the following information, among other things, in digital format at www.baumer.com:

- Operating manual
- Data sheet
- 3D CAD drawing
- Quickstart
- Dimensional drawing
- Connection diagram & pin assignment
- Certificates (EU conformity declaration, etc.)

2 Safety

2.1 Personnel requirements

Certain work with the product may only be carried out by specialized personnel.

Specialized personnel are staff members who can evaluate the tasks assigned to them and recognize potential danger, based on their training and work as well as a reliable understanding of technical safety issues.

Qualified personnel are divided into the following categories:

- **Instructed personnel:**
  A person who has been informed and, if required, trained, by a specialist about the assigned tasks and potential dangers of improper behavior.
- **Specialist:**
  A person who, based on his/her training, experience, and instruction, as well as his/her knowledge of applicable standards, rules, and accident prevention regulations, has been authorized to carry out the respectively required tasks, while recognizing and avoiding potential dangers.
- **Electrical specialist:**
  A person with the appropriate specialist training, knowledge, and experience allowing him/her to recognize and avoid dangers originating from electricity.

2.2 General information

Intended use

This product is a precision device and serves the detection of items, objects, or physical measurement variables and the preparation or provision of measured values as electric variables for the higher-level system.

Unless specifically labeled, this product may not be used in explosive environments.

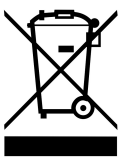
Commissioning

Assembly, installation, and calibration of this product may only be performed by a specialist.

Installation

Only use the fasteners and fastener accessories intended for this product for installation. Outputs not in use must not be wired. Unused wires of cable outputs must be insulated. Do not go below the permissible cable bending radii. Disconnect the system from power before the product is electrically connected. Use shielded cables to prevent electro-magnetic interference. If the customer assembles plug connections on shielded cables, then EMC-version plug connections should be used and the cable shield must be connected to the plug housing across a large surface area.

Disposal (environmental protection)



Used electrical and electronic devices may not be disposed of in household waste. The product contains valuable raw materials that can be recycled. Therefore dispose of this product at the appropriate collection point. For additional information visit www.baumer.com.

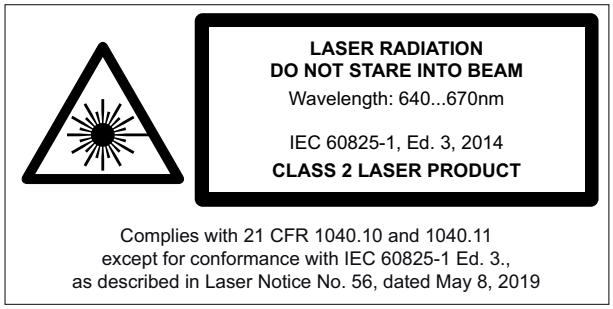
2.3 Laser

⚠ CAUTION

Use of controls or adjustments of performance of procedures other than those specified herein may result in hazardous radiation exposure. For a detailed description of the radiation pattern emitted by a particular device, refer to the data sheet of the respective device.

IEC 60825-1/2014
Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019

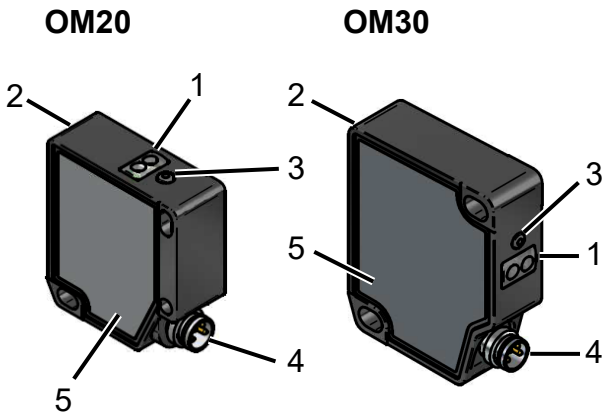
Products with the following type codes are rated as Laser Class 1:
OM20-xxxxx.HH.xxx
OM30-xxxxx.HH.xxx



Products with the following type codes are rated as Laser Class 2:
OM20-xxxxx.HV.xxx
OM30-xxxxx.HV.xxx

3 Description

3.1 Structure



Ill. 2: Structure OM20/OM30

1	Sensor LEDs	2	Front panel
3	Teach button	4	M8 plug, 4-pin
5	Imprint of laser information & name plate		

3.2 General functionality

The sensor measures the distance to an object to be measured by angle calculation (triangulation principle). For this purpose, the sensor projects a laser point on the object to be measured. This laser point is mapped on the receiver element by the receiving optics. The distance to the object to be measured is calculated from the location of the image on the receiver element. The measured distance is provided as a measured value via the following channels integrated in the sensor:

- RS485 interface with Modbus RTU protocol

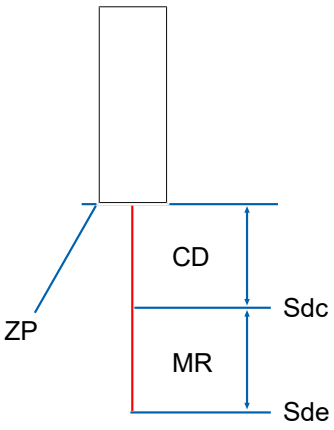
The following options are available to you for parameterizing the sensor:

- RS485 interface with Modbus RTU protocol
- Teach button on the sensor

3.3 Measurement field

INFO

The data for your sensor version can be found in the data sheet.



ZP	Zero position	CD	Blind region
Sdc	Start of the measurement range	MR	Measurement range
Sde	End of the measurement range		

Blind region (CD)

- Region in which the sensor cannot detect any measurement objects.
- Unwanted objects (objects not to be measured) in this region may lead to deviations in the measurement results.

Measuring range (MR)

- Region in which the measurement object must be present for the sensor to deliver reliable measurement results.
- Unwanted objects (objects not to be measured) in this region may lead to deviations in the measurement results.
- The limits of the measurement range (MR) are defined via the parameters *Start of the measurement range (Sdc)* and *End of the measurement range (Sde)*.

Zero position (ZP)

- In the factory settings, the zero point is located on the front of the sensor (ZP = `0 mm`). The output consists of the distance between the front of the sensor and the object to be measured.
- The following values depend on the zero position:
  - Output measured values
  - Switching points
- Capable of parameterization via:
  - Modbus RTU
  - Teach button

3.4 Operating and display elements

3.4.1 Sensor LEDs

Des.		Illuminated	Blinking
POWER	Green	Sensor ready for operation	-
OUTPUT	Yellow	No valid signal within the measurement range	Critical signal quality

In the factory settings, the yellow LED follows the function of the alarm output. Alternatively, you can select the function of the switching output for the yellow LED via Modbus RTU.

3.4.2 Teach button

Instead of parameterizing the sensor via the Modbus RTU protocol, you can configure the sensor via the Teach button. Adjustable parameters:

- Zero position (ZP)
- Reset the sensor to the factory settings

INFO

You have the additional option of adjusting the mode of the Teach button via Modbus RTU. You have a choice between *Xpert* (factory setting) and *Xpress* mode.

The teach button is automatically deactivated after 5 min (timeout can be parameterized via Modbus RTU). When the teach button is pressed for longer than 12 seconds, the sensor returns to operating mode without performing a parameterization.

Teaching the zero position

Instruction:

a) Press the teach button briefly.
   ✓ Green and yellow LEDs light up (teach button is active). If the LEDs do not light up, the teach button is deactivated by the timeout. Restart the sensor.

b) Keep the Teach button pressed for 2 seconds.
   ✓ Green LED blinks with 2 Hz.

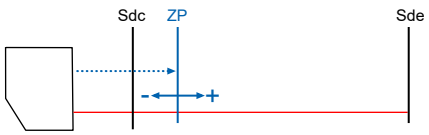
c) Place the object to be measured on the desired position for the zero point and briefly press the teach button within 60 seconds.

Result:

✓ Teach-in OK: Green and yellow LEDs light up briefly. Afterwards, the sensor returns to operating mode.

✓ Teach-in not OK: Green and yellow LEDs blink simultaneously with 8 Hz.

After shifting the zero point, the digital values before the zero point (closer to the sensor) are output with a negative sign. Distance values behind the zero point (furthermore the sensor) are output with a positive sign.



Resetting to the factory settings

a) Press the teach button briefly.
   ✓ Green and yellow LEDs light up (teach button is active). If the LEDs do not light up, the teach button is deactivated by the timeout. Restart the sensor.

b) Keep the Teach button pressed for 8 seconds.
   ✓ Yellow and green LEDs blink simultaneously with 2 Hz.

Result:

✓ Teach-in OK: Green and yellow LEDs light up briefly. Afterwards, the sensor returns to operating mode.

✓ Teach-in not OK: Yellow and green LEDs blink simultaneously with 8 Hz.

3.5 Modbus RTU

Modbus RTU is a standardized protocol that is based on a serial master/slave communication via RS485 in this case.

