MICRO-EPSILON

Operating Instructions

optoNCDT 1700

optoNCDT 1710

ILD1700-2
ILD1700-10
ILD1700-20
ILD1700-40
ILD1700-50
ILD1700-100

ILD1700-200
ILD1700-250VT
ILD1700-300
ILD1700-500
ILD1700-750

ILD1700-2DR
ILD1700-10DR
ILD1700-20DR

ILD1700-2LL
ILD1700-10LL
ILD1700-20LL
ILD1700-50LL

ILD1710-50
ILD1710-1000

ILD1700-20BL
ILD1700-200BL
ILD1700-500BL
ILD1700-750BL
ILD1710-50BL
ILD1710-1000BL

Intelligent laser optical displacement measurement

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Softwareversion: 6.000

Contents

1. Safety

The handling of the sensor assumes knowledge of the instruction manual.

1.1 Symbols Used

The following symbols are used in this instruction manual:


WARNING! - potentially dangerous situation


IMPORTANT! - useful tips and information

1.2 Warnings

Avoid unnecessary laser radiation to be exposed to the human body
- Switch off the sensor for cleaning and maintenance.
- Switch off the sensor for system maintenance and repair if the sensor is integrated into a system.

Caution - use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Connect the power supply and the display/output device in accordance with the safety regulations for electrical equipment.
> Risk of injury

> Damage to or destruction of the sensor

Avoid shocks and impacts to the sensor.
> Damage to or destruction of the sensor

Mount the sensor only to the existing holes on a flat surface. Clamps of any kind are not permitted.
> Damage to or destruction of the sensor

The power supply may not exceed the specified limits
> Damage to or destruction of the sensor

Avoid continuous exposure to spray on the sensor.
> Damage to or destruction of the sensor

Avoid exposure to aggressive materials (washing agent, penetrating liquids or similar) on the sensor.
> Damage to or destruction of the sensor

1.3 Notes on CE Marking

The following apply to the optoNCDT 1700:
- EU directive 2014/30/EU
- EU directive 2011/65/EU, “RoHS” category 9

Products which carry the CE mark satisfy the requirements of the EU directives cited and the European harmonized standards (EN) listed therein. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, article 10, at:

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Lessingstr. 14
01465 Langebrück / Germany

The measuring system is designed for use in industrial environments and meets the requirements.

1.4 Proper Use

- The optoNCDT 1700 is designed for use in industrial applications. It is used
  - for measuring displacement, distance, position and elongation
  - for in-process quality control and dimensional testing
- The sensor must only be operated within the limits specified in the technical data, see Chap. 3.4.
- The sensor must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the sensor.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

ⓘ IMPORTANT!
The protection class is limited to water (no penetrating liquids or similar)!

- Protection class: IP 65 (Only with sensor cable connected)
- Lenses are excluded from protection class. Contamination of the lenses leads to impairment or failure of the function.
- Operating temperature: 0 to +50 °C (+32 to +104 °F)
- Storage temperature: -20 to +70 °C (-4 to +158 °F)
- Humidity: 5 - 95 % (no condensation)
- Pressure: atmospheric pressure
- EMC: according to:
  - EN 61326-1: 2006-10
    Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
  - DIN EN 55011: 2007-11 (Group 1, class B)
    Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement
  - EN 61000-6-2: 2006-03
    Electromagnetic compatibility (EMC), Part 6-2: Generic standards, Immunity for industrial environments

2. Laser class

ⓘ IMPORTANT!
Comply with all regulations on lasers.

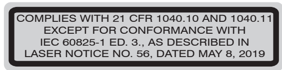
The optoNCDT1700 sensors operate with a semiconductor laser with a wavelength of 670 nm (visible/red, ILD 1700) respectively 405 nm (visible/blue, ILD 1700BL). The laser is operated on a pulsed mode, the pulse frequency corresponding to the measuring frequency. The duration of the pulse is regulated in dependency on the object to be measured and can form an almost permanent beam. The maximum optical power is ≤ 1 mW. The sensors fall within Laser Class 2 (II).

Class 2 (II) lasers are not notifiable and a laser protection officer is not required either.

The following warning labels are attached to the cover (front and/or rear side) of the sensor housing:

❗ WARNING!
Never deliberately look into the laser beam! Consciously close your eyes or turn away immediately if ever the laser beam should hit your eyes.

IEC label



Only for USA

IEC label for ILD1700-x BL only

During operation of the sensor the pertinent regulations acc. to EN 60825-1 on „radiation safety of laser equipment“ must be fully observed at all times. The sensor complies with all applicable laws for the manufacturer of laser devices.

ⓘ IMPORTANT!
If both warning labels are covered over when the unit is installed the user must ensure that supplementary labels are applied.

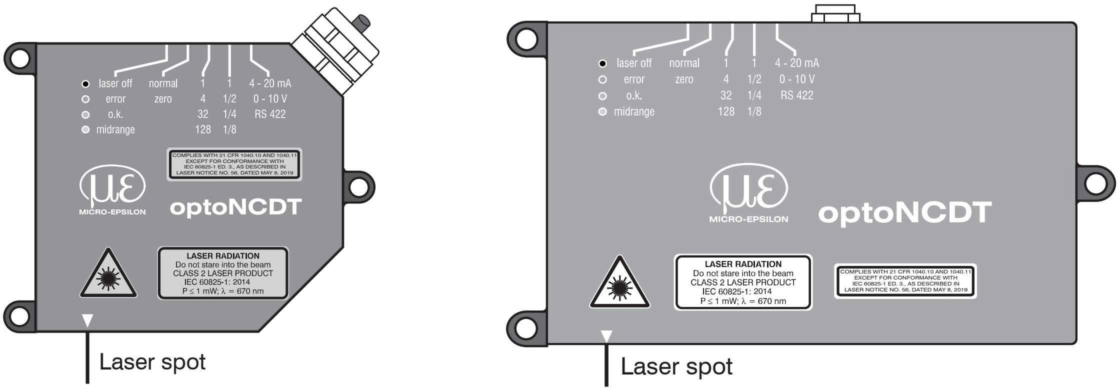


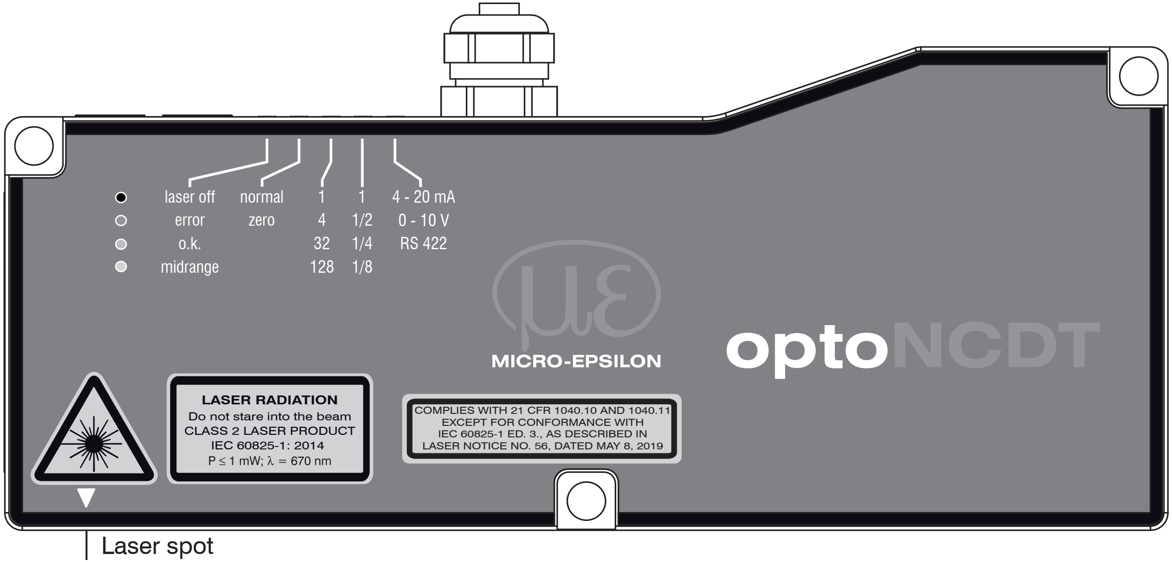
Fig. 1 True reproduction of the sensor with its actual location of the warning labels, ILD1700-x

The laser warning labels for Germany have already been applied. Those for other non German-speaking countries an IEC standard label is included in delivery. The versions applicable to the user’s country must be applied before the equipment is used for the first time. Laser operation is indicated by LED, see Chap. 3.5.

