Instruction manual

Laser distance sensors

PT169070 / PT169071 with IO-Link

table of contents

1 About this document

1.1 Purpose

This operating manual (hereinafter referred to as the *manual*) enables the safe and efficient use of the PT169070 and PT169071 products.

This manual does not provide instructions for the operation of the machine into which the product is integrated. For more information, please refer to the operating instructions of the machine.

The manual is an integral part of the product and must be kept in its immediate vicinity and accessible to personnel at all times.

The personnel must have carefully read and understood these instructions before starting any work. The basic prerequisite for safe working is compliance with all the 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. Deviations are always at the discretion of the manufacturer.

1.2 Warnings in these instructions

Warning notices draw attention to injuries or damage to property. The warnings in these instructions are marked with different danger levels:

Symbol	Warning word	Explanation
	**DANGER**	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
	WARNING	Indicates a possible hazard with medium risk, which can have death or (severe) bodily injury if not avoided.
	CAUTION	Indicates a low-risk hazard which, if not avoided, could result in minor or moderate injury.
	NOTE	Indicates a warning of property damage.
	**INFO**	Identifies practical information and tips that provide a enable optimal use of the devices.

1.3 Markings in this manual

Award elements

The following markup elements can be found in this guide:

Award	Usage	Example
Dialog element	Indicates dialog elements.	click the button ***OK***.
Proper name	Identifies names of products, files, etc.	*Internet Explorer* is not supported in any version.
`Code`	Indicates input.	Enter the following IP address: `192.168.0.250`

1.4 Limitation of liability

All information and notes in these instructions have been compiled taking into account the applicable standards and regulations, the state of the art and our many years of knowledge and experience.

The manufacturer assumes no liability for damage due to the following:

- Failure to follow the instructions
- Use contrary to the intended purpose
- Use of unqualified personnel
- Unauthorized modifications

The obligations agreed in the delivery contract, the General Terms and Conditions and the delivery conditions of the manufacturer and its suppliers and the legal regulations valid at the time of the conclusion of the contract shall apply.

1.5 Scope of delivery

Included in the scope of delivery:

- 1 x sensor
- 1 x quick reference guide

In addition, the following accompanying material is available in digital form at www.ipf.de:

- Instruction manual
- Data sheet
- 3D CAD drawing
- Quick guide
- dimensional drawing
- Wiring diagram & pin configuration
- IODD file
- Certificates (EU declaration of conformity, etc.)

2 Security

2.1 Requirements for the personnel

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

Qualified personnel are personnel who, due to their training and activities, as well as a reliable understanding of safety issues, can assess the work assigned to them and recognize possible hazards.

A distinction is made between the following personnel qualifications:

- **Instructed Personnel:**
  A person who has been instructed and, if necessary, trained by a specialist via the tasks assigned to him/her and possible dangers in case of improper behavior.
- **Specialist:**
  A person who, on the basis of his or her training, experience and instruction, as well as knowledge via relevant standards, regulations and accident prevention rules, has been authorized to perform the respective required versions and can recognize and avoid possible hazards.
- **Electrician:**
  A person with appropriate professional training, knowledge, and experience so that he or she can recognize and avoid hazards that may be posed by electricity.

2.2 General notes

Intended use

This product is a precision device and is used for the detection of objects, objects or physical measured values as well as the preparation or provision of measured values as an electrical quantity for the higher-level system.

Unless this product is specially marked, it must not be used for operation in an explosive environment.

start-up

Installation, assembly and adjustment of this product may only be carried out by a specialist.

Mounting

For mounting, use only the fasteners and mounting accessories provided for this product. Unused outputs must not be wired. For cable versions with unused cores, these must be insulated. Do not exceed the permissible cable bending radii. Before the electrical connection of the product, the system must be disconnected from the power supply. If specified, shielded cables must be used to protect against electromagnetic interference. If the customer assembles plug connections to shielded cables, plug connections in EMC version should be used and the cable shield must be connected to the plug housing over a large area.

Disposal (environmental protection)

Used electrical and electronic equipment must not be disposed of with household waste. The product contains valuable raw materials that can be recycled. Therefore, dispose of this product at the appropriate collection depot. For more information, see www.ipf.de.

2.3 Laser

CLASS 1 LASER PRODUCT

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

The PT169070 and PT169071 products are specified according to laser protection class 1.

3 Description

3.1 Structure

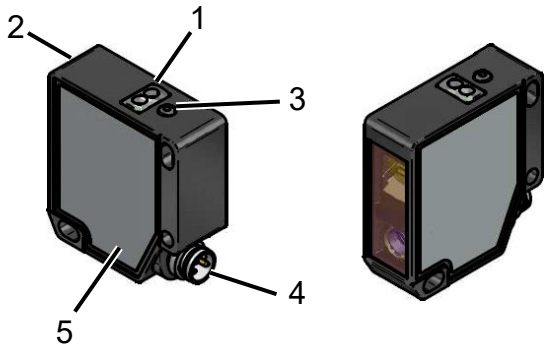


Fig. 1: Structure

1	Sensor LEDs	2	front screen
3	Teach button	4	Connector, M8 4-pin
5	Nameplate		

3.2 General operation

The sensor measures the distance to a measurement object by calculating the angle (triangulation principle). For this purpose, the sensor projects a laser spot onto the target. The surface of the measuring object reflects the impinging radiation into the receiver of the sensor. By evaluating this radiation, the distance between the sensor and the target can be determined. The measured distance is provided as a measured value via the following channels integrated in the sensor:

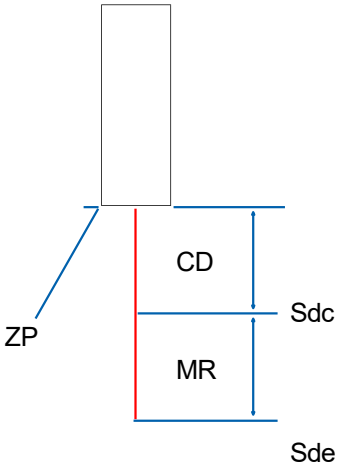
- digital IO-Link interface
- analog output

The following options are available for parameterizing the sensor:

- IO-Link parameters
- Teach button on the sensor

3.3 Measuring field

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



ZP point	Zero	CD	Blind range
Sdc	Lower range value	MR	Measuring
range Sde	End of measuring range		

Blind range (CD)

- Range in which the sensor cannot detect any targets.
- Unwanted objects (objects not to be measured) in this range can lead to deviations in the measurement results.

Measuring range (MR)

- Range in which the target must be located for the sensor to provide reliable measurement results.
- Unwanted objects (objects not to be measured) in this range can lead to deviations in the measurement results.
- The limits of the measuring range (MR) are defined via the parameters *Measuring range start (Sdc)* and *Measuring range end (Sde).*

Zero point (ZP)

- Reference point for measuring the distance (relative measurement).
- The zero point is on the sensor front. The distance between the sensor front and the target is output.
- Factory setting: ZP = `0 mm`
- Basis for:
  - Measured values output
  - Analog value
  - Switching points
- Can be parameterized via:
  - IO-Link
  - Teach button

3.4 Operating and display elements

3.4.1 Sensor LEDs

Ref.	Lights up	Flashing
POWER	GreenSensor ready for operation	-
OUTPUT	YellowNo valid signal within the Measuring range	Critical signal quality

In the factory settings, the ***OUTPUT*** (pin 4) and thus also the yellow LED follow the function of the alarm output. Alternatively, you can select the function of the switching output for the ***OUTPUT*** and the yellow LED.

3.4.2 Teach button

As an alternative to setting the sensor parameters via IO-Link, you can set the sensor via the Te- ach button. Adjustable parameters:

- Analog measuring field
- Zero point
- Reset sensor to factory settings

INFO

Via IO-Link, you also have the option of setting the mode of the teach button. You can choose between the *Xpert* (factory settings) and *Xpress* modes. For more information, see Function *of the teach button* [► *36].*

The teach button is automatically deactivated after 5min (timeout can be parameterized via IO-Link). If the teach button is held down for longer than 12s, the sensor switches to operational mode without performing a parameterization.

The parameterization via the teach button is carried out according to the procedure described below.

Teach analog measuring field

Procedure:

a) Briefly press the Teach button.
   ✓ Green and yellow LEDs light up (teach button is active). If the LEDs do not light up, restart the sensor.

b) Press and hold the teach button for 4s.
   ✓ Yellow LED flashes with 2Hz.

c) Place the target at position 1 (P1) and briefly press the teach button in- ner 60s.
   ✓ The min. limit of the analog measuring range is taught-in (distance at which 4mA are displayed).

d) Place the target on P2 and briefly press the Teach button within 60s.
   ✓ The max. limit of the analog measuring range is taught-in (distance, at which 20mA are displayed).