The functionality of the sensor can be accessed by reading or writing entries in the tables *Discrete Inputs*, *Input Registers*, and *holding registers*. The following Modbus function codes (FC) are supported:

- Read Discrete Inputs (FC 02)
- Read Input Registers (FC 04)
- Read Holding Registers (FC 03)
- Write Single Holding Register (FC 06)
- Write Multiple Holding Registers (FC 16)

Below you will find an overview of the available registers. The 2 described tables are independent of each other, so that the same address can represent different functions in different tables. The number of registers to be read or written with a Modbus command must correspond to the length specified for the respective sensor functionality. A partial reading or writing of parameters is not possible.

INFO

1 Modbus register corresponds to 2 bytes. If the data type of a sensor parameter is wider than a 2 byte Modbus register, the parameter is divided among several Modbus registers. The less significant bits are located at the smaller address and the more significant bits at the larger address (Little Endian).

As a general rule, all registers can be written and read. If a register is read that is only intended for write access, 0xFFFF is returned.

Holding register: function ID 03/06/16

Address	Number of registers	Command	Description
101	1	Precision	Select signal filtering
102	1	Custom Median Filter Length	Configurable filter length – median filter
103	1	Custom Average Filter Length	Configurable filter length – average filter
180	2	Zero Position	Set zero position numerically
185	1	Zero Position Teach	Teach zero position
200	2	Distance Near	Set measuring range limit (near)
202	2	Distance Far	Set measuring range limit (far)
220	1	Meas Range To Max	Maximize measurement range
300	2	Switch Point 1	Far threshold of the switching output
302	2	Switch Point 2	Near threshold of the switching output
304	2	Switch Mode	Select switching mode
306	2	Hysteresis Width	Hysteresis
308	1	Polarity	Polarity of the switching output
400	2	Trigger Mode	Configure trigger mode
402	2	Fix Time Trigger Interval	Time period for *Interval* trigger mode
410	1	Laser ON/OFF	Switch laser on and off
411	1	Teach Lock	Time until the Teach button is deactivated
412	1	Teach Pattern	Parameterize the mode of the Teach button
503	1	Sensor Reset	Reset the sensor to the factory settings
800	1	Dropout Timeout	Holding time for invalid measured value
1000	1	Reset All Statistics	Reset all statistical data (operating time, histograms)
1001	1	Reset Operation Time	Reset operating time
1002	1	Reset Distance Histogram	Reset histogram for distance
1003	1	Reset Exposure Reserve Histogramm	Reset the histogram for exposure reserve
1050	16	App Specific Tag	Customer-spec. identification of the sensor
1066	16	Function Tag	Customer-spec. identification of the sensor
1082	16	Location Tag	Customer-spec. identification of the sensor
1100	1	Modbus Slave Address	Slave address
1101	1	Modbus Baudrate ID	Baud rate
1102	1	Orange LED function	Parameterize function of the LED

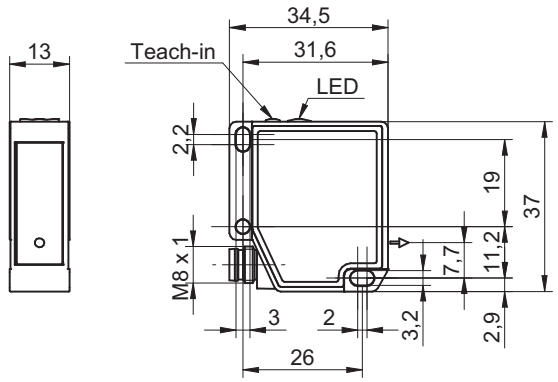
Input register: function ID 04

Address	Number of registers	Command	Description
0	16	Vendor Name	Manufacturer name
16	16	Vendor Text	Manufacturer note
32	26	Product Name	Product name
58	5	Product ID	Item number
63	32	Device Text	Product text
95	10	Serial Number	Serial number
105	5	Hardware Revision	Hardware version
110	5	Firmware Revision	Firmware version
115	6	P-Code	Production code
200	13	All Measurement Values	Measured value and additional information
301	2	Operation Time: Powerup	Operating time since the sensor powered up
303	2	Operation Time: Resetable	Operating time since a defined point in time
305	2	Operation Time: Lifetime	Total operating time
307	1	Histogramm Distance: Unit	Unit in distance histogram
308	2	Histogramm Distance: Range Start	Start of the valid range of the distance histogram
310	2	Histogramm Distance: Range End	End of the valid range of the distance histogram
312	1	Histogramm Distance: Number of Bins	Number of bins in the distance histogram
313	40	Histogramm Distance: Bin 1–20	Distance histogram: bins 1 - 20
353	2	Histogramm Exposure Reserve: Range Start	Start of the valid range of the exposure reserve histogram
355	2	Histogramm Exposure Reserve: Range End	End of the valid range of the exposure reserve histogram
357	1	Histogramm Exposure Reserve: Number of Bins	Number of bins in the exposure reserve histogram
359	40	Histogramm Exposure Reserve: Bin 1 - 20	Exposure reserve histogram: bins 1 - 20

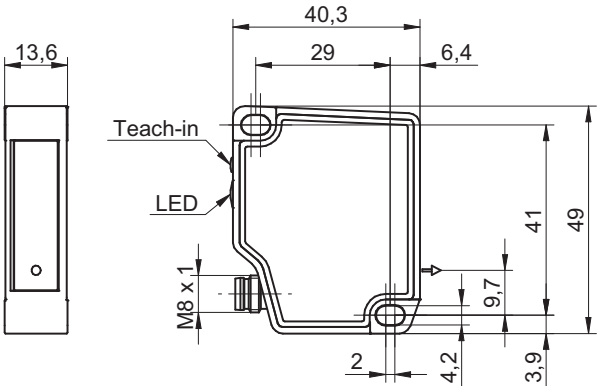
Also see about this

Functions [▶ 27]

3.6 Dimensional drawing



Ill. 3: Dimensional drawing OM20



Ill. 4: Dimensional drawing OM30

4 Transport and storage

4.1 Transport

NOTICE

Material damage due to improper transport.

a) Practice the greatest diligence when unloading the delivery packages and when transporting them within the company.

b) Note the information and symbols on the packaging.

c) Only remove packaging immediately before installation.

4.2 Delivery inspection

Upon receipt immediately inspect the delivery for completeness and transport damage.

Claim any defect as soon as it is detected. Damages can only be claimed within the applicable claims deadlines.

In case of externally visible transport damage, proceed as follows:

Instruction:

a) Do not accept the delivery or only with reservations.

b) Note the scope of the damage on the transport documents or the delivery slip of the carrier.

c) Initiate the claim.

4.3 Storage

Store the product according to the following conditions:

- Do not store outdoors.
- Store dry and free from dust.
- Do not expose to aggressive media.
- Keep away from the sun.
- Avoid mechanical agitation.
- Storage temperature: -10 ... +60 °C
- Ambient humidity: 20 ... 85 %
- When storing for longer than 3 months, regularly check the general status of all parts and the packaging.

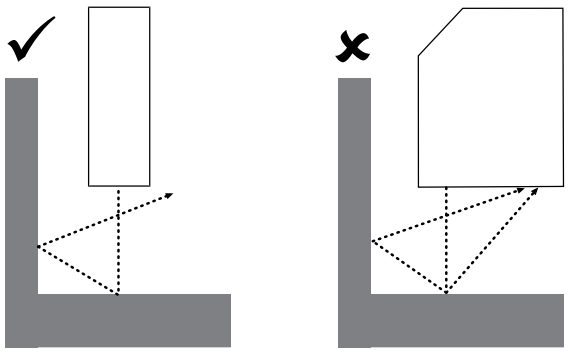
5 Installation instructions

INFO

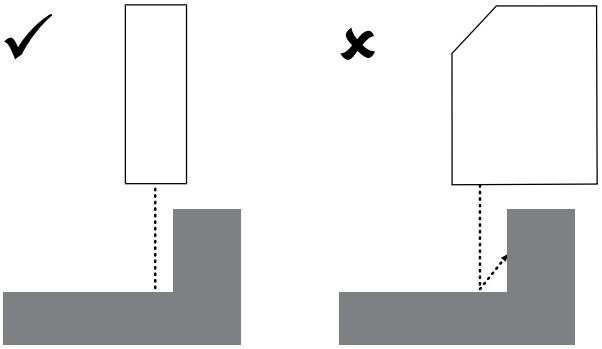
You can find the suitable installation accessories on the Baumer website. Go to www.baumer.com for this. Then enter the item number of the sensor in the search field of the website.

- For measurement objects with shiny surfaces: Tilt the sensor 6 to 10° to the side so that the light directly reflected by the surface does not hit the receiver of the sensor.
- For mounting, use at least 1 tooth lock washer to break open the paint layer of the sensor.