Although the laser output is low looking directly into the laser beam must be avoided. Due to the visible light beam eye protection is ensured by the natural blink reflex.

The housing of the optical sensors optoNCDT 1700 may only be opened by the manufacturer, see Chap. 12.

For repair and service purposes the sensors must always be sent to the manufacturer.



True reproduction of the sensor with its actual location of the warning labels, ILD1710-1000

3. Functional Principle, Technical Data

3.1 Functional Principle

3.1.1 Diffuse Reflection

SMR = Start of measuring range

MMR = Midrange

EMR = End of measuring range

The optoNCDT1700 consists of an laser-optical sensor and a signal conditioning electronics. The sensor uses the principle of optical triangulation, i.e. a visible, modulated point of light is projected onto the target surface.

The diffuse element of the reflection of the light spot is imaged by a receiver optical element positioned at a certain angle to the optical axis of the laser beam onto a high-sensitivity resolution element (CCD), in dependency on distance. From the output signal of the CCD element a digital signal processor (DSP) in the sensor calculates the distance between the light spot on the object being measured and the sensor. The distance is linearized and then issued via an analog or digital interface.

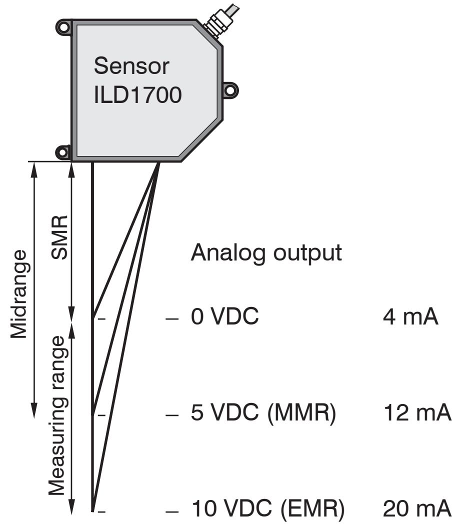


Fig. 2 Definition of terms, output signal

3.1.2 Direct Reflection

The optoNCDT1700DR consists of an laser-optical sensor and a signal conditioning electronics. The sensor uses the principle of optical triangulation, i.e. a visible, modulated point of light is projected onto the target surface. The direct element of the reflection of the light spot is imaged by a receiver optical element onto a high-sensitivity resolution element (CCD), in dependency on distance. From the output signal of the CCD element a digital signal processor (DSP) in the sensor calculates the distance between the light spot on the object being measured and the sensor. The distance is linearized and then issued via an analog or digital interface.

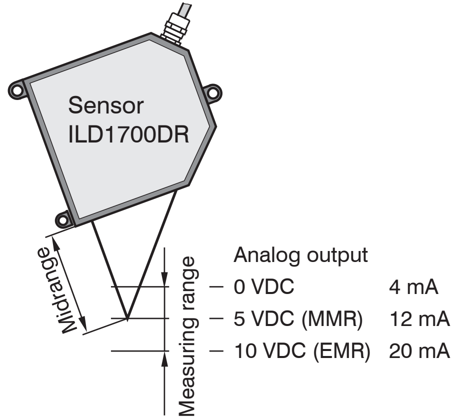


Fig. 3 Definiton of terms, output signal

SMR = Start of measuring range

MMR = Midrange

EMR = End of measuring range

On shining or mirroring surfaces the direct element of the reflection of the laser spot is greater and covers therefore the diffuse part. Suppression of the 2nd reflection from the glass rear side in the sensor is possible for measurements on glass panels. Sensors for direct reflection (ILD1700-2DR, ILD1700-10DR and ILD1700-20DR) are calibrated in tilted position. Therefore the can not be used for diffuse reflection.

3.2 Real Time Control

The signal from the CCD element is used to determine the intensity of the diffuse reflection. This enables the sensor to compensate for fluctuations in brightness on the object being measured. What is more, it does so in a range from almost total absorption to almost total reflection.

3.3 Exposure Control

Dark or shining objects to be measured may require a longer exposure time. However, the controller is not capable of providing exposure which is any longer than permitted by the measurement frequency. For a longer exposure time, therefore, the measurement frequency of the sensor has to be reduced either manually or by command, see Chap. 6.9.

3.4 Technical Data

Type	**ILD 1700-**	**2**	**10**	**20**	**40**	**50**	**100**	**200**	**250VT**	**300**	**500**	**750**
Measuring range	mm	2	10	20	40	50	100	200	250	300	500	750
Start of measuring range	mm	24	30	40	175	45	70	70	70	200	200	200
Midrange (MMR)	mm	25	35	50	195	70	120	170	195	350	450	575
End of measuring range	mm	26	40	60	215	95	170	270	320	500	700	950
Linearity	FSO	±0.1 %	±0.08 %					±0.1 %	±0.25 %	±0.08 %		±0.1 %
Resolution [1]	µm	0.1	0.5	1.5	4	3	6	12	50	18	30	50
Measurement frequency programmable		2.5 kHz (1); 1.25 kHz (1/2); 625 Hz (1/4); 312.5 Hz (1/8)										
Light source (laser diode)		Wave length 670 nm, red, max. power 1 mW, laser class 2										
Permissible ambient light (at 2.5 kHz)		10.000 lx							15.000 lx	10.000 lx		
Spot diameter	SMR	80	110	320	230	570	740	1300	1500	1500	1500	1500
	MMR	35	50	45	210	55	60	1300	1500	1500	1500	1500
	EMR	80	110	320	230	570	700	1300	1500	1500	1500	1500
Temperature stability	% FSO/°C	0.025	0.01						0.025	0.01		

Type	ILD 1700-	2	10	20	40	50	100	200	250VT	300	500	750
Operating temperature		0 ... +50 °C							0 ... +55 °C	0 ... +50 °C		
Storage temperature		-20 ... +70 °C										
Protection class		IP 65 (with plugged connection)										
Power supply U_B		24 V (11 ... 30 V) DC; max. 150 mA										
Measurement value output	selectable	4 -20 mA; 0 -10 V; RS422										
Voltage output		R_i = 100 Ohm, I_{max} = 5 mA, short-circuit proof										
Load current output		R_{Load} < (U_B -6 V) / 20 mA, R_{Load} 250 Ohm for U_B = 11 VDC										
Switching outputs	programmable	Error or/and limit values, short-circuit proof										
Switching inputs		Laser ON/OFF; Zero										
Synchronization	programmable	Simultaneous or alternating										
Sensor cable	Standard Extension	0.25 m (with cable jack) 3 / 10 m										
Electromagnetic compatibility (EMC)		EN 61326-1: 2006-10 DIN EN 55011: 2007-11 (Group 1, class B) EN 61 000-6-2: 2006-03										
Vibration (acc. to IEC 60068-2-6) [2]		2 g / 20 ... 500 Hz										
Shock (acc. to IEC 60068-2-29) [2]		15 g / 6 ms										
Housing size		S								M		
Weight (with 25 cm cable)		550 g			600 g	550 g				550 g	600 g	

The specified data apply to a white, diffuse reflecting surface (Reference: Ceramic).
SMR = Start of measurement range; MMR = Midrange; EMR = End of measuring range

FSO = Full Scale Output

1) At a measurement frequency of 2.5 kHz, without averaging

2) ILD1700-250VT: 20 g, vibration and shock resistant sensor model for use on vehicles

Legend:
mm (inches)

optoNCDT1700 - for direct reflective surfaces

Type	ILD 1700-	2DR	10DR	20DR
Measuring range	mm	2	10	20
Start of measuring range	mm	Dimensional drawing, see Fig. 16, et seq.		
Midrange (MMR)	mm			
End of measuring range	mm			
Linearity, φ/2	FSO	±0.1 %	±0.1 %	±0.2 %
Linearity, φ/2 ±0.3 °	FSO	±0.2 %	±0.25 %	±2 % [2]
Resolution [1]	µm	0.1	0.5	3
Tilt angle (φ/2)		20 °	17.6 °	11.5 °
Housing size		S		

Not specified data correspond to those of the standard sensors.
MMR = Midrange
FSO = Full Scale Output

1) At a measurement frequency of 2.5 kHz, without averaging

2) Measuring range 18 (.71)

optoNCDT 1700LL - for metallic shiny and rough surfaces

Type	ILD 1700-	2LL	10LL	20LL	50LL
Measuring range	mm	2	10	20	50
Spot diameter	SMR	85 x 240 µm	120 x 405 µm	185 x 485 µm	350 x 320 µm
	MMR	24 x 280 µm	35 x 585 µm	55 x 700 µm	70 x 960 µm
	EMR	64 x 400 µm	125 x 835 µm	195 x 1200 µm	300 x 1940 µm
Housing size		S			

For measurements against high glossary surfaces (targets), resolution depends on the material.