Result:

✓ Teach-in ok: Green and yellow LED light up briefly. The sensor then returns to operational mode.

✓ Teach-in not ok: Green and yellow LEDs flash simultaneously at 8Hz.

NOTE

The characteristic curve of the analog output can be inverted by the teaching process (negative slope). To do this, teach the maximum distance for P1 and the minimum distance for P2.

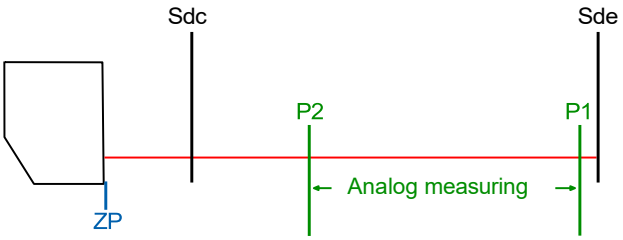


Fig. 2: Analog measuring field (inverted)

Teach zero point

Procedure:

a) Briefly press the Teach button.
   ✓ Green and yellow LEDs light up (teach button is active). If the LEDs do not light up, restart the sensor.

b) Press and hold the teach button for 2s.
   ✓ Green LED flashes at 2Hz.

c) Place the target at the desired position for the zero point and press the teach button briefly within 60s.

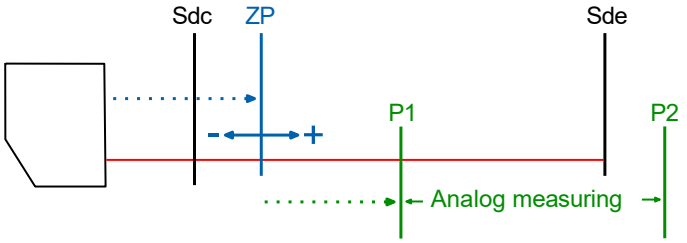
Result:

✓ Teach-in ok: Green and yellow LED light up briefly. The sensor then returns to operational mode.

✓ Teach-in not ok: Green and yellow LEDs flash simultaneously at 8Hz.

After shifting the zero point

- the digital measured values before the zero point (in the direction of the sensor) are output as negative measured values after the zero point as positive measured values.
- the limits of the analog measuring field have shifted. Therefore, parameterize the analog measuring field again.



Reset to factory settings

Procedure:

a) Briefly press the Teach button.
   ✓ Green and yellow LEDs light up (teach button is active). If the LEDs do not light up, restart the sensor.

b) Press and hold the Teach button for 8s.
   ✓ Yellow and green LEDs flash simultaneously at 2Hz.

Result:

✓ Teach-in ok: Green and yellow LEDs light up briefly. The sensor then returns to operational mode.

✓ Teach-in not ok: Yellow and green LEDs flash simultaneously at 8Hz.

3.5 IO-Link

IO-Link distinguishes between the following types of data:

- Process data
- Parameter
- Diagnostic data

Process data

Process data is cyclic data and is transferred in IO-Link communication mode with each query cycle. An explicit inquiry of the data is not necessary. The following process data is available for the sensor:

- Output:
  - Laser on/off
  - Find me (localization of the sensor by activating the LEDs)
- Input:
  - Status of the switching output
  - Signal quality status
  - Alarm output status
  - Scale of the measured value
  - measured value

IO-Link process data: Output

Name Process Date	Description
Bit 0: Laser ON/ OFF	Switch laser on/off.
Bit 1: Find me	Localization of the sensor by activating the LEDs.

IO-Link process data: Input

Name Process Date	Description
Bit 0: SSC1 (Switching Signal Channel 1)	▪ Status of the switching output. • Bit 0 = 0: Switching output is inactive. • Bit 0 = 1: Switching output is active.
Bit 2: Quality	Status of the signal quality. • Bit 1 = 0: Signal quality is sufficient for a valid measurement. • Bit 1 = 1: Signal quality is insufficient. The sensor must be checked (e.g. for soiling).
Bit 3: Alarm	Status of the alarm output • Bit 2 = 0: Alarm is inactive. Sensor is functioning properly. • Bit 2 = 1: Alarm is active. The sensor must be checked. No measured value can be recorded.
Bit 8 to 15: Scale	Scale of the measured value ▪ The transmitted scale value corresponds to the exponent of 10 (i.e.: 10).^{Scale} ▪ Formula for calculation of the measured value: • Measurement value (MDC^{I}) × 10^{Scale} × Unit

Name Process Date	Description
	▪ Example: • Measurement value (MDC): 1000 • Scale: -6 • Unit: m • So: 1000 × 10^{-6} × m = 1000 µm
Bit 16 to 47: Measurement value (MDC)	▪ measured value

I MDC = Measurement Data Channel

Parameter

Parameters are acyclic data (transmission takes place on demand). The following parameters are available for the sensor:

- Filter for smoothing the signal characteristics
- Trigger for recording the measured value
- Processing invalid measured values
- Switching points
- Polarity (output level switching output)
- hysteresis
- Zero point
- Limits of the measuring range
- Limits of the analog measuring field
- Output & LED (alarm/switching output)
- Configuration teach button

Diagnostic data

The diagnostic data is used to monitor the status of the device. The following diagnostic data is available for the sensor:

- Measurement rate
- Response delay
- Exposure reserve
- Signal quality
- Device status
- Operating time
- Histogram function

For a detailed description of the IO-Link functions, go to *Functions* [► *22]*. For a description of the diagnostic data, go to *Diagnostic data* [► *37].*

3.6 Dimensional drawing

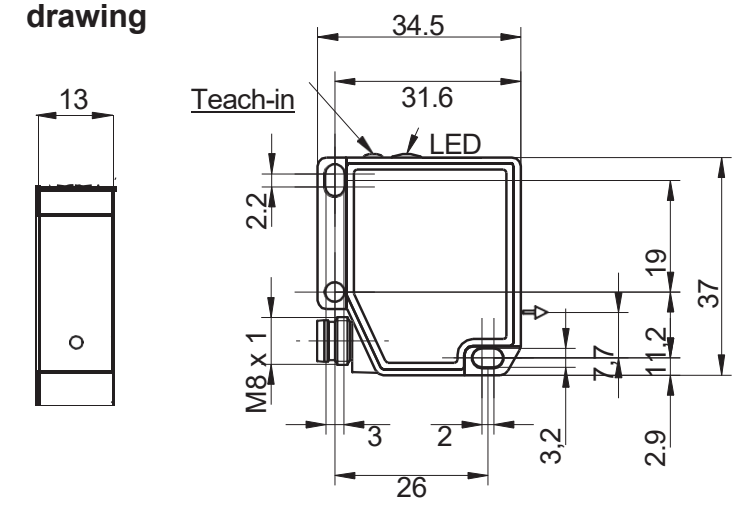


Fig. 3: Dimensional drawing

4 Transport and storage

4.1 Transportation

NOTE

Material damage in case of improper transport.

a) Exercise the utmost care when unloading the transport pieces as well as when transporting them within the company.

b) Observe the notes and symbols on the packaging.

c) Do not remove packaging until immediately before assembly.

4.2 Transport inspection

Check the delivery for completeness and transport damage immediately upon receipt.

Complain about any defect as soon as it is recognized. Claims for damages can only be asserted within the applicable complaint periods.

Proceed as follows in the event of externally visible transport damage:

Procedure:

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

b) Note the extent of damage on the transport documents or on the carrier's delivery bill.

c) Initiate the complaint procedure.

4.3 Storage

Store the product under the following conditions:

- Do not store outdoors.
- Store in a dry and dust-free place.
- Do not expose to aggressive media.
- Protect from sunlight.
- Avoid mechanical shock.
- Storage temperature: -10 ... +60 °C
- Ambient air humidity: 20 ... 85 %
- In case of storage longer than 3 months, regularly check the general status of all parts and packaging.

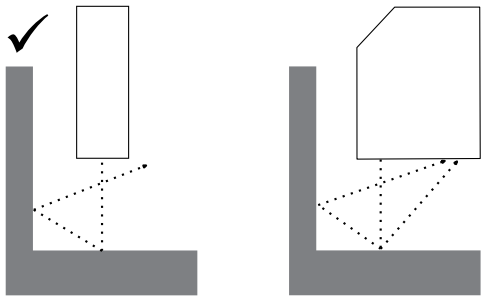
5 Assembly instructions

INFO

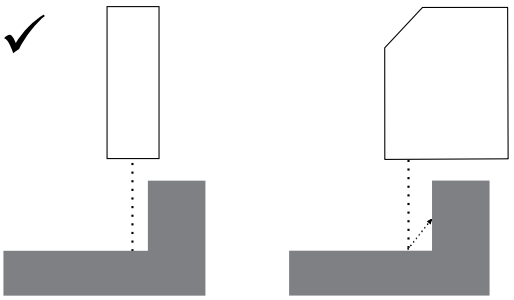
Suitable mounting accessories can be found on the ipf website. To do this, go to www.ipf.de. Then enter the article number of the transducer in the search field on the website.