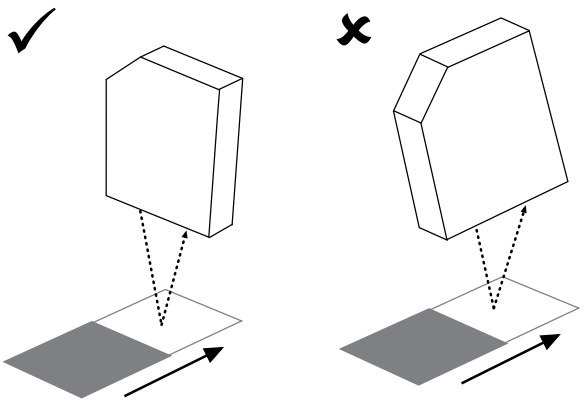
	OM20	OM30
Screws:	2 × M3	2 × M4
Torque:	0.6 Nm ±10 %	1 Nm ±10 %



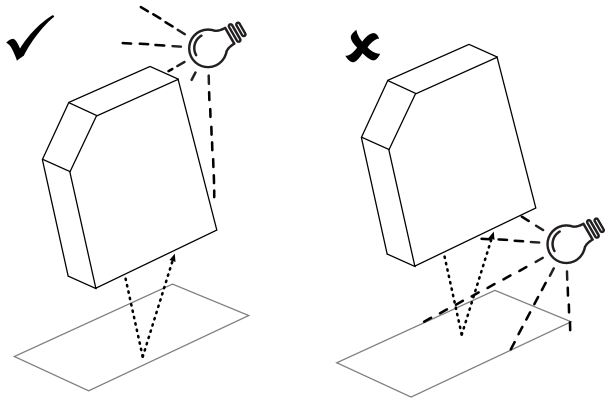
Mounting the sensor near a wall or a machine component:
Mount the sensor parallel to the wall to prevent disruptive reflections.



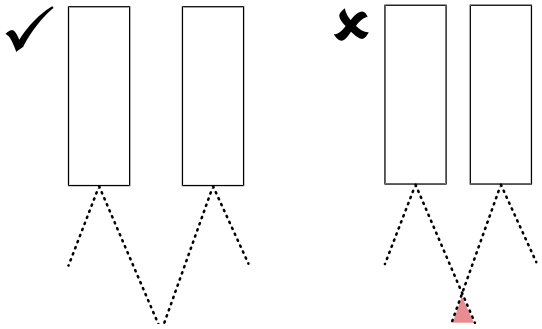
Measurement objects with height differences / measurements in holes or cracks:
Mount the sensor in such a way that the reception beam is not interrupted by the step.



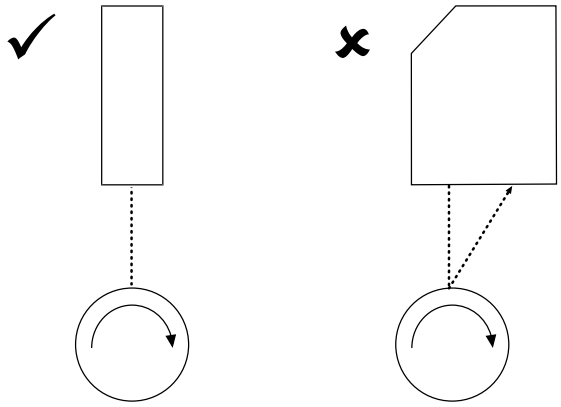
Mounting for measuring objects with colored edges / different reflective characteristics of the surface:
Align the sensor parallel to the colored edge to prevent measurement errors.



Mounting near strong ambient light:
Prevent the ambient light from entering the detection range of the receiver.



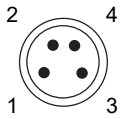
Mounting several sensors close to each other:
Prevent the detection ranges of the receivers from overlapping. Only the sensor's own laser spot may be in the detection range of the receiver.



Mounting for round measurement objects:
Align the sensor on the same axis as the measurement object to prevent reflections.

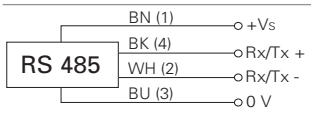
6 Electrical installation

6.1 Pin assignment



1	+Vs
2	Rx/Tx -
3	0 V
4	Rx/Tx +

6.2 Connection diagram



1	BN – Brown
2	WH – White
3	BU – Blue
4	BK – Black

6.3 Connecting the sensor to electricity

Instruction:

a) Ensure that the system is disconnected from power.

b) Connect the sensor according to the pin assignment.

7 Commissioning

7.1 Factory settings

Adjustable parameters		Factory setting in the sensor
Communication Parameter	Modbus Slave Address	1
	Baudrate	57600
Operation Mode	Precision Filter	Highest
	Sampling Mode	Free Running
Measurement Range	Zero Position	0 mm
	Distance Near	Sdc
	Distance Far	Sde
Invalid Value Handling	Hold Time	0 ms
SSC1 Configuration	SP 1	Sde -10 mm[I]
	SP 2	Sdc +10 mm[II]
	Polarity	Active High
	Mode	Window
	Hysteresis	*depending on MR*
Input/Output Settings	LED function	SSC1 - Alarm
Local User Interface	Local Teach Mode	XPert
	Button Time Out	5 min

[I] Type OM20-P0026.xx.xxx: SSC1 Param.SP 1 = -2 mm

[II] Type OM20-P0026.xx.xxx: SSC1 Param.SP 2 = +2 mm

7.2 Set up RS485 interface with Modbus RTU

The sensor supports Modbus RTU via RS485 for retrieving measured values and for parameterization.

Communication via the RS485 interface is a serial master-slave communication, which is why the serial communication parameters must first be known for all participants:

- Slave address: 1 (factory setting)
- Data bits: 8
- Number of stop bits: 1 bit
- Parity: even
- Baud rate (bps): 57600 (factory setting)

Example: Reading out measured values

Instruction:

a) Set the communication parameters (see above) on the master.

b) Read the input register.
Function ID: 04
Address 200: All Measurements
Number of registers: 13

Result:

✓ You receive the response telegram with the following structure (the measured value is in address 202 and 203).

INFO

1 Modbus register corresponds to 2 bytes. If the data type of a sensor parameter is wider than a 2 byte Modbus register, the parameter is divided among several Modbus registers. The less significant bits are located at the smaller address and the more significant bits at the larger address (Little Endian).

Address	Number of registers	Data type	Description
200	1	uint16_t	Measured value signal quality: ■ 0 = ok ■ 1 = weak signal ■ 2 = critical signal
201	1	uint16_t	■ Bit 0: switching output: ▪ 0 = Inactive ▪ 1 = Active ■ Bit 1: alarm output ▪ 0 = Inactive ▪ 1 = Active
202 - 203	2	float32_t	Distance [mm]
204 - 205	2	float32_t	Measurement rate [Hz]
206	1	uint16_t	Exposure reserve
207 - 208	2	uint32_t	Response delay [µs]
209 - 210	2	uint32_t	Time stamp [s]
211 - 212	2	uint32_t	Time stamp [µs]

The following data (hexadecimal) is read out for the distance value:

- 202 = 7C37
- 203 = 428B

The distance value is divided between 2 Modbus registers (Little Endian). Thus, the less significant bits are located at the smaller address, in this case 202. The more significant bits are located at the larger address, in this case 203. The distance value must therefore be evaluated as 42 8B 7C 37. This results in a distance of 69.743 mm.

7.3 Measured value and additional information

The measured value and additional information can be called up by calling up the input register with the address 200.

Modbus RTU command – input register: measured value and additional information

Address 200 – All Measurement Values:

Address	Access	Number of registers	Data type	Description
200	Read	1	unit16_t	Measured value signal quality: ▪ 0 = ok ▪ 1 = weak signal ▪ 2 = critical signal
201	Read	1	unit16_t	Bit 0: switching output: ▪ 0 = inactive ▪ 1 = active Bit 1: alarm output ▪ 0 = inactive ▪ 1 = active
202 - 203	Read	2	float32_t	Distance [mm]
204 - 205	Read	2	float32_t	Measurement rate [Hz]
206	Read	1	unit16_t	Exposure reserve
207 - 208	Read	2	unit32_t	Response delay [µs]
209 - 210	Read	2	unit32_t	Time stamp [s]
211 - 212	Read	2	unit32_t	Time stamp [µs]

INFO

The distance value in address 202 and 203 can also be read individually. For this, read out register 202 with register number 2. A single readout of the distance can reduce the transmission time.

7.3.1 Measurement rate

The measurement rate is equivalent to the number of measurements per second. Example: With a measurement rate of 500 Hz, a measurement takes place every 0.002 s (1/ 500 Hz = 0.002 s). The measurement rate is useful for the following questions, among others:

- How quickly can a change in distance be detected?
- How many measurements can be performed on a static object?

INFO

The max. speed in dynamic applications is limited by the measurement rate, and the distance change at the output is influenced by the selected filter value settings. Therefore, consider the measurement rate in connection with the settings of the filter.

The measuring frequency value depends on the exposure time. The sensor automatically adjusts its exposure time to the object to be measured in order to always receive an optimum light quantity and thus achieve a sufficient exposure reserve. The exposure time depends on the properties of the measured surface (color/structure, etc.) and the alignment of the sensor to the object to be measured. Dark objects to be measured reflect less light and thus need longer exposure times than light-colored objects, decreasing the measuring frequency. The measurement and change of the output always take place with the same frequency.

7.3.2 Exposure reserve

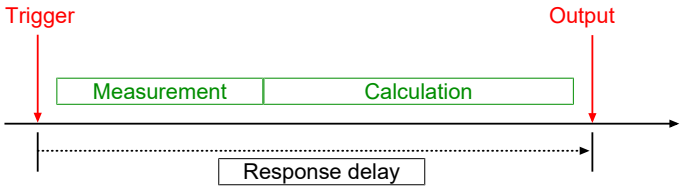
The exposure reserve indicates the light quantity reflected by the measurement object (as a relative factor without unit). The exposure reserve helps you with the following problems, among others:

- Check whether a valid measurement result is present (signal quality). The signal quality is weak
  - when the sensor is not optimally aligned, and
  - when the distance between the sensor and measurement object is too large.
- During ongoing operation: Check the front panel of the sensor for contamination – if the exposure reserve decreases over time, it may be an indication of increased contamination of the front panel. Use the histogram function for this purpose (*Histogram function [▶ 45]*).