Not specified data correspond to those of the standard sensors.
SMR = Start of measurement range; MMR = Midrange; EMR = End of measuring range

optoNCDT 1710 - for long distance to the target

Type		ILD 1710-50	ILD 1710-1000
Measuring range	mm	50	1000
Start of measuring range	mm	550	1000
Midrange (MMR)	mm	575	1500
End of measuring range	mm	600	2000
Linearity	mm	±0.05	±1
Resolution [1]	µm	5	100
Spot diameter	SMR	0.4 ... 0.5 mm	2.5...5 mm
	MMR	0.4 ... 0.5 mm	2.5...5 mm
	EMR	0.4 ... 0.5 mm	2.5...5 mm
Sensor cable		0.25 m integrated	
Weight		ca. 0.8 kg	
Protection class		IP 65	
Temperature stability	% FSO/ °C	0.01	
Operating temperature	°C	0 ... 50	
Housing size		L	

Not specified data correspond to those of the standard sensors.

SMR = Start of measurement range; MMR = Midrange; EMR = End of measuring range

FSO = Full Scale Output

1) At a measurement frequency of 2.5 kHz, without averaging

optoNCDT 17x0BL

Type	ILD	1700-20BL	1700-200BL	1700-500BL	1700-750BL	1710-50BL	1710-1000BL
Measuring range	mm	20	200	500	750	50	1000
Start of measuring range	mm	40	100	200	200	550	1000
Midrange	mm	50	200	450	575	575	1500
End of measuring range	mm	60	300	700	950	600	2000
Linearity	FSO	≤ ±0.08 %	≤ ±0.1 %	≤ ±0.08 %	≤ ±0.1 %		
Resolution [1]	µm	1,5	12	30	50	5	100
Measurement frequency		2.5 kHz; 1.25 kHz; 625 Hz; 312.5 Hz (adjustable)					
Light source		Semiconductor laser < 1 mW, 405 nm (blue purple)					
Laser protection class		Class 2 acc. to DIN EN 60825-1: 2015-07					
Light spot diameter (µm)	SMR, µm MMR, µm EMR, µm	320 45 320	1300 1300 1300	1500 1500 1500	1500 1500 1500	400 x 500 400 x 500 400 x 500	2.5 ... 5 mm 2.5 ... 5 mm 2.5 ... 5 mm
Housing size		S		M		L	
Weight (with 25 cm cable)		appr. 550 g	appr. 550 g	appr. 600 g	appr. 600 g	appr. 800 g	appr. 800 g

The specified data apply to a white, diffuse reflecting surface (Reference: Ceramic).

SMR = Start of measurement range; MMR = Midrange; EMR = End of measuring range

FSO = Full Scale Output

1) At a measurement frequency of 2.5 kHz, without averaging

3.5 Control and Indicator Elements

ⓘ IMPORTANT!
Keys can be locked via the serial interface, see Chap. 8.5.16.
For the meanings of the LEDs in setup mode, see Chap. 6.3.

Fig. 4 Keys and LED's on the sensor

ⓘ IMPORTANT!
If the `function/enter` key is pressed more than 5 sec, all para-meters are over-written by the factory settings.

(1) `select/zero` key Measurement mode: Sets analog output to „Master" or „Mid-point", see Chap. 6.7, see Chap. 6.8.
Setup mode: For changing the sensor parameters, see Chap. 6.5.

(2) `function/enter` key
For switching between measurement mode and setup mode.

(3) LEDs, see Fig. 5.

LED		Color	Meaning
output	o		**Current (4 ... 20 mA)**
	☼	red green	Voltage (0 ... 10 V) Serial (RS422)
speed	o		**Measurement frequency 1 = 2.5 kHz**
	☼	red green yel-low	1/2 = 1.25 kHz 1/4 = 625 Hz 1/8 = 312.5 Hz
avg	o		**Average: 1 (Median: 3)**
	☼	red green yel-low	4 (5) 32 (7) 128 (9)
zero	☼	red flashing	Mid-point set / mastered Slave not synchronized
state	o		Laser off
	☼	red green yel-low	Error O.K. MMR (midrange)

Fig. 5 Meanings of the LEDs in measurement mode

Note: In measurement mode (factory setting) only the LED „state" lights up, subject to the current position of the object to be measured.

4. Delivery

4.1 Scope of Delivery

1 Sensor optoNCDT1700 with 0.25 m connecting cable and cable jack

2 Laser warning labels in accordance with IEC standards

1 Instruction manual

1 CD with driver and demo program

For ILD1700-xxDR: 1 fit-up aid (convenient to measuring range)

Optional accessory, packed separately:

1 PC1700 sensor cable, 3 m or 10 m in length, with cable plug and open cable ends (subject to order).

Check for completeness and shipping damage immediately after unpacking. In case of damage or missing parts, please contact the manufacturer or supplier.

4.2 Storage

Storage temperature:	-20 up to +70 °C (-4 to +158 °F)
Humidity :	5 - 95 % (no condensation)

5. Installation

The sensor optoNCDT 1700 is an optical sensor for measurements with micrometer accuracy. Make sure it is handled carefully when installing and operating.

Bolt connection					**Direct fastening**			
Housing	Through length	Screw	Washer	Tightening torque per screw	Screw depth		Screw	Tightening torque per screw
		ISO 4762-A2	ISO 7089-A2	$\mu = 0.12$	Minimum	Maximum	ISO 4762-A2	$\mu = 0.12$
	mm			Nm	mm	mm		Nm
S	30	M4	A4,3	2	-	-	-	-
M	35	M4	A4,3	2	8	10	M5	3.5
L	48	M5	A5,3	3.5	9.6	10	M6	5

Fig. 6 Mounting conditions

Housing sizes, see Chap. 3.4.

Recommended tightening torque ➪ max. + 10 % permissible, not deceed min. -20 %!

The tightening torques specified in the table are approximate and may vary depending on the application.

Basis of considerations $\mu = 0.12$

The bearing surfaces surrounding the fastening holes (through-holes) are slightly raised.

i Mount the sensor only to the existing holes on a flat surface. Clamps of any kind are not permitted.

To align the sensor, please comply with the “Instructions for Operation“, see Chap. 9.3, especially.

If the sensors are to be used in soiled environments or in higher ambient temperatures than normal, MICRO-EPSILON recommends the use of protective housings, see Chap. 9.4.

The suggested free space in the tuning range, see Fig. 8, is kept clear at least until the end of the measuring range of foreign material and ambient light of other laser sensors.

IMPORTANT!
Mount the sensor only to the existing holes on a flat surface. Clamps of any kind are not permitted. Do not exceed torques.

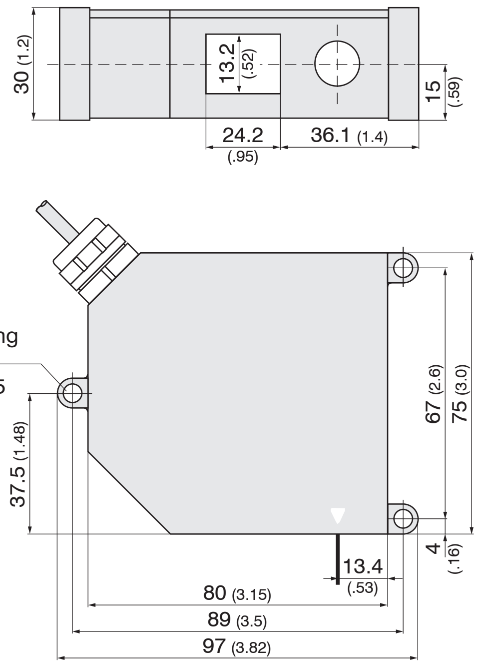
IMPORTANT!
Handle optical sensors with care.