- For measurement objects with shiny surfaces: Tilt the sensor 6 to 10° to the side so that the light reflected directly from the surface does not hit the sensor's receiver.
- Use at least 1 toothed lock washer for mounting to break open the paint layer of the sensor.

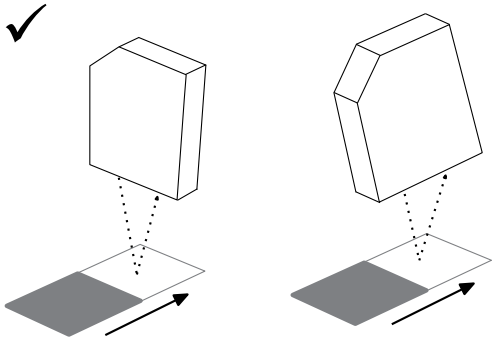
	PT16907x
Screws:	2 × M3
Tightening torque:	0. 6 Nm ±10 %



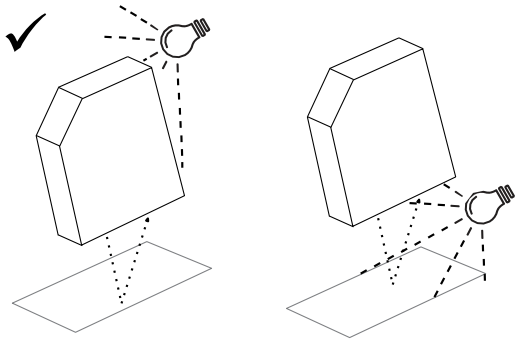
Mounting the sensor near a wall or a machine component:
Mount the sensor parallel to the wall to avoid disturbing reflections.



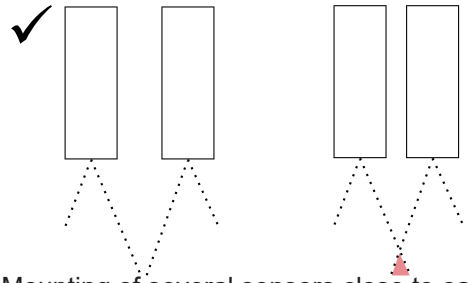
Measurement objects with height differences/measurements in holes or crevices:
Mount the sensor so that the receiving beam is not interrupted by the step.



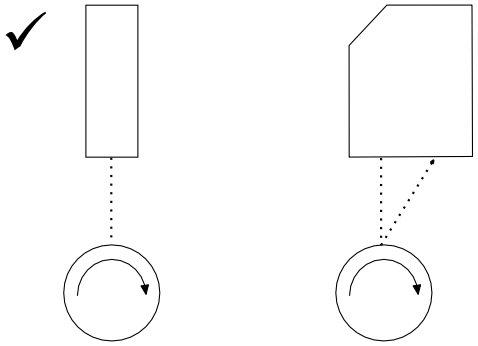
Mounting on targets with colored edges/with different surface reflectivity: Align the sensor parallel to the colored edge to avoid measured value errors.



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



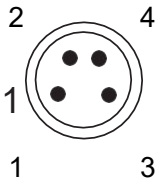
Mounting of several sensors close to each other:
Avoid overlapping the detection ranges of the receivers. Only your own laser spot may be within the detection range of the receiver.



Mounting for round measuring objects:
Align the sensor in one axis with the target to avoid reflections.

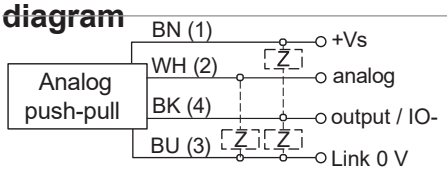
6 Electrical installation

6.1 Pin configuration



1	+Vs
2	analog
3	0 V
	4output / IO-Link

6.2 Wiring diagram



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

6.3 Connect sensor electrically

Procedure:

a) Ensure that there is no voltage.

b) Connect the sensor according to the pin configuration.

7 Start-up

7.1 Factory settings

Adjustable parameters		Factory settings on sensor
Operation Mode	Precision Filter	Highest
	Sampling Mode	Free Running
Measurement Range	Zero Position	0 mm
	Distance Near	Sdc
	Distance Far	Sde
Invalid Value Handling	Value after Dropout	Near
	Hold Time	0 ms
SSC1 Configuration	SP 1	Sde -10 mm[I]
	SP 2	Sdc +10 mm [II]
	Polarity	Active High
	Fashion	Window
	Hysteresis	*depending on MR*
Input/Output Settings	OUT1 Mode (Output & LED function)	SSC1 - Alarm
Analog output	Output Type	4 ... 20 mA
	Output Characteristic	Not inverted
	Distance @AnalogMin	Sdc
	Distance @AnalogMax	Sde
Local User Interface	Local Teach Mode	XPert
	Button Time Out	5 min
Device Access Locks	Data Storage Lock	False

[I] Type PT169070: SSC1 Param.SP 1 = -2 mm
[II] Type PT169070: SSC1 Param.SP 2 = +2 mm

7.2 Set up IO-Link

Procedure:

- Download the IODD file for the sensor from one of the two following websites (IODD file can be found via the part number of the sensor): www.ipf.de
  or
  ioddfinder.io-link.com

8 Functions

8.1 Filter

The *Filter* function can be used to reduce noise and increase repeatability.

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

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

General

The response and decay times are increased; moving objects can thus be detected with a delay. The precision filter calculates the results on a sliding basis. The oldest measured value is removed as soon as a new measured value is added. Therefore, the measurement frequency is not affected by the precision filter.

Filter *Moving Median*

This filter enables the suppression of individual measurement errors by calculating the median of a specified number of measured values from a series of numbers. The median is the measured value that lies exactly "in the middle" when sorting the measured values by size.

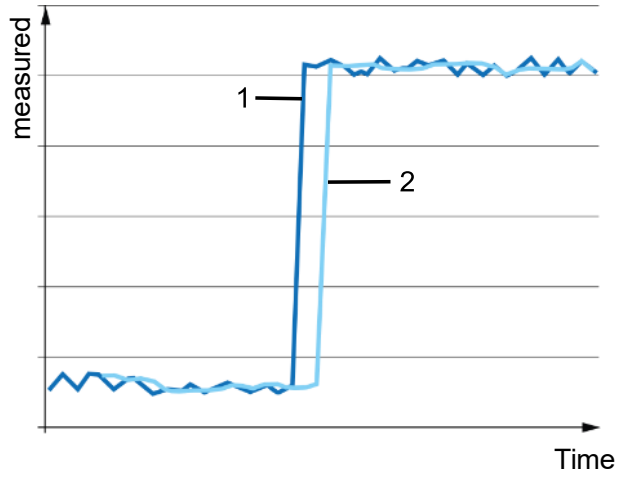


Fig. 4: Filter *Moving Median*

1	Raw data	2	Data after filtering with Moving Median

Filter *Moving Average*

This filter smoothes the signal course with the help of an average calculation of a fixed number of measured values from a numerical series. A change in distance becomes visible as a result of the average calculation.

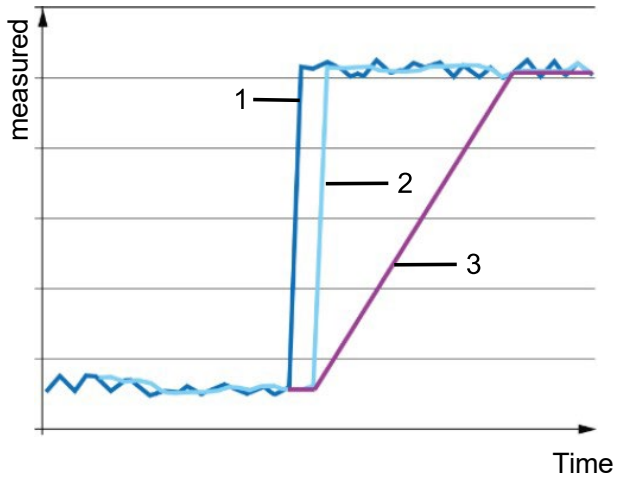


Fig. 5: Filter Moving Average

1	Raw data	2Data after filtering with Moving Median
	3Data 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 at the output after a delay.