7.3.3 Response delay

The response delay is equivalent to the time elapsed between the triggering of the measurement (internal signal) and the change in the measured value at the output.

The duration of the response delay depends on the exposure time. The sensor automatically adjusts its exposure time to the object to be measured in order to always receive an optimum light quantity and thus achieve a sufficient exposure reserve. The exposure time depends on the properties of the measured surface (color/structure, etc.) and the alignment of the sensor to the object to be measured. Dark objects to be measured reflect less light and thus need longer exposure times than light-colored objects; the response delay increases.



Ill. 5: Response delay

INFO

Filter settings do not affect the response delay.

8 Functions

The functions of the sensor are mapped within the Modbus RTU protocol by holding registers.

8.1 Communication parameters

The slave address and the baud rate must be set for a successful communication. The sensor is set as follows in the factory settings:

- Slave address: `1`
- Baud rate: `57600 Bd`

Modbus RTU command – holding register: communication

Address 1100 – Modbus slave address:

Address	Access	Number of registers	Data type	Description
1100	Read/write	1	uint8_t	Set / read out slave address.

Address 1101 – Modbus baud rate ID:

Address	Access	Number of registers	Data type	Description
1101	Read/write	1	uint8_t	Set or read out baud rate: ▪ 0 = 38400 ▪ 1 = 57600 ▪ 2 = 115200 ▪ 3 = 230400

8.2 Filter

With the *Filter* function, the noise can be reduced and the repeatability increased.

The number of measured values per string of numbers (filter length) can be adjusted as follows via the parameter settings:

- Option 1: Select the required filter length from predefined filter lengths.
  - `Standard`
  - `High`
  - `Very High`
  - `Highest`
- Option 2: Enter the required filter length as a numerical value.
  - `Custom`

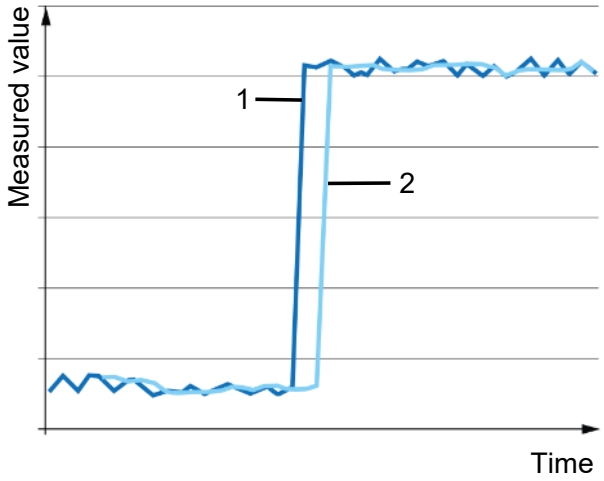
General

The response and drop-off times are increased and moving objects can be detected with a delay as a result. The precision filter calculates the results in the form of floating values. The oldest measured value is removed as soon as a new measurement is added. Therefore the measuring frequency is not affected by the precision filter.

In the factory settings, the filter is set to `Highest`. In general, the more measured values per filter, the better the repeatability and the higher the reproducibility of the results.

Moving Median filter

This filter allows the suppression of individual measurement errors by calculating the median of a specified number of measured values in a string of numbers. The median value is the measured value located right “in the center” if the measured values are sorted by size.

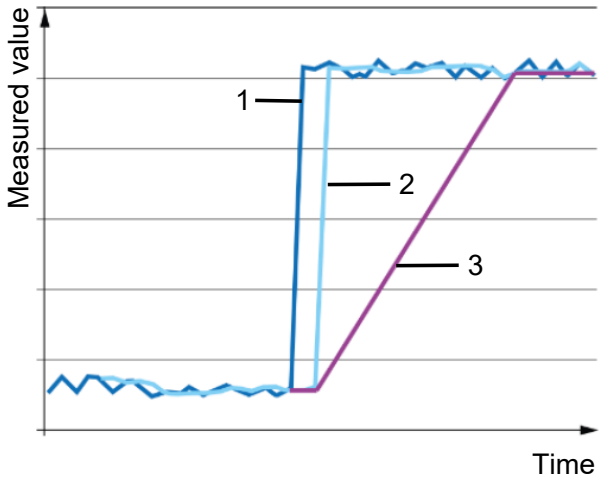


Ill. 6: Moving Median filter

1	Raw data	2	Data after filtering with Moving Median

Moving Average filter

This filter smoothes the signal course by calculating the average of a specified number of measured values in a string of numbers. Due to average calculation, a change in distance becomes increasingly visible.



Ill. 7: Moving Average filter

1	Raw data	2	Data after filtering with Moving Median
3	Data after filtering with Moving Average and Moving Median		

The higher the number of measured values per filter, the longer the response time of the sensor. This means that a change in distance only becomes fully visible for the output after a delay.

Option 1: Select the required filter length from predefined filter lengths

The following selection options are available:

	Number of measured values	
Value	**Moving Median**	**Moving Average**
`Standard`	1	1
`High`	9	1
`Very High`	9	16
`Highest`	9	128

INFO

When several sensors are calculated, for example, for thickness measurement, the *Standard* filter should always be chosen to obtain a raw measured value of both sensors for further calculations.

Option 2: Enter the filter length as a numerical value

If the predefined filter lengths are not suitable, an individual filter length can be entered for the *Moving Average* and *Moving Median* filters. Especially when it comes to applications without dynamic changes in distances, such as the verification of the position of an object, a greater filter length can improve the performance of the sensor. You can specify the length of the *Moving Average* and *Moving Median* filters after selecting the *Custom* filter.

- *Moving Median* filter: 1 - 21 values
- *Moving Average* filter: 1 - 256 values

Modbus RTU command – holding register: *Filter* mode

Address 101 – Precision:

Address	Access	Number of registers	Data type	Description
101	Read/write	1	uint8_t	Select signal filter: ■ 0: Standard ■ 1: High ■ 2: Very High ■ 3: Highest ■ 4: Custom

Address 102 – Custom Median Filter Length:

Address	Access	Number of registers	Data type	Description
102	Read/write	1	uint16_t	Only possible with the filter setting *Custom*. Configurable filter length – Median Filter: ■ Min. length: 1 ■ Max. length: 21

Address 103 – Custom Average Filter Length:

Address	Access	Number of registers	Data type	Description
103	Read/write	1	uint16_t	Only possible with filter setting *Custom*. Configurable filter length – Average Filter: ■ Min. length: 1 ■ Max. length: 256

8.3 Trigger mode

The *Trigger mode* function controls the acquisition of the measured values and thus also the measurement frequency. The parameter settings offer you a choice between the *Free Running* and *Interval* trigger modes.

***Free Running* trigger mode**

- The sensor measures constantly and at the highest possible measurement frequency.
- The maximum measurement frequency varies depending on the characteristics of the measurement object (or the exposure time). Example: Dark measurement objects (longer exposure time) result in a lower measurement frequency than light-colored measurement objects.
- The maximum measurement frequency is independent of the selected filter settings, since measurement and processing of data proceed simultaneously.
- Purpose/application: The *Free Running* trigger mode can be used in most applications (factory setting). The fastest possible recording of measurement results ensures a larger amount of data.

***Interval* trigger mode**

- The sensor measures with a constant time interval (adjustable in µs).
- Observe the maximum possible measurement frequency in the *Interval* mode as well. If the maximum possible measurement frequency is exceeded, the performance can worsen. Therefore:
  - Measure the maximum possible measurement frequency in the *Free Running* mode.
  - Calculate the minimum time interval as follows:
    min. time interval = 1/max. measurement frequency
- Purpose/application: Use with dynamic applications (e.g. measurement objects on a conveyor belt) to detect all measurement objects.

Modbus RTU command – holding register: *Trigger* mode

Address 400 – Trigger Mode:

Address	Access	Number of registers	Data type	Description
400 - 401	Read/write	2	int32_t	Select the trigger mode: ■ 0: Free Running ■ 2: Interval

Address 402 – Fix Time Trigger Intervall:

Address	Access	Number of registers	Data type	Description
402 - 403	Read/write	2	uint32_t	Numerical time interval in *Interval* mode [µs]

8.4 Zero position

The measured distance value is relative to the set zero point position. By default, the zero position of the sensor coincides with the sensor front and can be set to any value between 0 and the maximum measurement distance of the sensor.

The distance value and the switching point positions are calculated relative to the zero position. The function allows tolerance measurements for quality testing, for example.