5.1 Sensor Mounting Diffuse Reflection

The sensor is mounted by means of 3 screws according to the table, see Fig. 6.

The bearing surfaces surrounding the fastening holes (through-holes) are slightly raised.

The laser beam must be directed perpendicularly onto the surface of the target after sensor mounting. In case of misalignment it is possible that the measurement results will not always be accurate.



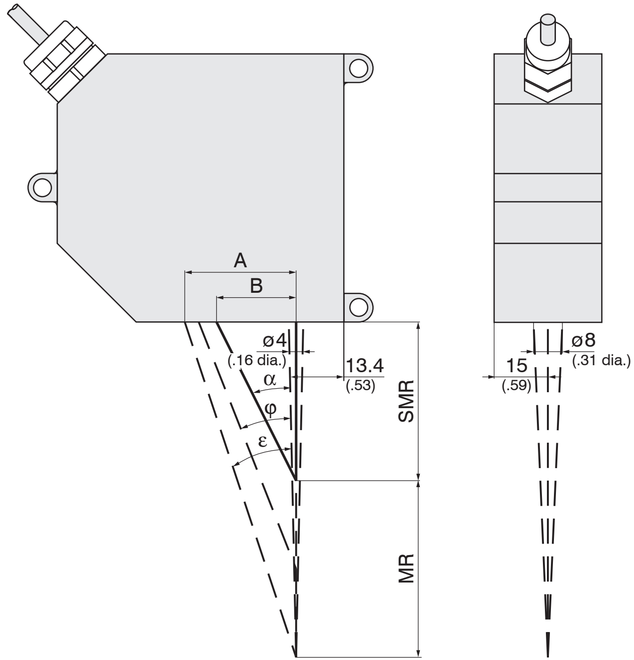
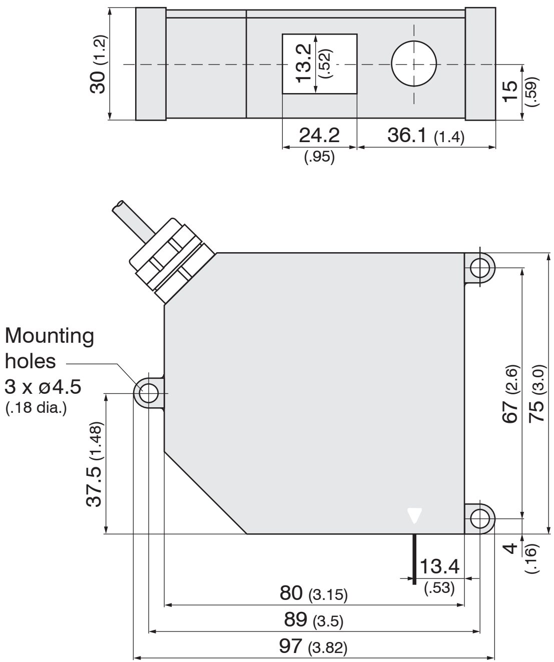


Fig. 7 Dimensional drawing optoNCDT 1700-2/10/20/50/100/200/250VT 1700-2LL/10LL/20LL/50LL dimensions in mm (inches), not to scale

MR	SMR	α	ε	A	B
2	24	35.0 °	44.8 °	25.8	16.8
10	30	34.3 °	35.6 °	28.7	20.5
20	40	28.8 °	26.7 °	30.1	22.0
50	45	26.5 °	18.3 °	31.5	22.5
100	70	19.0 °	10.9 °	32.6	24.1
200	70	19.0 °	7.0 °	33.1	24.1
250VT	70	19.0 °	6.0 °	33.5	24.1

Fig. 8 Free space for optics

SMR = Start of measuring range
MR = Measuring range



Housing size S

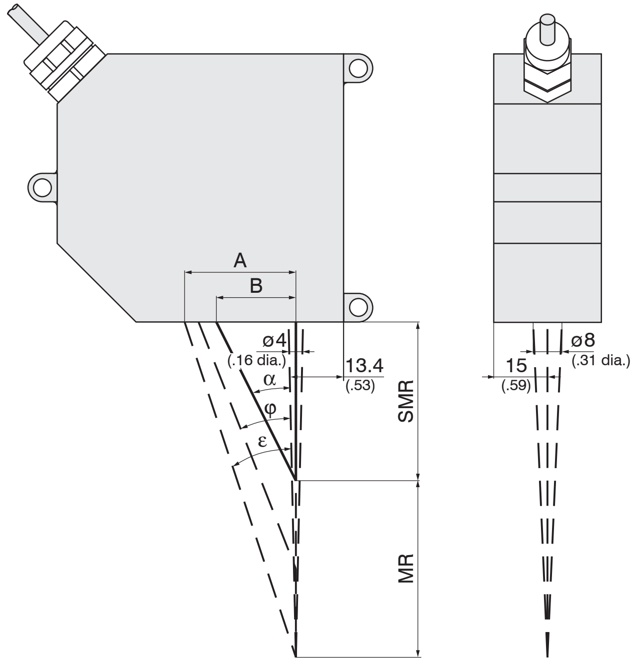


Fig. 9 Dimensional drawing optoNCDT 1700-20/200BL dimensions in mm, not to scale

MR	SMR	α	ε	A	B
20	40	28.8 °	26.7 °	30.1	22.0
200	100	13.5 °	6.3 °	33,1	24.1

Fig. 10 Free space for optics optoNCDT 1700-20/200BL dimensions in mm, not to scale

SMR = Start of measuring range
MR = Measuring range

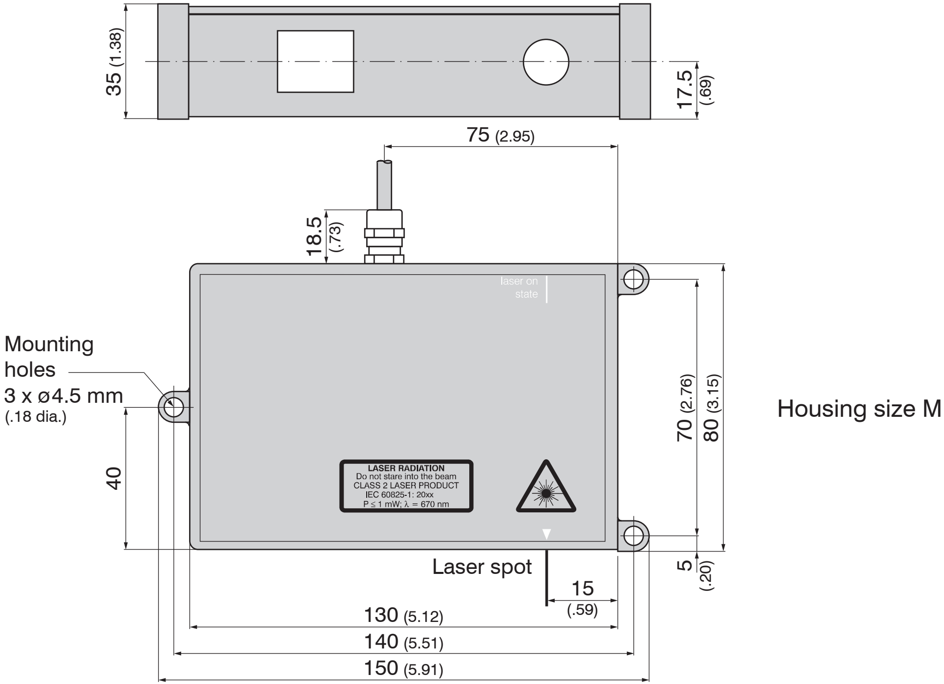
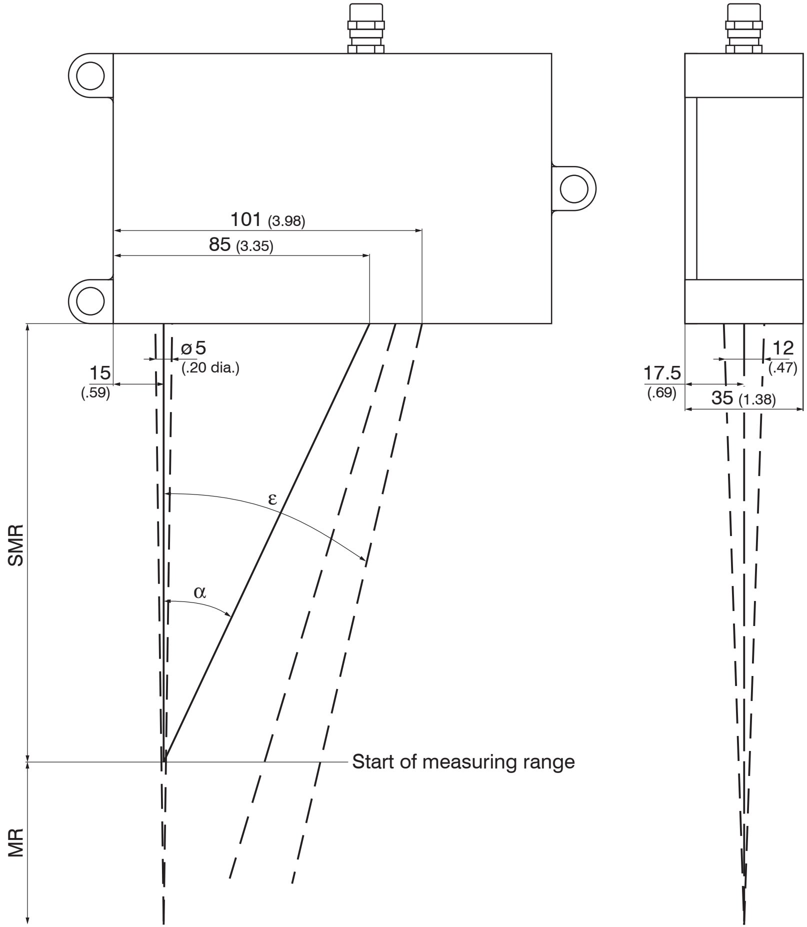