Option 1: Select required filter length from predefined filter lengths

The following selections are available:

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

Option 2: Enter 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 for applications without dynamic distance changes, e.g. checking the position of an object, a higher filter length can lead to a better performance of the sensor. You can set the length of the *Moving Average* and *Moving Median* filters after you have selected the *Cu- stom* filter.

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

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.

INFO

When calculating several sensors, for example for a thickness measurement, the *Standard* filter should generally be selected in order to obtain an unprocessed measured value of both sensors for further calculation.

IO-Link parameters: *Filter* operational mode

Parameter name	Values	description
Operation Mode.Precision Filter	`Standard`, `High`, `Very High`, `Highest`, `Custom`	· Choice between predefined filters (number of measured values per filter). · `Custom`: Filter length as numerical value on give.
MovAvgFilter.Custom Moving Average Length	-	· Freely adjustable filter length for Moving *Average*.
MovMedianFilter.Custom Moving Median Length	-	· Freely adjustable filter length for Moving *Median*.

8.2 Trigger mode

The *trigger mode* function actuates the recording of the measured values and thus also the measuring frequency. Via the parameter settings you can choose between the trigger modes *Free Running* and *Interval.*

Trigger mode *Free Running*

- The sensor measures continuously and with maximum possible measurement frequency.
- The maximum measurement frequency varies depending on the properties of the target (or the exposure time). Example: With dark measurement objects (longer exposure time), a lower measurement frequency is achieved than with bright measurement objects.
- The maximum measurement frequency is independent of selected filter settings, since measurement and processing of the data run in parallel.
- Purpose/Application: The *Free Running* trigger mode can be used in most applications (factory settings). Recording the measurement results as quickly as possible ensures a larger amount of data.

Trigger mode *Interval*

- The sensor measures with a constant time interval (adjustable in µs).
- Observe the maximum possible measurement frequency also in *Interval* mode. If the maximal possible measurement frequency is overrun, it can lead to a deterioration of the performance. That is:
  - Test the maximum possible measurement frequency in *Free Running* mode.
  - Calculate the minimum time interval as follows:
    min. Time interval = 1/max. measurement frequency
- Purpose/Application: Used in dynamic applications (e.g. measurement objects on an assembly line) to detect all measurement objects.

IO-Link parameters: *Sampling mode (trigger)* operational mode

Parameter name	Values	Description
OperationMode.Sampling Mode	`Free Running, Interval`	· Trigger mode
OperationMode.Sampling Time	-	· Time interval for trigger mode ***Interval***

8.3 Zero point

The *Zero point* function allows you to set the position of the zero point. This position is the reference point for distance measurement (from the front of the sensor housing; ne- gative values are not permitted). The function can be used to perform e.g. reference measurements (relative measurement).

The zero point position is the basis for the output distance, the analog value (unchanged scaling) and the switching points. When shifting the zero point position, the analog window and the switching points are also shifted automatically, since the numerically configured values are retained.

IO-Link parameters: Zero point

Parameter name	Values	description
Zero Position.Zero Position	-	· Zero point
ipf Commands - Zero Position Teach	-	· Teach current position as new zero point.

8.4 Measuring range

The purpose of the *measuring range* function is to exclude unwanted objects from the measurement (e.g. transparent materials within the measuring range). For this purpose, you can set the limits of the measuring range within the maximum limitation of the sensor (MR).

- The Near limit of the measuring range must be greater than the minimum limitation of the sensor (Sdc).
- The far limit of the measuring range must be smaller than the maximum limitation of the sensor (Sde).

The alarm output is active as soon as there is no measuring object within the measuring range or the signal quality is insufficient.

IO-Link parameters: Measuring range

Parameter name	Values	description
Measurement Range. Distance Near	-	· Near limit of measuring range
Measurement Range. Distance Far	-	· Far limit of the measuring range

8.5 Processing invalid measured values

The function *Processing invalid measured values* defines the behavior of the sensor when the sensor records an invalid measured value. The function can be used, e.g. in a dynamic application, to hide recurring reflections from machine components or reflections from the measured object. Invalid measured values occur when

- there is no object in the measuring range (MR) or
- the signal is too weak due to reflections or undetectable objects.

The function is adjustable via the following parameters:

- Set status of analog output in case of invalid measured value. Possible options:
  - Analog output holds the last valid measured value.
  - Analog output holds the min. output point.
  - Analog output holds the max. output point.
- Time span (Hold Time), how long an invalid measured value is to be suppressed. The time span is used to hide invalid measured values at the outputs. The output (digital or analog output) is only set after the time span has elapsed.

Processing invalid measured values - Example 1

- Parameters:
  - Type of processing invalid measured values: *min. output point*
  - Time span (Hold Time): *1000 ms*
- Interpretation: Invalid measured values are ignored at both the digital and analog outputs. During the time span, the last valid value is held. The type of processing of invalid measured values has no influence here yet.

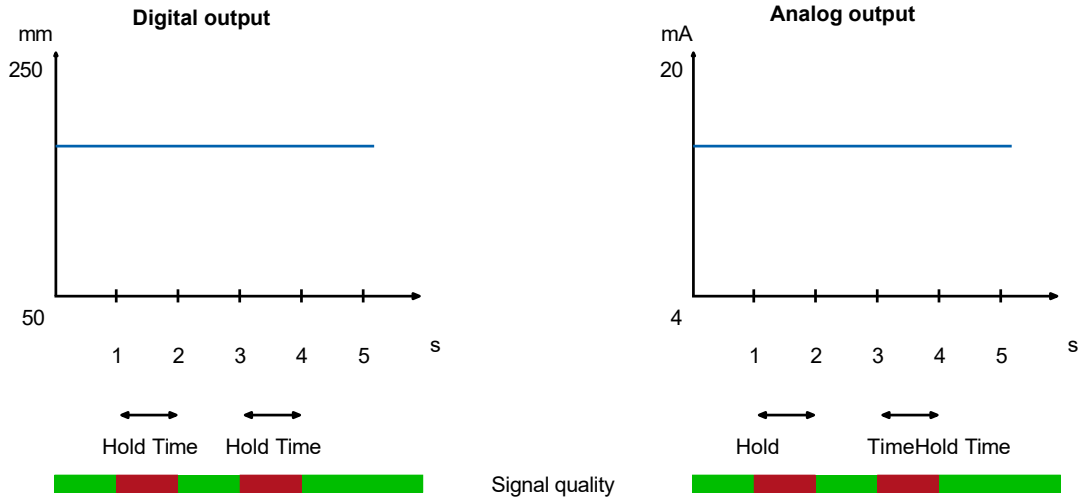


Fig. 6: Processing invalid measured values - Example 1

Processing invalid measured values - Example 2

- Parameters:
  - Type of processing invalid measured values: *min. output point*
  - Time span (Hold Time): *1000 ms*
- Interpretation: After the time period has elapsed, the placeholder for an invalid value is output on the digital output. For the analog output the type of processing of invalid measured values de-energizes and the current de-energizes to 4 mA.

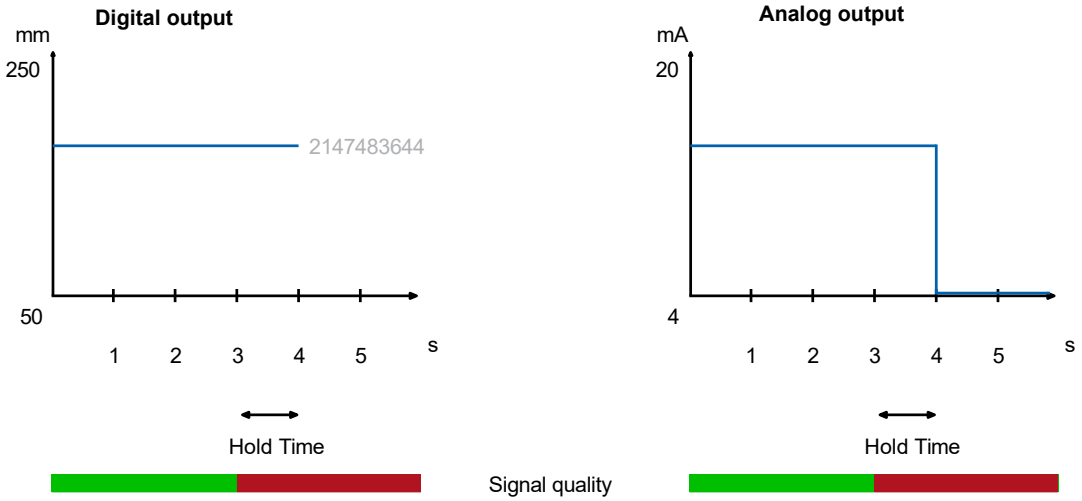


Fig. 7: Processing invalid measured values - Example 2

IO-Link parameters: Processing invalid measured values

Parameter name	Values	Description
AnalogSetting.Value after Dropout	`Load valid`, `near`, far	· Type of processing invalid measured values: ▪ `Last valid`: last valid measured value ▪ `near`: min. output point ▪ `far`: max. output point
Process Value Disruption Filter.Hold Time	-	· Time period for how long an invalid measured value is suppressed.