Example 1:

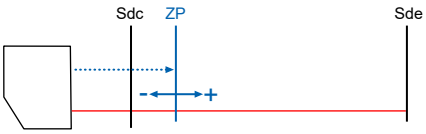
- Physical distance to the object to be measured: 150 mm
- Set zero position: 0 mm (default setting)
- Output measured value: 150 mm

Example 2:

- Physical distance to the object to be measured: 150 mm
- Set zero position: 100 mm
- Output measured value: 50 mm

The following options are available to you for parameterizing the zero position:

- Define the zero position numerically.
- Teach in the zero position by writing the address 185 to the currently measured distance.



Ill. 8: Zero position

INFO

Negative values are not permitted for the zero position.

Modbus RTU command – holding register: zero position

Address 180 – Zero Position:

Address	Access	Number of registers	Data type	Description
180 - 181	Read/write	2	int32_t	Numerical zero position [µm]

Address 185 – Teach Zero Position:

Address	Access	Number of registers	Data type	Description
185	Write	1	x	Teach zero position: Call up the function by writing any number.

8.5 Measurement range

With the *Measurement range* function, the limits of the measurement range can be set so that the active measurement range is limited to a partial range of the maximum measurement range of the sensor. The purpose of this function is to eliminated interfering reflections (e.g. if there is a pane of glass between the sensor and the object to be measured).

- The Near limit of the measurement range must be larger than the minimum limitation of the sensor (Sdc).
- The Far limit of the measurement range must be smaller than the maximum limitation of the sensor (Sde).

The alarm output is activated as soon as no object to be measured is located within the configured measurement range or the signal quality is insufficient.

Modbus RTU command – holding register: measurement range

Address 200 – Distance Near:

Address	Access	Number of registers	Data type	Description
200 - 201	Read/write	2	float32_t	Measurement range limit near [mm]

Address 202 – Distance Far:

Address	Access	Number of registers	Data type	Description
202 - 203	Read/write	2	float32_t	Measurement range limit far [mm]

Address 220 – Meas Range to MAX:

Address	Access	Number of registers	Data type	Description
220	Read	1	x	Maximize measurement range: Call up the function by writing any number.

8.6 Invalid Value Handling

The *Invalid Value Handling* function defines the behavior of the sensor when the sensor records an invalid measured value. This function can be used, for example, to mask recurring reflections of machine parts or reflections of objects to be measured in a dynamic application. Invalid measured values occur when

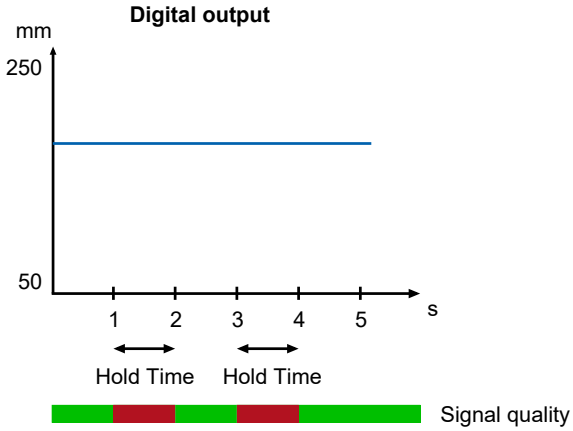
- there are no objects in the measurement range (MR) or
- the signal is too weak due to reflections or unidentifiable objects.

The function can be configured via the following parameter:

- Time period (Hold Time): The time period indicates how long an invalid measured value should be suppressed. The time period is used to mask invalid measured values at the outputs. The output is set only after expiration of the time period.

Invalid Value Handling – example 1

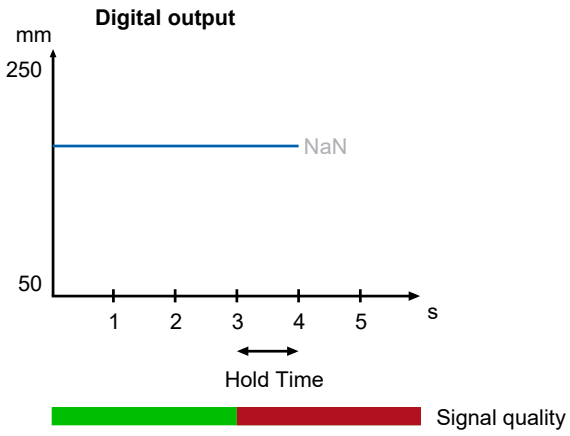
- Parameters:
  - Time period (Hold Time): *1000 ms*
- Interpretation: Invalid measured values are ignored at the digital output. The last valid value is maintained during the time period.



Ill. 9: Invalid Value Handling – example 1

Invalid Value Handling – example 2

- Parameters:
  - Time period (Hold Time): *1000 ms*
- Interpretation: After expiration of the time period, the placeholder for an invalid value is output at the digital output.



Ill. 10: Invalid Value Handling – example 2

Modbus RTU command – holding register: Invalid Value Handling

Address 800 – Dropout Timeout:

Address	Access	Number of registers	Data type	Description
800	Read/write	1	uint16_t	Interval for suppressing invalid measured values [ms]

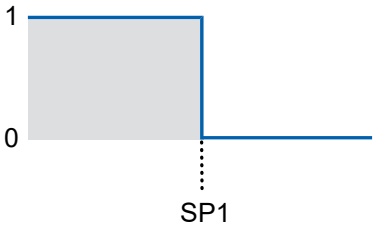
8.7 Switching points

Via the *Switching Points* function, distances (switching points) are defined at which the switching output is to be activated.

The function can be configured via the following parameters:

- Select measurement mode (point mode or window mode).
- Define the position of the switching points (SP1 and SP2):
  - Point mode: SP1
  - Window mode: SP1 and SP2

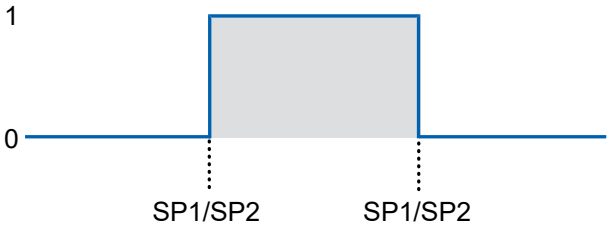
Point mode



Ill. 11: Sensor in the point mode measurement mode

- Purpose/application (example):
  - Quality control: Check the minimum/maximum height of a measurement object.
  - Reach a desired position with a tool that edits an object.

Window mode



Ill. 12: Sensor in the window mode measurement mode

- Purpose/application (example):
  - Quality control: Check the dimensions of a measurement object within a tolerance window.

Modbus RTU command – holding register: switching points

Address 300 – Switch Point 1:

Address	Access	Number of registers	Data type	Description
300 - 301	Read/write	2	float32_t	Far threshold

Address 302 – Switch Point 2:

Address	Access	Number of registers	Data type	Description
302 - 303	Read/write	2	float32_t	Near threshold

Address 304 – Switch Mode:

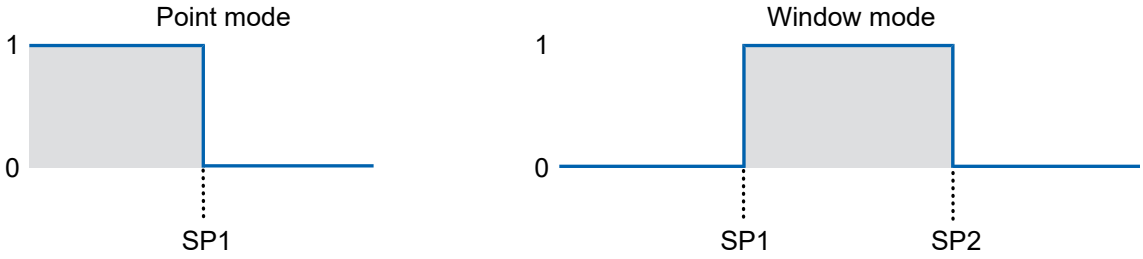
Address	Access	Number of registers	Data type	Description
304 - 305	Read/write	2	int32_t	Select switching mode: ▪ 0: Point ▪ 1: Window

8.8 Polarity

With the *Polarity* function, you can define the behavior of the switching outputs regarding the output level.

With parameterization you can choose between *Active High* and *Active Low*.

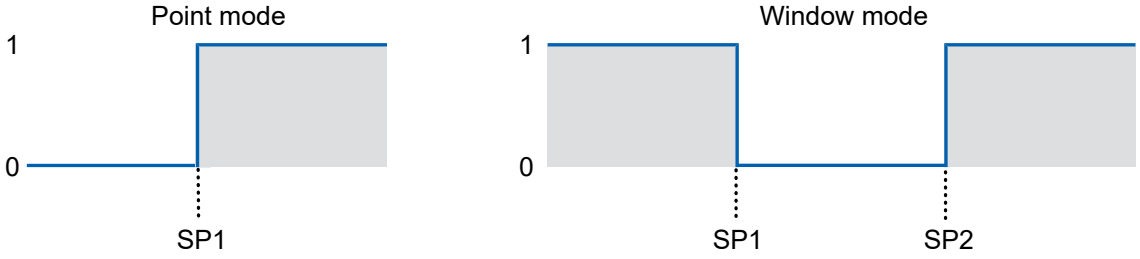
Active High



Ill. 13: Polarity – Active High

- Point mode: The switching output is activated as soon as the defined distance SP1 is not reached.
- Window mode: The switching output is activated as soon as the measured value is within the window of SP1 and SP2.