Fig. 11 Dimensional drawing
optoNCDT 1700-40/300/500/750
optoNCDT 1700-500/750BL
dimensions in mm, not to scale



Housing size M

MR	SMR	α	ε
40	175	22.1 °	21.8 °
300	200	18,3	9,6
500	200	19.3 °	7.0 °
750	200	19.3 °	5.0 °

Fig. 12 Free space for optics, ranges 1700-40/500/750 mm, ranges 1700-500/750BL mm, dimensions in mm (inches), not to scale

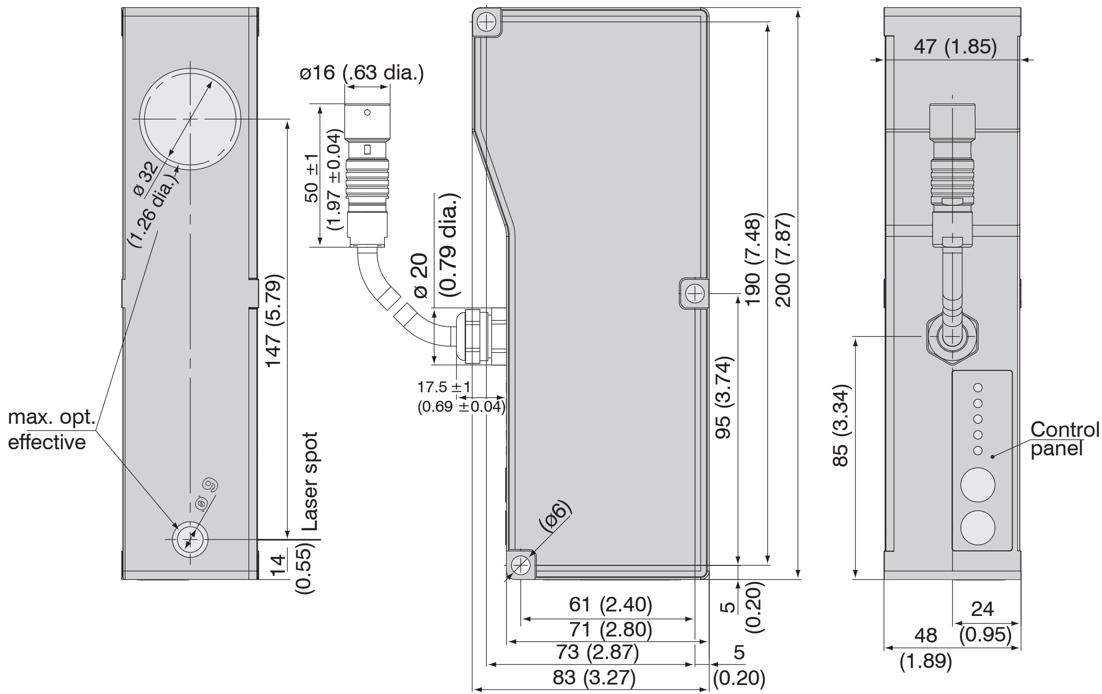


Fig. 13 Dimensional drawing
optoNCDT ILD 1710-50/1000
optoNCDT ILD 1710-50/1000BL
dimensions in mm, not to scale

Housing size L

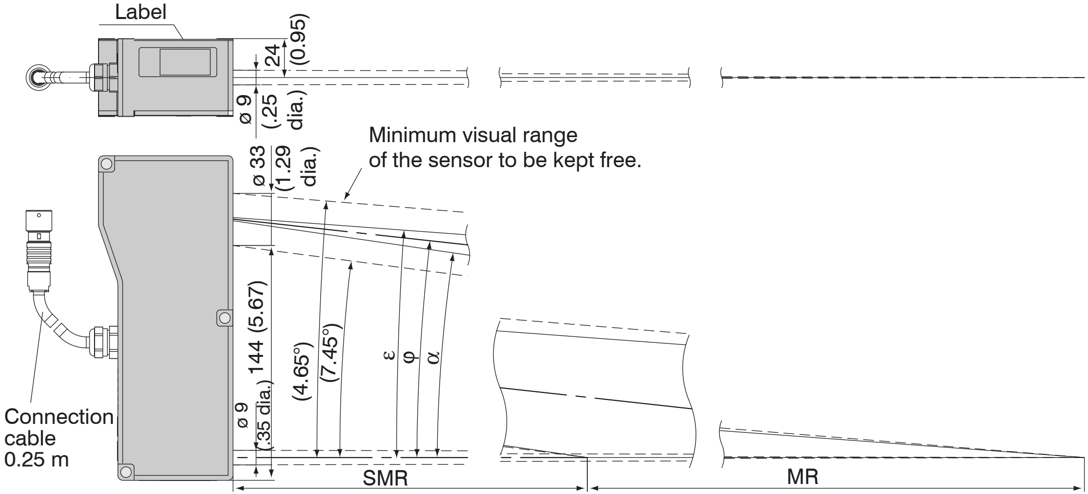


Fig. 14 Free space for optics optoNCDT ILD 1710-50/1000, optoNCDT ILD 1710-50/1000BL, dimensions in mm, not to scale

MR	SMR	α	ε
50	550	13.35 °	15.15 °
1000	1000	7.45 °	4.65 °

5.2 Sensor Mounting Direct Reflection

The sensor is mounted by means of 3 screws type M4. The bearing surfaces surrounding the fastening holes (through-holes) are slightly raised.

Mount the sensor, that the reflected laser light hits the receiver element, see Fig. 16, see Fig. 17, see Fig. 18.

Use a fit-up aid to mount the sensor, see Fig. 15.

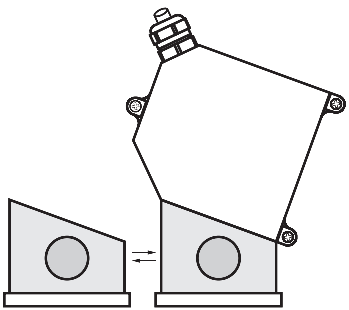


Fig. 15 Accessory to mount the sensor

i IMPORTANT!
Handle optical sensors with care!