8.6 Switching points

Distances (*switching points)* at which the switching output is to be activated are defined via the switching points function.

The function is adjustable 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

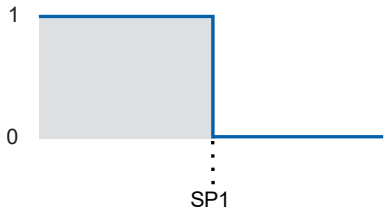


Fig. 8: Sensor in measuring mode Point mode

- Purpose/Application (Example):
  - Quality assurance: Check minimum/maximum height of a target.
  - Reach a desired position with a tool that is machining an object.

Window mode

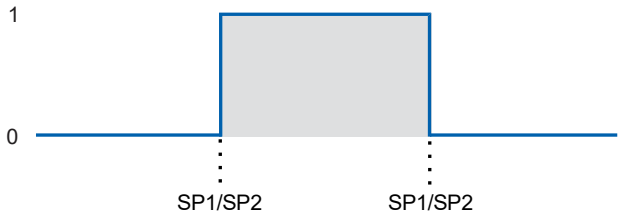


Fig. 9: Sensor in measurement mode Window mode

- The smallest switching window is 2 mm.
- Purpose/Application (Example):
  - Quality control: Check dimensions of a measured object within a tolerance window.

IO-Link parameters: Switching points

Parameter name	Values	description
SSC1 Config.Mode	`Disabled`, `Single Point`, `Window`	· Selection of the switching output mode: ▪ Point mode (switching point SP1) ▪ Window mode (SP1 and SP2)
SSC1 Param.SP1	-	· Distance at which SSC1 is set active or inactive.
SSC1 Param.SP2	-	· Distance at which SSC1 is set active or inactive. Only relevant for window mode.

8.7 Polarity

The *Polarity* function defines the behavior of the switching outputs in relation to the output level.

Via the parameterization you have the choice between *Active High* and *Active Low*.

Active High

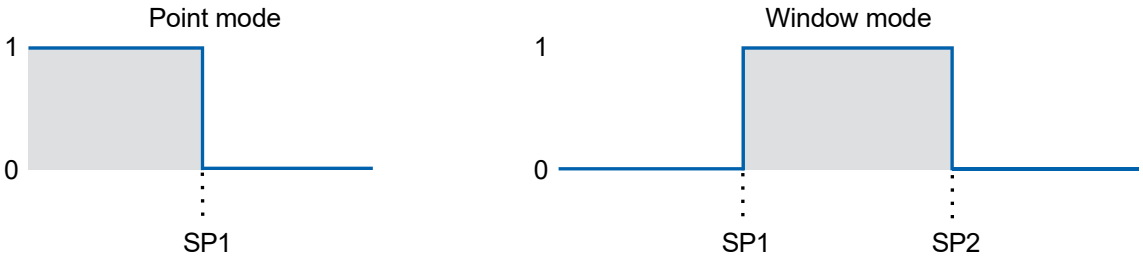


Fig. 10: Polarity - Active High

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

Active Low

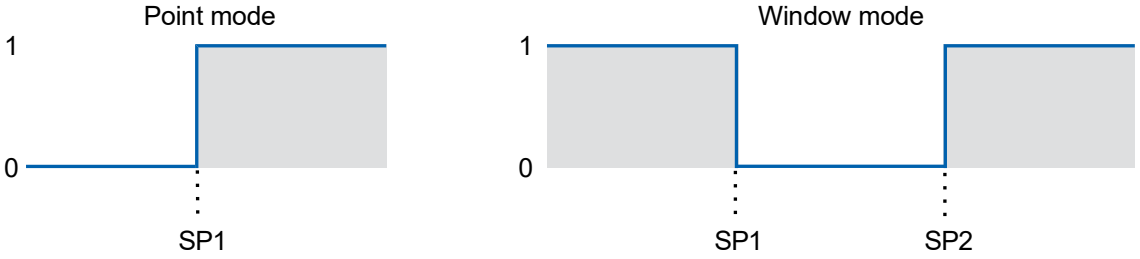


Fig. 11: Polarity - Active Low

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

IO-Link parameters: Polarity

Parameter name	Values	Description
SSC1 Config.Polarity	`Active Low`, `Active High`	Polarity of the switching output

8.8 Hysteresis

Via the function *hysteresis* you can set the difference between the switching on and switching off threshold (in mm). Without hysteresis, objects close to the switching point lead to repeated switchover of the switching output.

You can specify the hysteresis as a positive or negative value. The minimum value of the hysteresis depends on whether the hysteresis is positive or negative. In both cases, the minimum value is selected so that the distance between the switching points is equal to 0. This prevents the switching output from constantly changing its status (switching between active and inactive).

Positive hysteresis

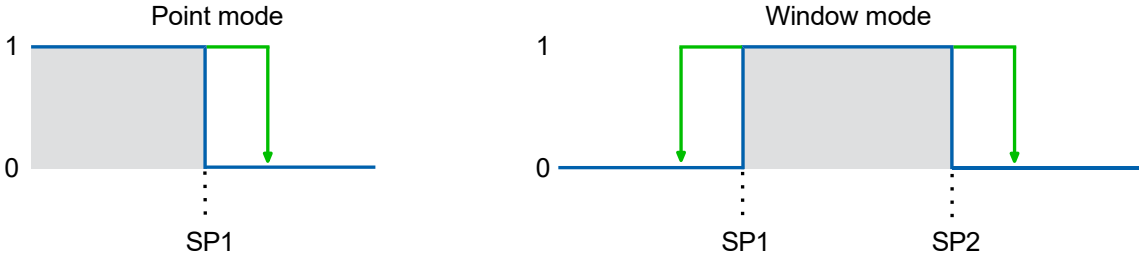


Fig. 12: Positive hysteresis

- The hysteresis is outside the switching points (window mode) or points to larger measured values (point mode). With positive hysteresis, the minimum distance between the switching points is 0.

Negative hysteresis

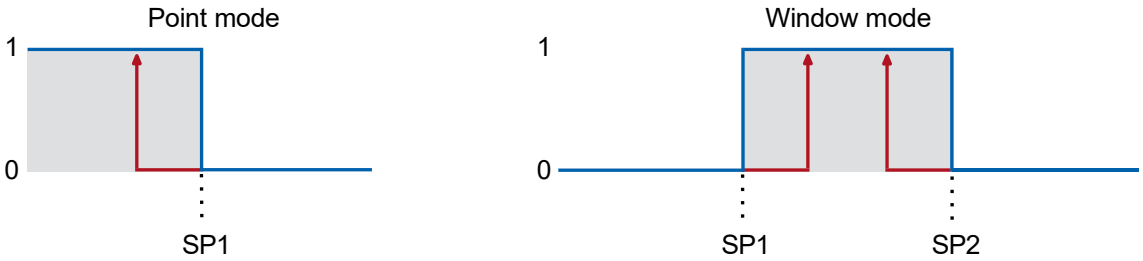


Fig. 13: Negative hysteresis

- The hysteresis is between the switching points (window mode) or points to smaller measured values (point mode).
- With negative hysteresis, the minimum distance between the switching points is twice the hysteresis.