Active Low



Ill. 14: Polarity – Active Low

- Point mode: The switching output is activated as soon as the defined distance SP1 is exceeded.
- Window mode: The switching output is activated as soon as the measured value is outside the window of SP1 and SP2.

Modbus RTU command – holding register: polarity

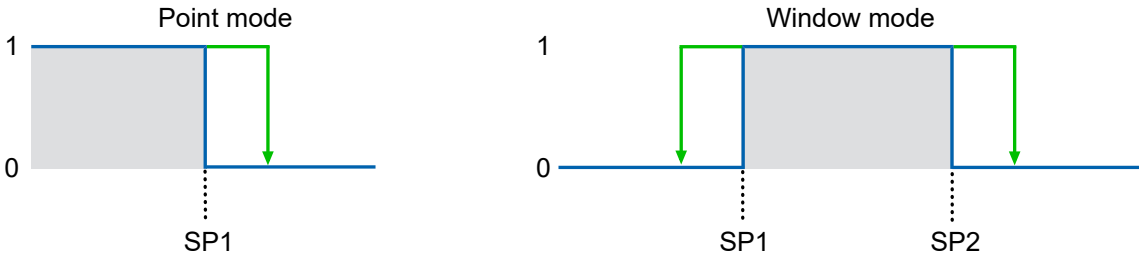
Address 38 – Polarity:

Address	Access	Number of registers	Data type	Description
308	Read/write	1	uint8_t	Polarity of the switching output: ▪ 0 = Active low ▪ 1 = Active high

8.9 Hysteresis

The *Hysteresis* prevents unwanted switching of the switching output. The parameterized value of the hysteresis is the difference in distance between the points at which the switching output is activated and deactivated. Baumer recommends always setting the hysteresis not equal to 0.

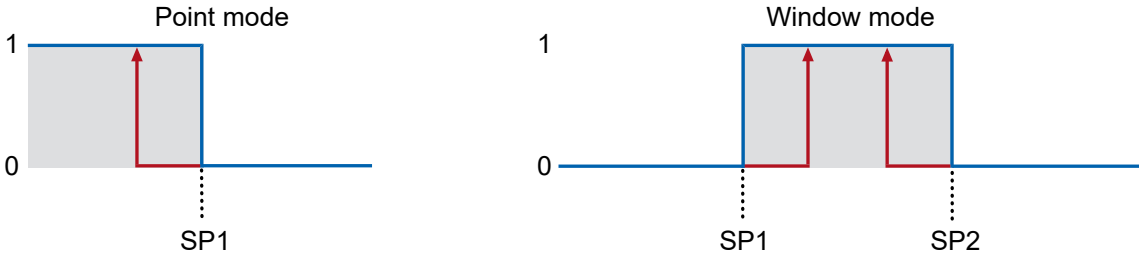
Positive hysteresis



Ill. 15: Positive hysteresis

- Switching output in point mode: A positive hysteresis value corresponds to a right aligned hysteresis.
- Switching output in window mode: A positive hysteresis value corresponds to a hysteresis aligned outside of the window.
- Example:
  - Measuring mode of the switching output: point mode
  - Switching point (SP1): 200 mm
  - Hysteresis: 1.5 mm
  - This results in a right aligned hysteresis. If the measured distance is less than 200 mm, the switching output is active. If the object to be measured moves from 200 mm to 201 mm, the switching output remains active due to the hysteresis. As soon as the measured distance is greater than 201.5 mm, the switching output is deactivated (switching output switches to *low*). If the object to be measured moves from 202 mm to 201 mm, the switching output remains deactivated. The switching output only changes its state at 200 mm (parameterized switching point).

Negative hysteresis



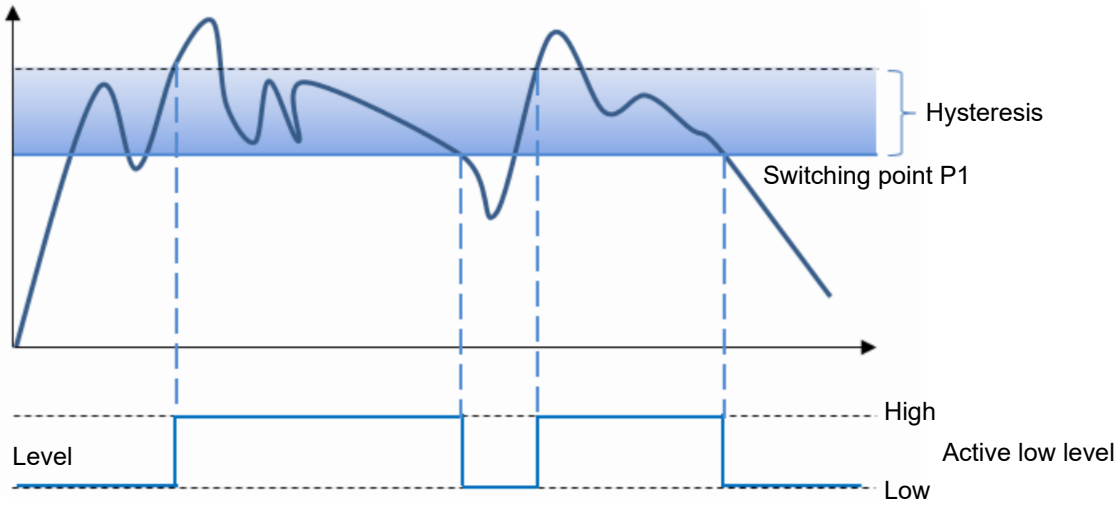
Ill. 16: Negative hysteresis

- Switching output in point mode: A negative hysteresis value corresponds to a left aligned hysteresis.
- Switching output in window mode: A negative hysteresis value corresponds to a hysteresis aligned within the window.
- Example:
  - Measuring mode of the switching output: window mode
  - Switching point 1 (SP1): 200 mm
  - Switching point 2 (SP2): 300 mm
  - Hysteresis: -1.5 mm

- This results in a left aligned hysteresis. When the object to be measured nears the switching points from outside of the window, the switching output remains deactivated until a distance of 201.5 mm and 298.5 mm. When the object to be measured nears the switching points from the inside of the window, the switching output remains active until 200 mm and 300 mm (parameterized switching points).

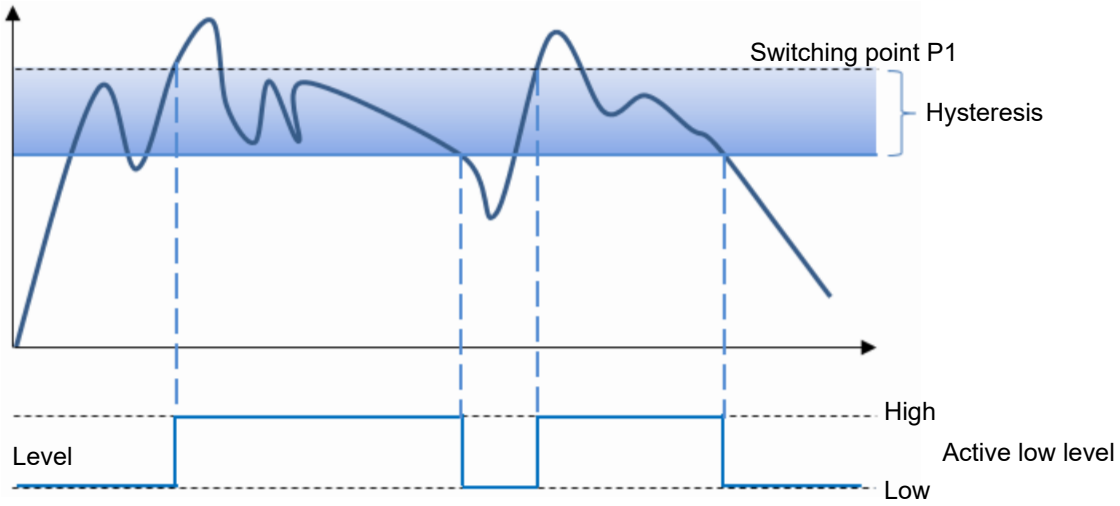
Point mode (switching output behavior)

Positive hysteresis:



Ill. 17: Behavior of the switching output in point mode (positive hysteresis)

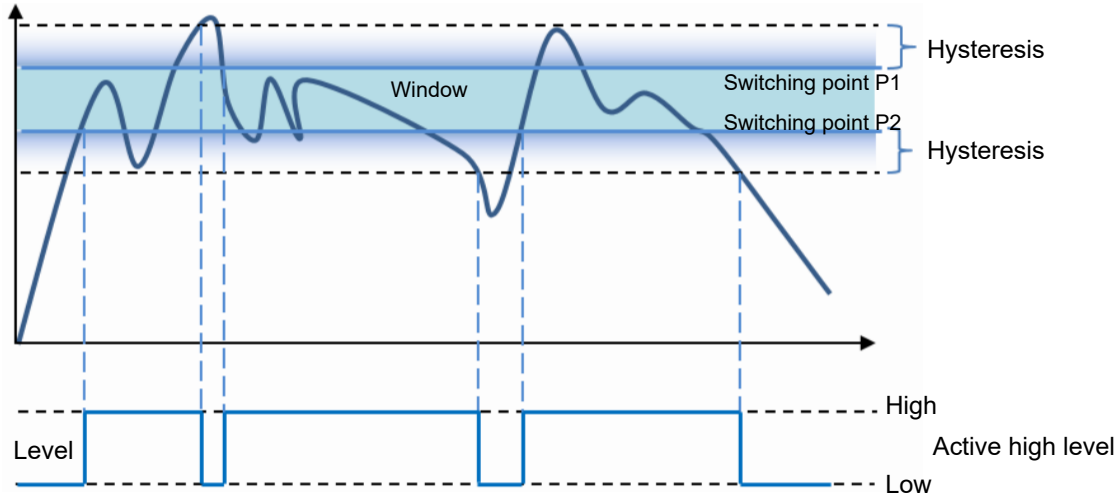
Negative hysteresis:



Ill. 18: Behavior of the switching output in point mode (negative hysteresis)

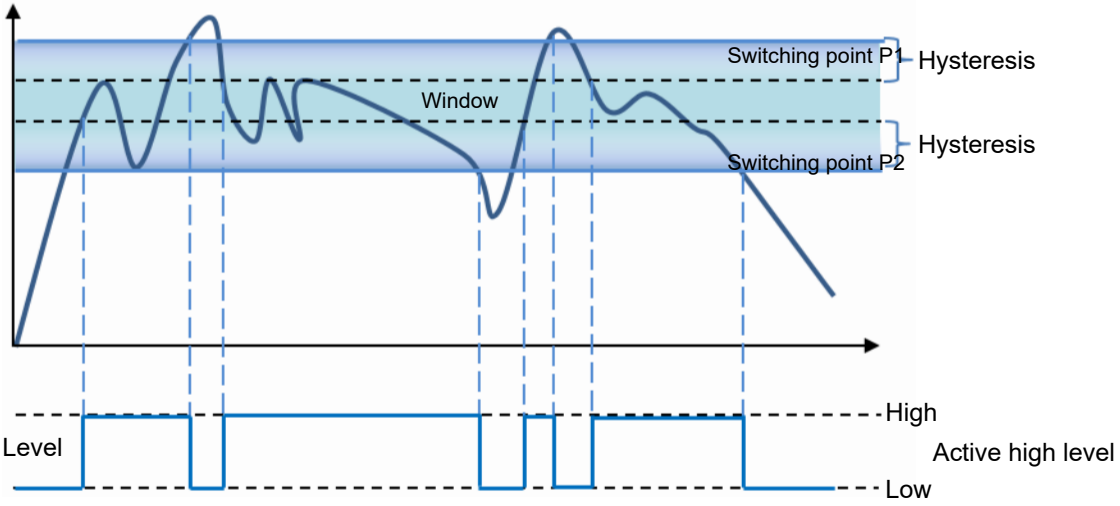
Window mode (switching output behavior)

Positive hysteresis:



Ill. 19: Behavior of the switching output in window mode (positive hysteresis)

Negative hysteresis:



Ill. 20: Behavior of the switching output in window mode (negative hysteresis)

Modbus RTU command – holding register: hysteresis

Address 306 – hysteresis:

Address	Access	Number of registers	Data type	Description
306 - 307	Read/write	2	float32_t	Hysteresis [mm]

8.10 Function of the LED

In the factory settings, the function of the LED follows the alarm output. This means that the output is activated as soon as no measured value can be recorded. The function of the LED can be switched via Modbus RTU so that it follows the function of the parameterizable switching output.

Modbus RTU command – holding register: LED Function

Address 1102 – LED Function:

Address	Access	Number of registers	Data type	Description
1102	Read/write	1	uint16_t	Determine the function of the LED: ▪ 100 = switching output ▪ 101 = alarm output

8.11 Function of the Teach button

With the Teach button function (*Local User Interface*), you have the option of specifying the mode of the Teach button. You have a choice between the *Xpert* (factory setting) and *Xpress* modes. The mode is selected via Modbus RTU.

Adjustable parameters in the *Xpert* mode:

- Zero position
- Reset the sensor to the factory settings

Adjustable parameters in the *Xpress* mode:

- Zero position

The Teach button is automatically deactivated after 5 min (timeout can be parameterized via Modbus RTU).

Teaching the zero position (in the *Xpress* mode)

Instruction:

a) Place the measurement object at the desired position for the zero position.

b) Keep the Teach button pressed for 2 seconds.

✓ Green LED blinks with 2 Hz.

Result:

✓ Teach-In ok: Sensor goes back to the operating mode.

✓ Teach-in not OK: Green and yellow LEDs blink simultaneously with 8 Hz.

Modbus RTU command – holding register: teach button

Address 411 – Teach Lock:

Address	Access	Number of registers	Data type	Description
411	Read/write	1	uint8_t	Time until the Teach button is deactivated: ▪ Minimal – Teach button is continuously active: 0 ▪ Maximal – Teach button is continuously inactive: 0xFF

Address 412 – Teach Pattern:

Address	Access	Number of registers	Data type	Description
412	Read/write	1	uint8_t	Parameterize mode of the teach button: ▪ 0 = *Xpert* ▪ 1 = *Xpress*

Also see about this

Teach button [▶ 11]

8.12 Switching the laser on and off

INFO

The laser continues to flash very weakly when switched off. This keeps the laser element at operating temperature so that it is fully functional when it is switched on again.

The laser can be switched on and off again, for example, for maintenance of the system.

Modbus RTU command – holding register: laser

Address 410 – Laser On/Off:

Address	Access	Number of registers	Data type	Description
410	Read/write	1	uint16_t	Status of the laser: ▪ 0 = off ▪ 1 = on

8.13 Resetting the sensor

The sensor can be reset to the factory settings (see *Factory settings [▶ 21]*).

Modbus RTU command – holding register: factory reset

Address 503 – Sensor Reset:

Address	Access	Number of registers	Data type	Description
503	Write	1	x	Reset the sensor to the factory settings: Call up the function by writing any number.

8.14 Individual sensor identification

You have the option of giving the sensor various individual identifiers in order to uniquely identify the sensor. An identification of the sensor can be stored in relation to the application, the function, or the place of use as well.

Modbus RTU command – holding register: identification

Address 1050 – App Specific Tag:

Address	Access	Number of registers	Data type	Description
1050	Read/write	16	STRING[]	Enter use of the sensor.

Address 1066 – Function Specific Tag:

Address	Access	Number of registers	Data type	Description
1066	Read/write	16	STRING[]	Enter function of the sensor.

Address 1082 – Location Tag:

Address	Access	Number of registers	Data type	Description
1082	Read/write	16	STRING[]	Enter location of the sensor.

9 Diagnostic data

The diagnostic data is used for monitoring the status of the device. You can monitor both the momentary status (via parameters) as well as the development over time (via a histogram function). You have the option of resetting diagnostic data.

Modbus RTU command – holding register: reset all statistics

Address 1000 – Reset All Statistics:

Address	Access	Number of registers	Data type	Description
1000	Write	1	x	Reset statistical data (operating time, histograms): Call up the function by writing any number.

9.1 Operating time

The operating time of the sensor is permanently recorded. 3 different time periods are available:

- Operating time since the last power up
- Operating time since an individually configurable point in time (by reset)
- Operating time since the initial power up

Modbus RTU command – input register: operating time

Address 301 – Operation Time: Powerup

Address	Access	Number of registers	Data type	Description
301	Read	2	uint32_t	Operating time since power up of the sensor.

Address 303 – Operation Time: Resetable

Address	Access	Number of registers	Data type	Description
303	Read	2	uint32_t	Operating time since a defined point in time.

Address 305 – Operation Time: Lifetime

Address	Access	Number of registers	Data type	Description
305	Read	2	uint32_t	Total operating time

Modbus RTU command – holding register: operating time

Address 1001 – Reset Operation Time

Address	Access	Number of registers	Data type	Description
1001	Write	1	x	Reset operating times: Call up the function by writing any number.