Legend:
mm (inches)

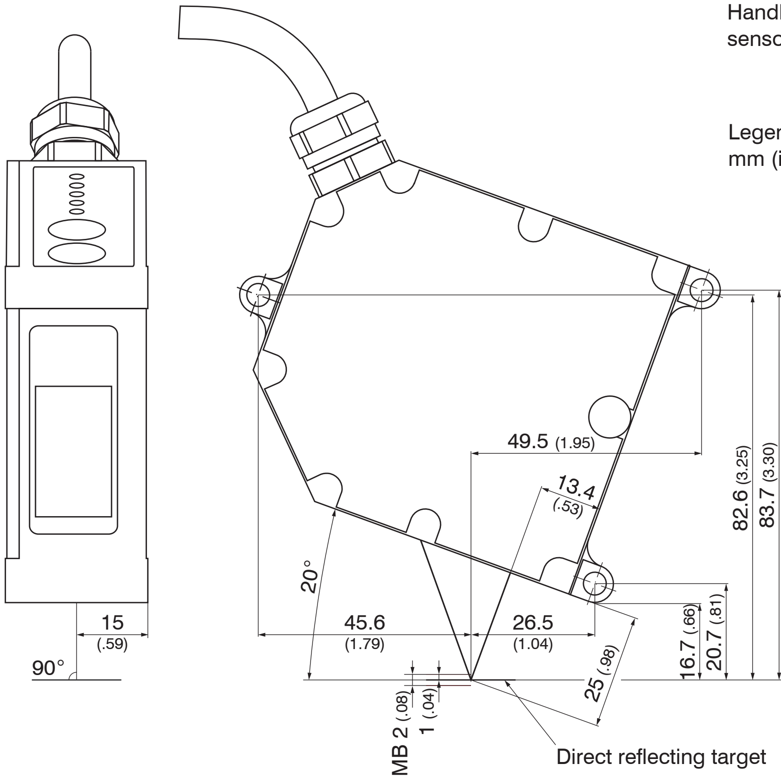


Fig. 16 Dimensional drawings optoNCDT1700-2DR (not to scale)

Legend:
mm (inches)

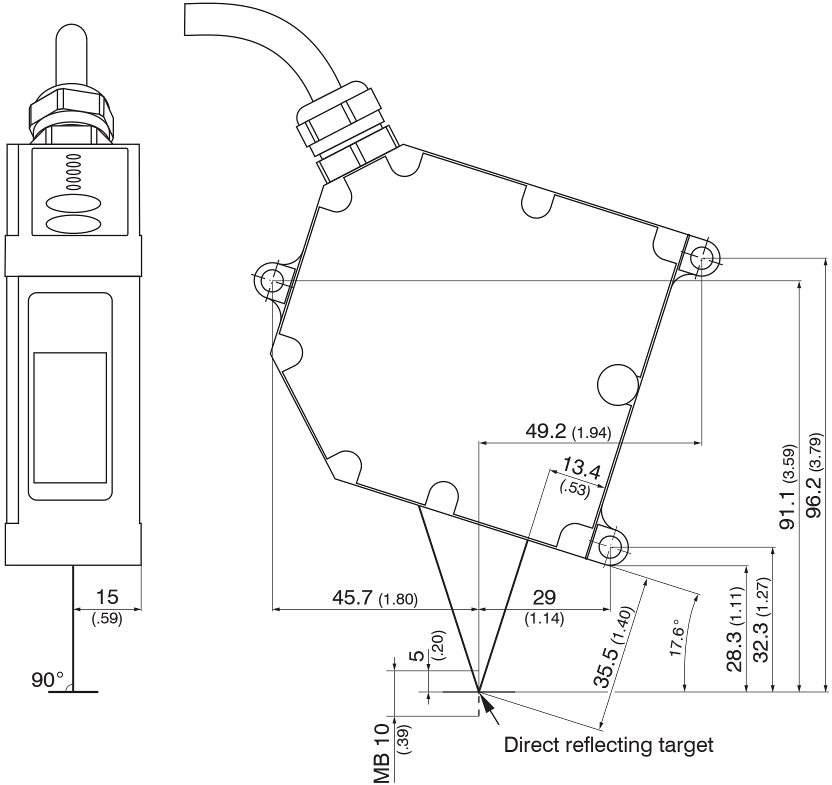
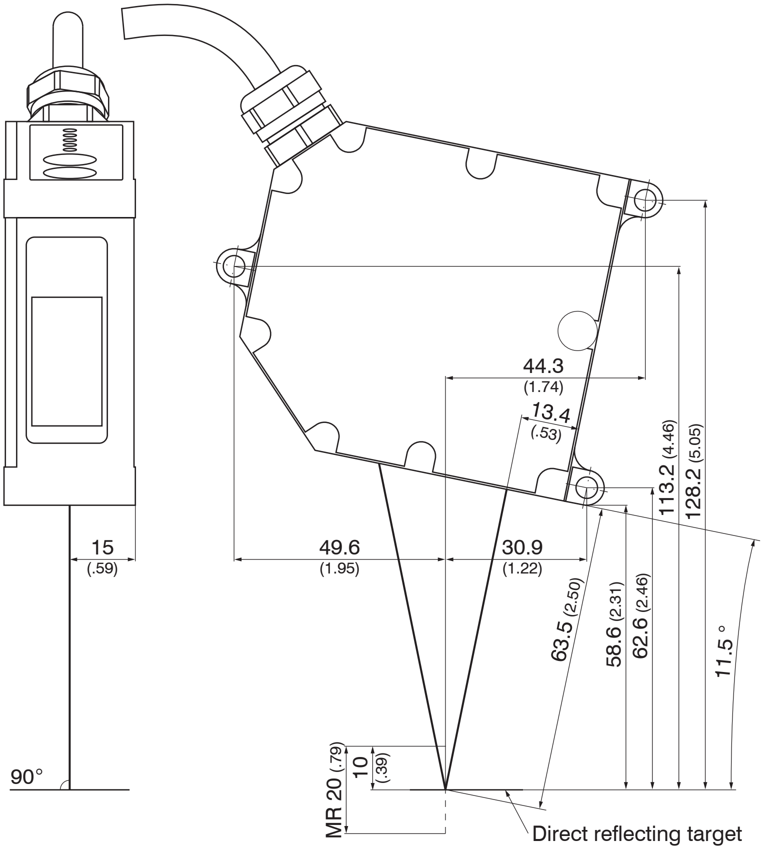


Fig. 17 Dimensional drawings optoNCDT1700-10DR (not to scale)

MR = Measuring range

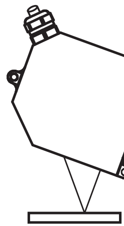


Legend:
mm (inches)

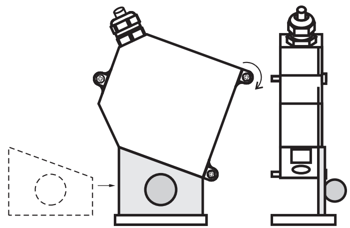
MR = Measuring range

Fig. 18 Dimensional Drawings range optoNCDT1700-20DR (not to scale)

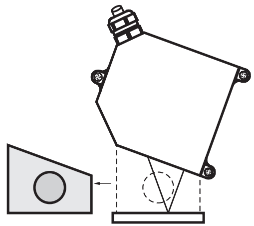
Mounting steps
- Switch on the operating voltage
- Watch the “State“ LED on the top side of the sensor, see Fig. 20.
- Position a shining or mirroring measuring object.



- Move the fit-up aid between sensor and measuring object.
- The “State“ LED illuminates yellow, see Fig. 20.
- Mount the sensor by means of 3 screws type M4.



- Remove the fit-up aid between sensor and measuring object.



5.3 Connector and Sensor Cable

Never bend the sensor cable by more than the bending radius of 60 mm.
The sensor comes with a permanently mounted connection cable of 0.25 m in length. Depending on where it is installed, a 3 m or 10 m sensor cable has to be attached to the connection cable.
MICRO-EPSILON recommends the use of the PC1700 standard sensor cable with a chain-type cable capability.