Point mode (behavior switching output)

Positive hysteresis:

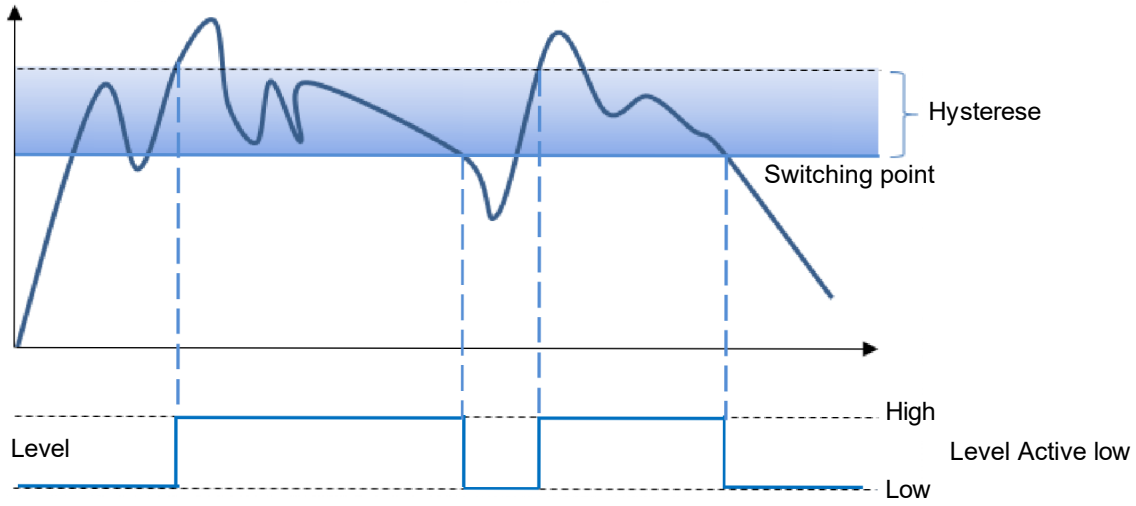


Fig. 14: Behavior of the switching output in point mode (positive hysteresis)

Negative hysteresis:

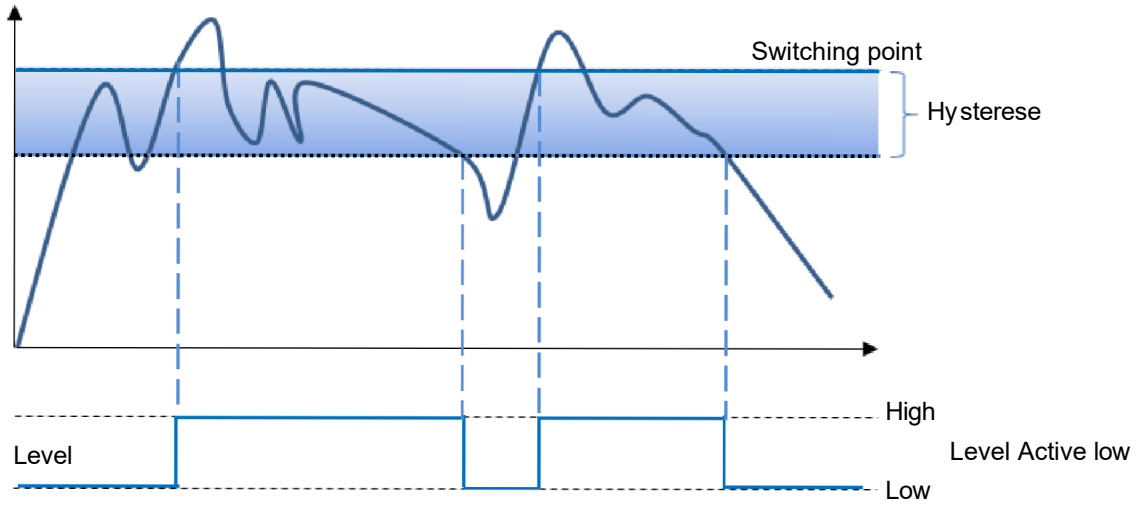


Fig. 15: Behavior of the switching output in point mode (negative hysteresis)

Window mode (behavior switching output)

Positive hysteresis:

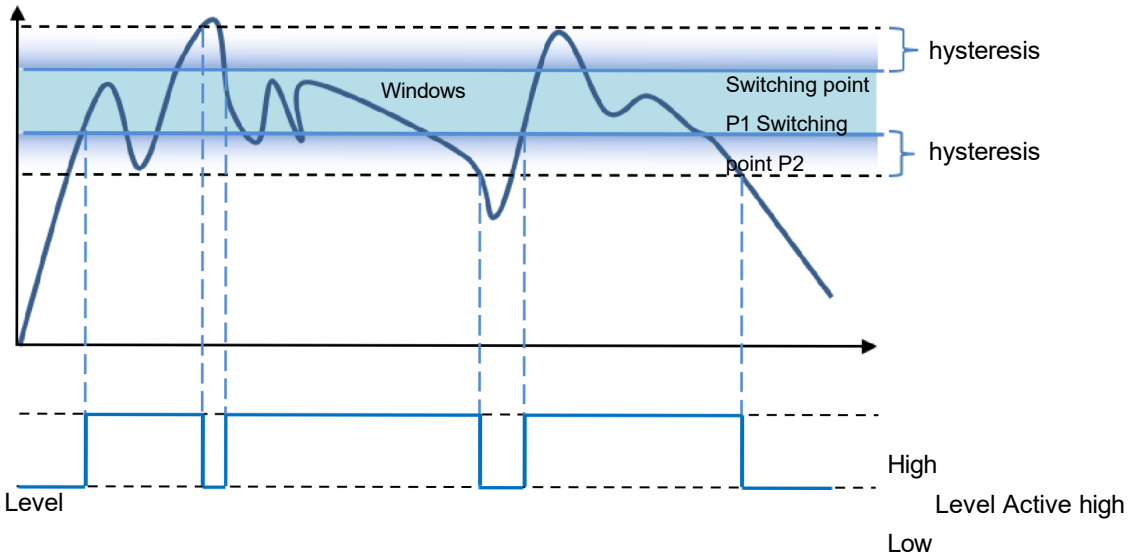


Fig. 16: Behavior of the switching output in window mode (positive hysteresis)

Negative hysteresis:

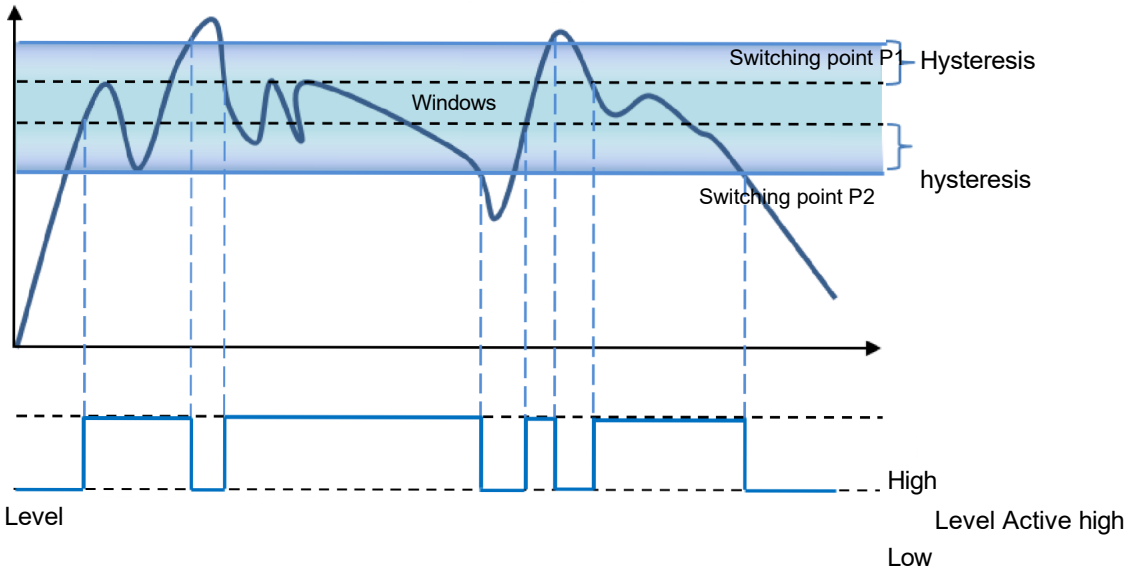


Fig. 17: Behavior of the switching output in window mode (negative hysteresis)

IO-Link parameters: Hysteresis

Parameter name	Values	description
Hysteresis.SSC1 Width	-	Enter hysteresis as a positive or negative numerical value (in mm).

8.9 Function of the output

The IO-Link communication principle can also be used as a switching output. In the factory settings, the function of the output corresponds to the alarm output. This means: The output is activated as soon as no measured value can be recorded. Via IO-Link, this can be changed to a parameterizable switching output.

IO-Link parameters: Output

Parameter name	Values	Description
DI/DO Settings.OUT 1 Mode	`SSC1 - Alarm`, `SSC1 - Switch State`	Selection of the function of the turn.

8.10 Analog measuring field

Via the function *Analog measuring field* the resolution of the analog output is defined by shifting the limits of the analog measuring field. By delimiting the analog measuring field, smaller distance changes can be displayed.