9.2 Histogram function

The histogram function counts the appearance of values within defined intervals (bins). The number of values refers to the followings key data:

- Distance
- Exposure reserve

Distance

With each cycle, a measured value (distance) is recorded. The following information is available:

- Unit
- Start of valid range
- End of valid range
- Number of intervals/bins

Example:
Measurement range of the sensor: 50 - 550 mm:

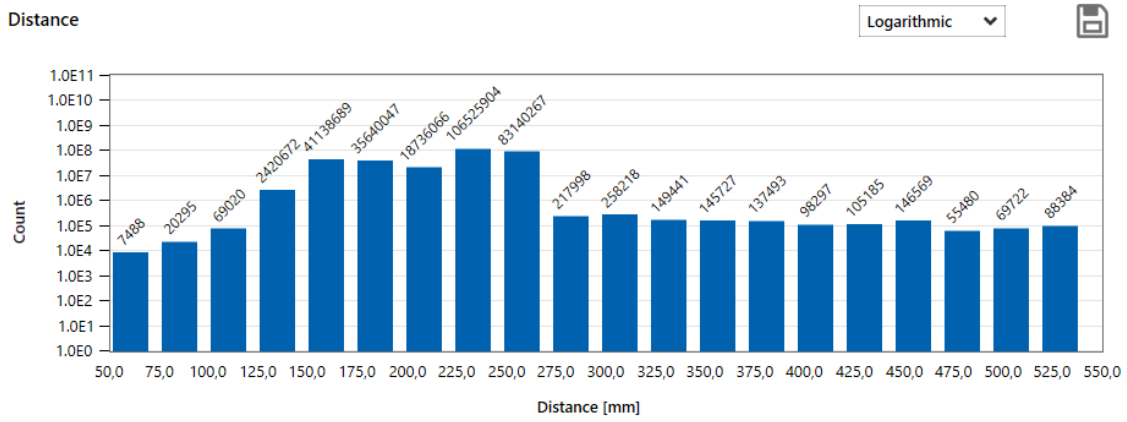
- Unit: mm
- Start of valid range: 50 mm
- End of valid range: 550 mm
- Number of intervals/bins: 20

This yields:
Interval/bin covers the following range: (550 mm - 50 mm)/20 = 25 mm

If the sensor records the value 76 mm 5 times and the value 162 mm 15 times in 20 measurements, the following distribution results:

Bin	Value range min.	Value range max.	Number of measurements
Bin 1	50 mm	< 75 mm	0
Bin 2	75 mm	< 100 mm	5
Bin 3	100 mm	< 125 mm	0
Bin 4	125 mm	< 150 mm	0
Bin 5	150 mm	< 175 mm	15
...	...	...	...

Example of a recorded distance histogram:



Modbus RTU command – input register: histogram function distance

Address 307 – Histogram Distance: Unit

Address	Access	Number of registers	Data type	Description
307	Read	1	STRING[]	Unit of the histogram (distance)

Address 308 – Histogram Distance: Range Start

Address	Access	Number of registers	Data type	Description
308	Read	2	int32_t	Start of valid range

Address 310 – Histogramm Distance: Range End

Address	Access	Number of registers	Data type	Description
310	Read	2	int32_t	End of valid range

Address 312 – Histogramm Distance: Number of Bins

Address	Access	Number of registers	Data type	Description
312	Read	1	uint16_t	Number of bins

Address 313 – Histogramm Distance: Bin 1 - 20

Address	Access	Number of registers	Data type	Description
313	Read	40	uint32_t	Bins 1 - 20

Modbus RTU command – holding register: histogram function distance

Address 1002 – Reset Distance Histogramm

Address	Access	Number of registers	Data type	Description
1002	Write	1	x	Reset histogram (distance): Call up the function by writing any number.

NOTICE

Reset the histogram after the zero position has been moved (the measured distance depends on the zero position).

Exposure reserve

In each measurement, a value is recorded for the exposure reserve.

As the exposure reserve is always described by a fixed value range, the following information has a fixed value:

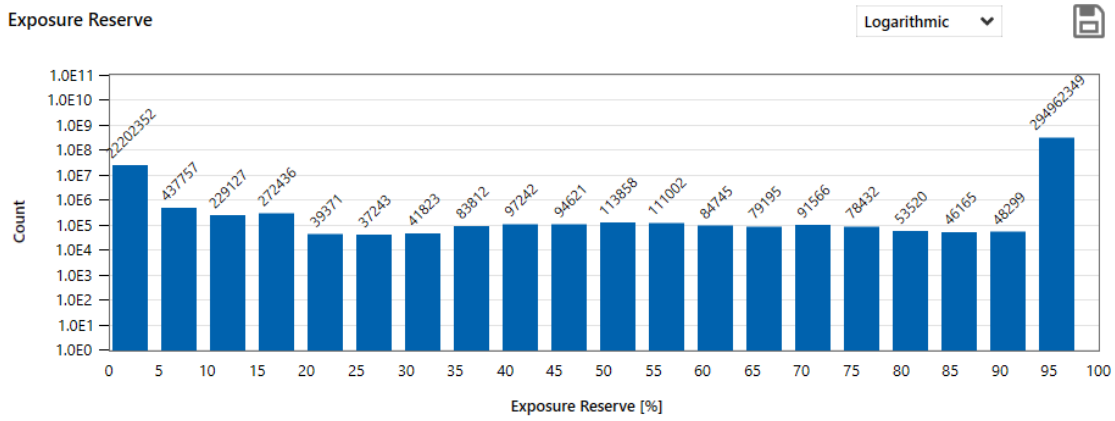
- Start of valid range: 0
- End of valid range: 100
- Number of intervals/bins: 20

This yields:
1 interval covers a value range of 5.

Example:
The object to be measured is outside the measurement range for 5 measurements. Therefore, the sensor records an exposure reserve of 0. This results in the following distribution:

Bin	Value range min.	Value range max.	Number of measurements
Bin 1	0	< 5	5
Bin 2	5	< 10	0
Bin 3	10	< 15	0
Bin 4	15	< 20	0
Bin 5	20	< 25	0
...	...	...	...

Example of a recorded exposure reserve histogram:



Modbus RTU command – input register: exposure reserve histogram function

Address 353 – Histogramm Exposure Reserve: Range Start

Address	Access	Number of registers	Data type	Description
353	Read	2	uint32_t	Start of valid range

Address 355 – Histogramm Exposure Reserve: Range End

Address	Access	Number of registers	Data type	Description
355	Read	2	uint32_t	End of valid range

Address 357 – Histogramm Exposure Reserve: Number of Bins

Address	Access	Number of registers	Data type	Description
357	Read	1	uint16_t	Number of bins

Address 359 – Histogramm Exposure Reserve: Bin 1 - 20

Address	Access	Number of registers	Data type	Description
359	Read	40	uint32_t	Bin 1 - 20

Modbus RTU command – holding register: exposure reserve histogram function

Address 1003 – Reset Exposure Reserve Histrogramm

Address	Access	Number of registers	Data type	Description
1003	Write	1	x	Reset the histogram (exposure reserve): Call up the function by writing any number.

9.3 Device information

You have the option of reading out various device information.

Have the following information ready for service cases:

- Product ID
- Serial number
- Firmware version
- Production code

Modbus RTU command – input register: device information

Address 0 – Vendor Name:

Address	Access	Number of registers	Data type	Description
0	Read	16	STRING[]	Manufacturer

Address 16 – Vendor Text:

Address	Access	Number of registers	Data type	Description
16	Read	16	STRING[]	Manufacturer’s note

Address 32 – Product Name:

Address	Access	Number of registers	Data type	Description
32	Read	26	STRING[]	Product name

Address 58 – Product ID:

Address	Access	Number of registers	Data type	Description
58	Read	5	STRING[]	Item number

Address 63 – Device Text:

Address	Access	Number of registers	Data type	Description
63	Read	32	STRING[]	Product text

Address 95 – Serial Number:

Address	Access	Number of registers	Data type	Description
95	Read	10	STRING[]	Serial number of the sensor

Address 105 – Hardware Revision:

Address	Access	Number of registers	Data type	Description
105	Read	5	STRING[]	Hardware version of the sensor

Address 110 – Firmware Revision:

Address	Access	Number of registers	Data type	Description
110	Read	5	STRING[]	Firmware version of the sensor

Address 115 – P-Code:

Address	Access	Number of registers	Data type	Description
115	Read	6	STRING[]	Production code of the sensor

10 Preventive maintenance

The sensor is maintenance-free. No special preventive maintenance is required. Regular cleaning and regular checking of the plug connections are recommended.

10.1 Cleaning the sensor

Exterior cleaning

When cleaning the exterior of the sensor, make sure to use cleaning agents that do not affect the housing surface and seals.

NOTICE

Material damage due to improper cleaning.

Unsuitable cleaning agents and methods can cause leaks and damage the sensor, the seals, or the connections.

a) Always check the suitability of the cleaning agent for the surface to be cleaned.

b) Do not use scouring agents, solvents, or other aggressive cleaning agents.

c) Do not use jets of liquid for cleaning, for example, a high-pressure cleaner.

d) Do not scrape off contamination with sharp-edged items.

Interior cleaning

No interior cleaning of the sensor is required.

11 Troubleshooting

- *Error:*
  Sensor does not start even though the power supply is connected. The LEDs of the sensor are switched off.
- *Possible cause:*
  The power supply is interrupted. A short-circuit is present.
- *Remedy:*
  Check the electrical connection of the sensor according to the connection diagram.
- *Error:*
  No valid measured value can be recorded, the LED lights up yellow, and the laser is switched on.
- *Possible cause:*
  The measurement object is outside of the measurement range (MR). The measurement range for your sensor version can be found in the data sheet.
- *Remedy:*
  Move the measurement object into the measurement range.
- *Error:*
  The measurement results are incorrect.
- *Possible cause:*
  The direct reflection of the laser hits the receiver of the sensor. This happens especially with shiny surfaces.
- *Remedy:*
  Tilt the sensor to the side so that the direct reflection of the laser does not hit the receiver of the sensor.
- *Error:*
  The measured value shows faulty, erratic behavior.
- *Possible cause:*
  Too much ambient light enters the field of view of the sensor receiver. This leads to disturbing peaks on the receiver.
- *Remedy:*
  Reduce the ambient light (e. g. with a cover).

11.1 Return and repair

In case of complaints, please contact the relevant sales company.

11.2 Accessories

You can find accessories at the website at:

https://www.baumer.com

List of illustrations

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Passion for Sensors