The connector and the cable component are marked with red markings which have to be aligned opposite each other before connection. In addition, they come with guidance grooves to prevent them from being wrongly connected. To release the plug-in connection, hold the plug-in connector on the grooved grips (outer sleeves) and pull apart in a straight line. Pulling on the cable and the lock nut will only lock the plug-in connector (ODU MINI-SNAP FP - lock) and will not release the connection. It is important, therefore, that the cable is never subjected to excessive pull force. If a cable of over 5 m in length is used and it hangs vertically without being secured, make sure that some form of strain-relief is provided close to the connector. Never twist the connectors in opposite directions to one another when connected.

Connect the cable shield to the potential equalization (PE, protective earth conductor) on the evaluator (control cabinet, PC housing) and avoid ground loops.

Never lay signal leads next to or together with power cables or pulse-loaded cables (e.g. for drive units and solenoid valves) in a bundle or in cable ducts. Always use separate ducts.

Recommended strand cross-section for self-made connection cables: ≥ 0.14 mm² (AWG 25)

i Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

5.4 Switching Inputs Laser On/Off, Setting Masters and the Mid-point

The switching inputs for Laser On/Off and Setting Masters / Mid-point are similarly wired.

➡ Please connect Pin 9 and Pin 6 in order to activate the laser.

If the connection is released, the laser is deactivated.

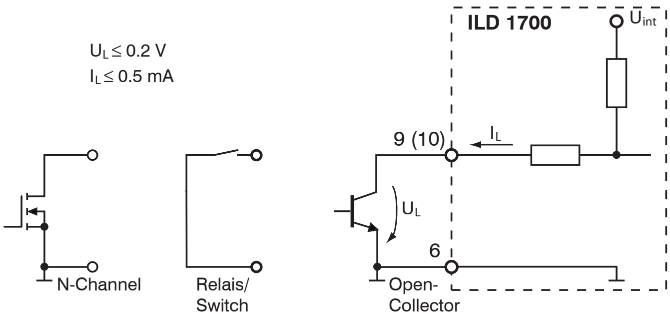


Fig. 19 Switching examples for Laser Off, Mastering, Set Mid-point

6. Operation

6.1 Getting Ready for Operation

Install and assemble the optoNCDT1700 in accordance with the instructions set out, see Chap. 5. and connect with the indicator or monitoring unit and the power supply, having full regard to the connection instructions set out, see Chap. 6.3.

ⓘ IMPORTANT!
The laser diode in the sensor will only be activated
if the input „Laser on/off" is connected to GND.

The laser diode in the sensor can only be activated if the input „Laser on/off" (Pin 9 or the red-blue wire in the sensor cable) is connected to GND.

Once the operating voltage has been switched on the sensor runs through an initialization sequence. This is indicated by the momentary activation of all the LEDs and the two switch outputs. If initialization has been finished, the sensor transmits the info string once in ASCII format via the serial interface independent of the selected interface. The initialization including the info string transmission takes up to 10 seconds. Within this period, the sensor neither executes nor replies commands.

To be able to produce reproducible measurements the sensor typically requires a start-up time of 20 minutes. Once this has elapsed the sensor will be in measurement mode and, in accordance with the factory settings, see Chap. A 2, only the "state" LED will be illuminated.

If the "state" LED is not on, this means that

- either there is no operating voltage or

- the laser has been switched off.

Operating Voltage

- Nominal value: 24 VDC (11 ... 30 V, max. 150 mA).
- Use the power supply unit for measurement instruments only, and not for drive units or similar sources of pulse interference at the same time.

➡ Switch on the power supply unit, if wiring is done.

6.2 Membrane Keys

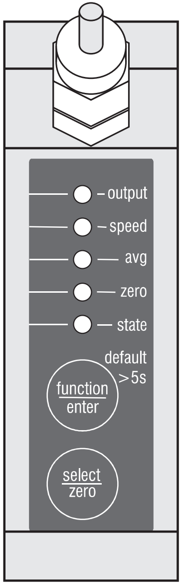


Fig. 20 Top view of the optoNCDT1700

The two membrane keys `function/enter` and `select/zero` have dual assignments, depending on the operating status.

Measurement mode (normal operation):

- `zero` key:
  - Sets the analog output to the value for the mid-point of the measurement range, i.e. 5 VDC or 12 mA.
  - Pressing the `zero` key again resets the function, see Chap. 6.7, see Chap. 6.8.
- `function` key:
  - Switches the sensor to setup mode, see Chap. 6.5.

Pressing and holding the `function/enter` key for longer than 5 seconds overwrites all the parameter values with the factory settings (default values, see Chap. A 2.

Setup mode („function" key actuated):

- `function` key:
  - For running through the levels and parameters.
- `select` key
  - To open the selection list and
  - select the value of the parameter in sequence.
- `enter` key:
  - For saving the selected parameter value and
  - Returning to measurement mode.

If approximately 15 seconds have elapsed since the last press of the `function` key or 30 seconds since the last press of the `select` key, the sensor returns to measurement mode without changing the parameters.

ⓘ IMPORTANT!
In setup mode the sensor continues to send measurement values to the output.

The LEDs on the sensor, see Fig. 20, have different indicator functions depending on whether the sensor is in measurement mode or setup mode.

6.3 LED-Functions

LED	Status	Measurement mode	Setup mode
state	illuminated	Object is in the measurement range or error	...
	off	Sensor off or laser off	
	flashes slowly	...	Selected parameter value matches the saved value
	flashes quickly	...	Selected parameter value does not match the saved value
output speed avg	illuminated or flashing	Indication of the parameter value from level 1	Selected parameter value
	flashing red		Status „off“
zero	illuminated	Sensor „master“ or „ set to mid-point“	
	off	Normal operation	
	flashing	Sensor as slave without synchronous signal	

6.4 Inputs and Outputs

Signal	Pin	Explanation	Configuration
Analog output	13	Current 4 ... 20 mA	$R_{Limit} < (U_B - 6\ V) / 20\ mA$; R_{Limit} max. = 250 Ohm with U_B = 11 V
		Voltage 0 ... 10 VDC	R_i = 100 Ohm, I_{max} = 5 mA, short-circuit protection from 7 mA, [2]
Laser on/off	9	Switching input	Laser operates if pin 9 is connected with GND
Zero	10	Switching input, Chap. 6.7	Connect 0.5 ... 3 s with GND: SET, connect 3 ... 6s with GND: RESET
Switching output 1	8	Error or limit output 1	Open-Collector (NPN), I_{max} = 100 mA, U_{max} = 30 VDC, Interrupt supply voltage to cancel the short-circuit protection
Switching output 2	7	Limit output 2	
Sync +/Sync	3/4	Synchronizaton [1]	Symmetrical synchron output (Master) or synchron input (Slave)
Tx +/Tx -	1/2	Serial output RS422	Terminate with 120 Ohm receive-site
Rx +/Rx -	12/11	Serial input RS422	Internally terminated with 120 Ohm

1) Input is used for triggering in trigger mode, see Chap. 6.14.

2) The use of a 10 nF capacitance at the entrance for interference suppression is recommended.