The function is adjustable via the following parameters:

- Min. limit of the analog measuring range (factory setting: `Sdc`)
- Max. Limit of the analog measuring range (factory setting: `Sde`)

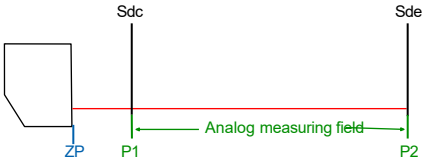


Fig. 18: Analog measuring field (factory setting)

Sdc	Lower range value	Sde	End of measuring range
P1	Min . limit of the analog measuring range	P2	Max. Limit of the analog measuring range
ZP	Zero point		

You have the option to invert the characteristic curve of the analog measuring field.

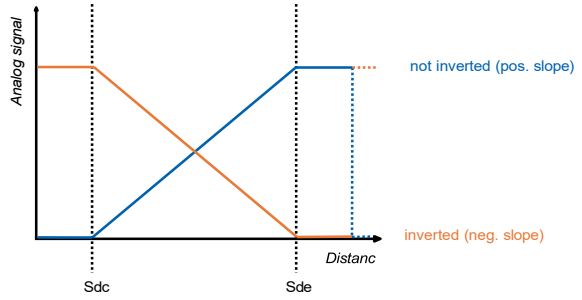
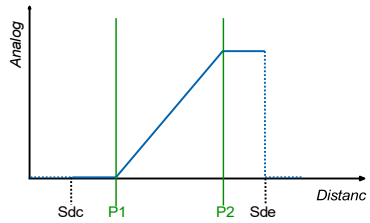


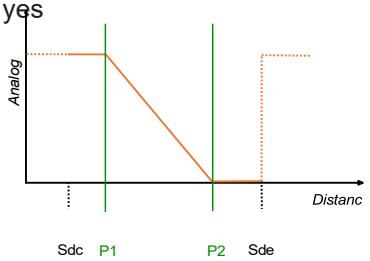
Fig. 19: Analog measuring field - Inverted

Examples of the behavior of the analog output

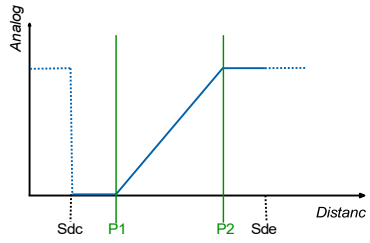
Behavior in case of invalid measured values: **close**
Characteristic curve inverted: no



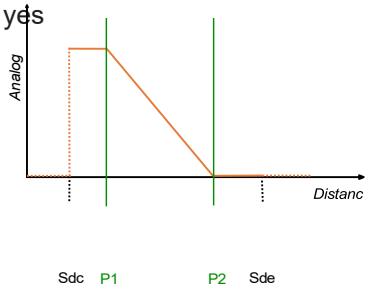
Behavior in case of invalid measured values: **close**
Characteristic curve inverted: yes



Behavior in case of invalid measured values: **remote**
Characteristic curve inverted: no



Behavior in case of invalid measured values: **remote**
Characteristic curve inverted: yes



IO-Link parameters: Analog measuring field

Parameter name	Values	Description
AnalogSetting.Output Type	`4 ... 20 mA`, `2 ... 10 mA/`	Set analog output range
Distance@Analog Min		-Min. limit of the analog measuring range Enter (in mm)
Distance@Analog Max		-Max. Limit of the analog measuring range Enter (in mm)
Output Characteristic	`Not Inverted`, `Inverted`	invert analog output
ipf Commands - Output Scale at Analog Min	-	Teach in min. limit of analog measuring range (alternative to teach button)
ipf Commands - Output Scale at Analog Max	-	Max. Teach in max. limit of analog measuring range (alternative to teach button)
ipf Commands - Output Scale is set to the possible max.	-	Set the analog measuring range to the maximum possible limits.

8.11 Function of the teach button

Via the function of the teach button (*Local User Interface*), you have the option of defining the mode of the teach button. The *Xpert* (factory setting) and *Xpress* modes are available for this purpose. The mode is selected via IO-Link.

Adjustable parameters in *Xpert* mode:

- Analog measuring field
- Zero point
- Reset sensor to factory settings

For more information on operating the teach button in Xpert mode, see *Teach button* [► *11].*

Adjustable parameters in *Xpress* mode:

- Zero point

The teach button is automatically deactivated after 5min (timeout can be parameterized via IO-Link).

Teach zero point (in *Xpress* mode) *Procedure:*

a) Place the target at the desired position for the zero point.

b) Press and hold the teach button for 2s.

✓ Green LED flashes at 2Hz.

Result:

✓ Teach-in ok: Sensor returns to operational mode.

✓ Teach-in not ok: Green and yellow LEDs flash simultaneously at 8Hz.

IO-Link parameters: Teach button (Local User Interface)

Parameter name	Values	Description
Teach Mode Settings.Local Teach Mode	`Xpert`, `Xpress`	Selection of the mode for the teach button
Teach Lock Settings.Button Time Out	-	Enter the time period (timeout) after which the Teach button is to be deactivated after a teach process (in min). With a value of `0`, the teach button is always active. With a value of `255 (0xFF)`, the teach button is permanently deactivated.

9 Diagnostic data

The diagnostic data is used to monitor the status of the device. You can monitor both the momentary status (by means of parameters) and the development over time (by means of histogram function).

9.1 Measurement rate

The measurement rate corresponds to the number of measurements per second. Example: With a measuring rate of 500 Hz, a measurement is made every 0.002 s (1/ 500 Hz = 0.002 s). The measuring rate helps you with the following questions, among others:

- How quickly can a change in distance be recognized?
- How many measurements can be made on an object in static status?

For particularly dynamic applications, always consider the measuring rate together with the filter settings (*Filter* [▶ *22]*).

The measuring rate depends on the exposure time. The sensor automatically adjusts its exposure time to the measuring object in order to receive an optimal amount of light at any time and thus to achieve a sufficient exposure reserve. The exposure time depends on the properties of the surface to be measured (color/structure/etc.) and the alignment of the sensor to the target. Dark measurement objects reflect less light and thus require longer exposure times than bright measurement objects, the measurement rate is
is reduced. The measurement and the change of the output take place with the same frequency.

INFO

The max. speed for dynamic applications is limited by the measuring rate. Filter settings have no influence on the measuring rate.

IO-Link diagnostic data: Measuring rate

Name	Description
Measurement Values. PV1	RateOutput of the measurement rate.

9.2 Response delay

The response delay corresponds to the time between the trigger of the measurement (internal si- gnal) and the change of the measured value at the output. With the response delay you can determine how fast a distance change is recognized at the output of the sensor.

For particularly dynamic applications, always consider the response delay together with the filter settings (*Filter* [► *22*]).

The duration of the response delay depends on the exposure time. The sensor automatically adapts its exposure time to the measured object in order to receive an optimal amount of light at any time and thus to achieve a sufficient exposure reserve. The exposure time depends on the properties of the surface to be measured (color/structure/etc.) and the alignment of the sensor to the target. Dark measurement objects reflect less light and therefore require longer exposure times than light measurement objects, the response delay is increased.

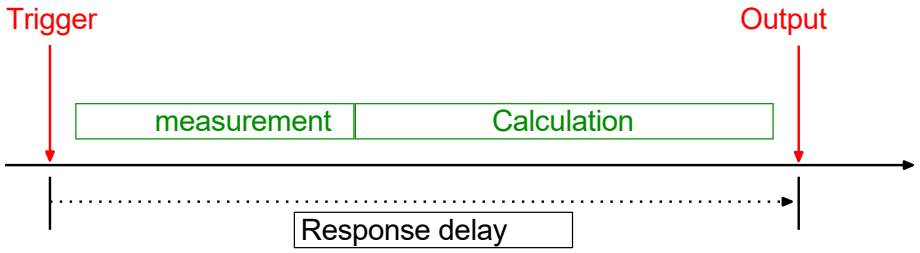


Fig. 20: Response delay

INFO
Filter settings do not affect the response delay.

IO-Link diagnostic data: Response delay

Name	Description
Measurement Values. PV1 Response Delay	Output of the response delay.

9.3 Exposure reserve

The exposure reserve reflects the amount of light reflected by the target (as a relative factor without unit). The exposure reserve supports you with the following problems, among others:

- Check whether there is a valid measurement result (signal quality). The signal quality is weak,
  - if the sensor is not optimally aligned,
  - if the distance between sensor and target is too large.
- In running operation: Check the front screen of the sensor for soiling: If the exposure reserve decreases via time, this may indicate increasing soiling of the front screen.Use the histogram function (*Histogram function* [▶ *41]*) for this purpose.

IO-Link diagnostic data: Exposure reserve

Name	Description
Exposure Reserve. Exposure	ReserveOutput of the exposure reserve.

9.4 Signal quality

The signal quality serves as an indicator of the reliability of the measurement.

IO-Link diagnostic data: Signal quality

Name	Description
Exposure Reserve.Quality Level	- Output of the signal quality. ▪ 0 = valid signal ▪ 1 = weak signal *Low singal quality can lead to larger measured value errors. Reduce the distance to the target or optimize the alignment of the sensor.* ▪ 2 = critical signal *Valid measured value recording is no longer ensured. Reduce the distance to the target or optimize the alignment of the sensor.* *LEDs flash when critical signal is reached. Alarm output is activated when no more measured value can be recorded.*

9.5 Device status

The device status provides information on the status of the device.

IO-Link diagnostic data: Device status

Name	Description
DeviceStatus	· Output of the device status. ▪ 0 = Device OK (in operational state) ▪ 1 = Maintenance required (critical signal quality) ▪ 2 = out of specification (measured value cannot be recorded)

9.6 Operating time

The operating time of the sensor is permanently recorded and output as the following values:

- Operating time since last startup.
- Operating time since an individually adjustable time (by reset).
- Operating time since the first start-up.

IO-Link diagnostic data: Operating time

Name	Description
Operation Time.	PowerupOutput of the operation time since the last startup.
Operation Time. adjustable	ResetableOutput of the operation time since an individually Time (by reset).
Operation Time.	LifetimeOperating time since the first startup.

9.7 Histogram function

The histogram function records the following key figures within defined intervals (bins):

- Distance
- Exposure reserve

Distance

A measured value (distance) is recorded with each cycle (cyclic date). The following information is available:

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

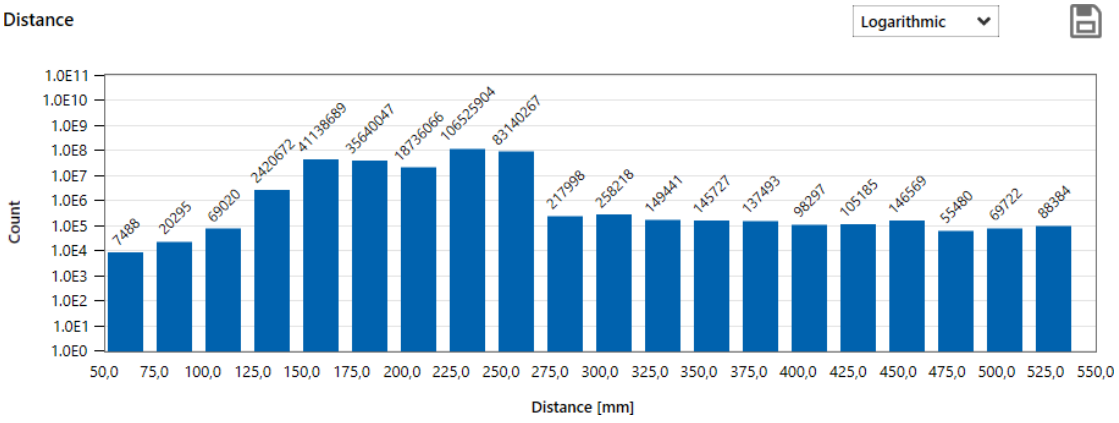
Example:
Measuring range of the sensor: 50 - 550 mm:

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

So:
Interval/Bin covers the following range: (550 mm - 50 mm)/20 = 25 mm

If the sensor reads 76 mm 5 times and 162 mm 15 times in 20 measurements, it will be the distribution is as follows:

Am	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
Am 5	150 mm	< 175 mm	15
...	...	...	...



IO-Link diagnostic data: Histogram function distance

Name	Description
ipf Commands - Distance Resetable Histogram Reset	Reset histogram distance
Distance Resetable Histogram.Unit	Unit
Distance Resetable Histogram.Range Start	StartRange of validity
Distance Resetable Histogram.Range End	End of range of validity
Distance Resetable Histogram.Nbr of Bins	Number of intervals/bins
Distance Resetable Histogram.Bin 1 - 20	Bin 1 - 20

NOTE

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

Exposure reserve

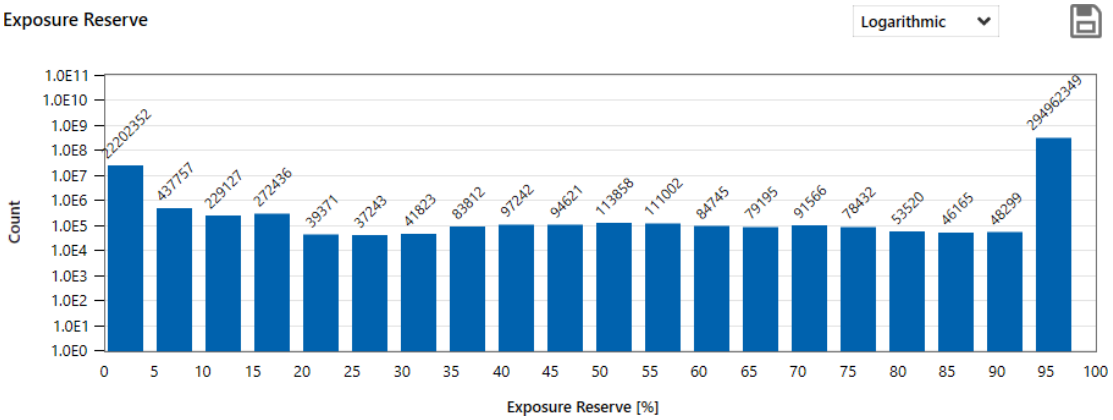
A value for the exposure reserve is recorded for each measurement. The exposure re- serve (acyclic date) must be called up explicitly.

Since the exposure reserve is always described by a fixed range of values, the following specifications have a fixed value:

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

So: 1 interval covers a value range of 5. Example:
The measuring object is outside the measuring range for 5 measurements. The sensor thus takes an exposure reserve of 0. This results in the following distribution:

Am	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
Am 5	20	< 25	0
...	...	...	...



IO-Link diagnostic data: Histogram function Exposure reserve

Name	Description
ipf Commands - Exposure Reserve Resetable Histogram Reset	Histogram Reset exposure reserve
Exposure Reserve Resetable Histogram.Range Start	StartRange of validity
Exposure Reserve Resetable Histogram.Range End	End of range of validity
Exposure Reserve Resetable Histogram.Nbr of Bins	Intervalle/Bins Exposure
Reserve Resetable Histogram.Bin 1 - 20	Bin 1 - 20

10 Maintenance

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

10.1 Clean sensor

Exterior cleaning

When cleaning the outside of the sensor, make sure that the cleaning agent used does not attack the housing surface and seals.

NOTE

Material damage due to improper cleaning.

Unsuitable cleaning agents and methods can lead to leaks at the sensor, at the seals or at the connections and to material damage.

a) Always check the cleaning agent for suitability for the surface to be cleaned.
b) Never use abrasive cleaners, solvents or other aggressive cleaning agents for cleaning.
c) Never clean with liquid jets, for example high-pressure cleaners.
d) Never scrape off soiling with sharp-edged objects.

Interior cleaning

In principle, no internal cleaning of the sensor is provided.

11 Troubleshooting

- *interference:*
  Despite connected voltage supply, the sensor does not start up. The LEDs of the sensor are switched off.
- *Possible Cause:*
  The voltage supply is interrupted. There is a short circuit.
- *Remedy:*
  Check the electrical connection of the sensor according to the wiring diagram.

- *interference:*
  No valid measured value can be detected, the LED lights up yellow and the laser is switched on.
- *Possible Cause:*
  The measuring object is outside the measuring range (MR). Refer to the data sheet for the measuring range for your sensor version.
- *Remedy:*
  Move the measuring object into the measuring range.

- *interference:*
  The measurement results are erroneous.
- *Possible Cause:*
  The direct reflection of the laser hits the receiver of the sensor. Occurs especially on shiny surfaces.
- *Remedy:*
  Tilt the sensor laterally so that the direct reflection of the laser does not hit the receiver of the sensor.

- *interference:*
  The measured value shows an erroneous, erratic behavior.
- *Possible Cause:*
  Too much ambient light enters the field of view of the sensor receiver. This leads to interfering peaks on the receiver.
- *Remedy:*
  Reduce ambient light (e.g. by using a coverage).

11.1 Return and repair

If you have any complaints, please contact the Sales Unit responsible for you.

11.2 accessories

Accessories can be found on the website at:

https://www.ipf.de

List of Figures