ⓘ IMPORTANT!
Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

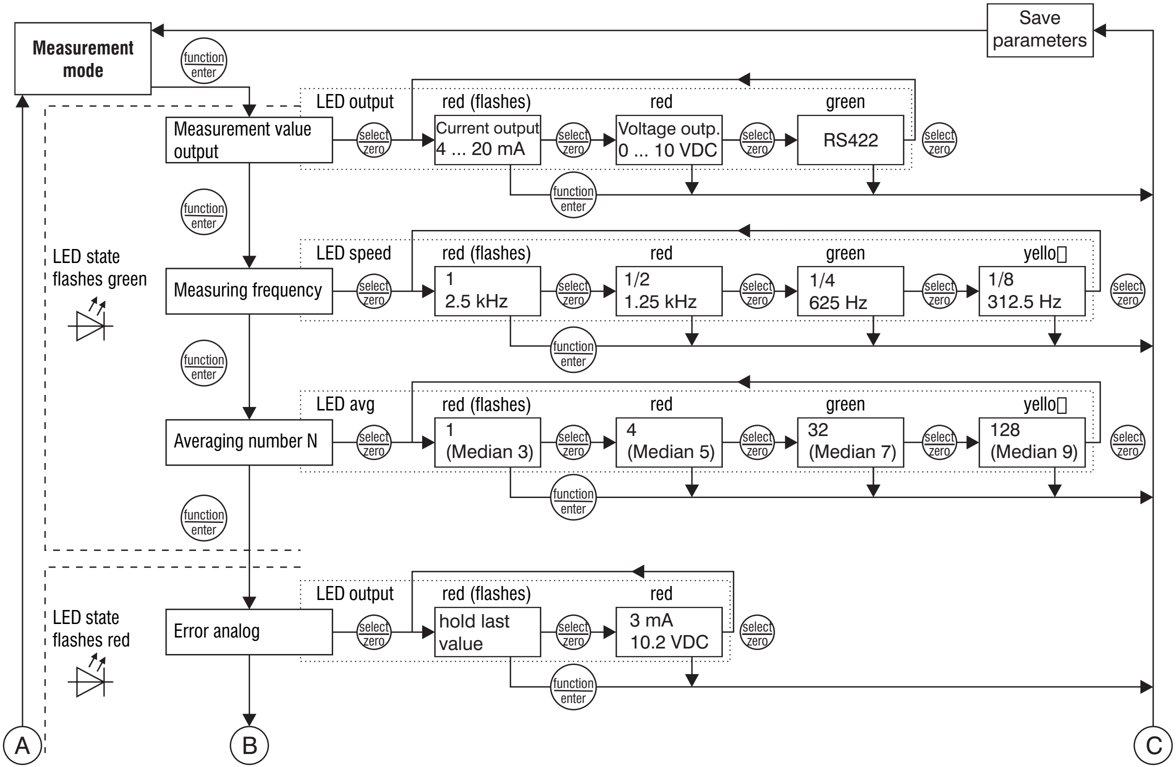
ⓘ IMPORTANT!
Parameters for
- Output type („Measurement value output“)
- Measurement frequency
- Average number
- Analog error

The system returns to measurement mode without saving the parameters:
- if 15 seconds elapse after the last press of the `function/enter` key.

- if 30 seconds elapse after the last press of the `select/zero` key.

6.5 Menu, Setting the Parameters

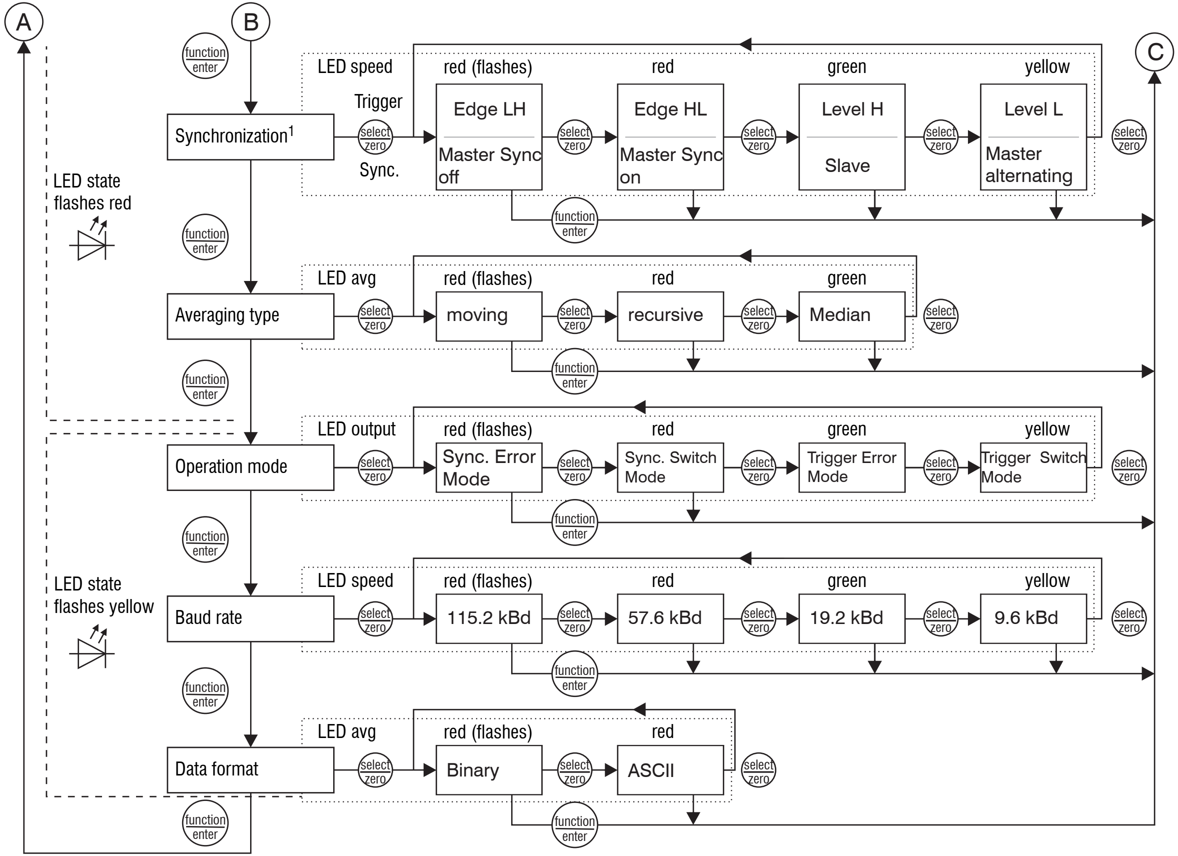
The sensor parameters can be set in setup mode using the `function/enter` and `select/zero` keys.



ⓘ IMPORTANT!

Parameters for
- Synchronization
- Averaging type
- Operation mode
- Trigger mode
- Baud rate
- Data format

The system returns to measurement mode without saving the parameters:
- if 15 seconds elapse after the last press of the `function/enter` key
- if 30 seconds elapse after the last press of the `select/zero` key.



1) Depends on operation mode settings (synchronization or trigger).

6.6 Average Setting

The optoNCDT1700 is supplied ex factory with the default setting „moving averaging, number of averaging N = 1“ (no averaging activated).

Averaging methods:
- Moving average
- Recursive average
- Median

The purpose of averaging is to:
- Improve the resolution
- Eliminate signal spikes
- „Smooth out“ the signal.

Averaging has no effect on linearity.

6.6.1 Averaging Number N

In every measurement cycle (at a measurement frequency of 2.5 kHz every 0.4 ms) the internal average is calculated anew. The averaging number N indicates the number of consecutive measurement values to be averaged in the sensor.

IMPORTANT!
The preset average value and the number of averaging are saved after switching off.

Averaging type	Averaging number	LED „avg“
moving recursive Median	1 (no averaging) 1 (no averaging) 3	off
moving recursive Median	4 4 5	red
moving recursive Median	32 32 7	green
moving recursive Median	128 128 9	yellow

Fig. 21 Specification of the averaging count

In setup mode the averaging number can be set to 4 different, predefined fixed values. Further details on these, see Chap. 6.5. The selected averaging number is also indicated in measurement mode by the “avg“ LED, see Fig. 21.

Averaging does not affect the measurement frequency or data rates in digital measurement value output.

More averaging counts can also be used if programmed via the digital interface, see Chap. 8.5.4.

The averaging is recommended for static measurements or slowly changing measuring values.

6.6.2 Moving Average (Default Setting)

The selected number N of successive measurement values (window width) is used to generate the arithmetic average value M_{gl} on the basis of the following formula:

$$M_{gl} = \frac{\sum_{k=1}^{N} MV(k)}{N}$$

MV = Measuring value
N = Averaging number
k = Running index
M_{gl} = Averaging value respectively output value

Mode:

Each new measurement value is added and the first (oldest) measurement value from the averaging process (from the window) taken out again. This results in short transient recovery times for jumps in measurement values.

Example: N = 4

... 0, 1, 2, 2, 1, 3   ... 1, 2, 2, 1, 3, 4   Measurement value

$$\frac{2, 2, 1, 3}{4} = M_{gl}\,(n) \qquad \frac{2, 1, 3, 4}{4} = M_{gl}\,(n+1)$$

Output value

Standard values for N: The values N = 1, 4, 32, 128 are permanently stored in the sensor. For other permissible values for N, see Chap. 8.5.4.

Characteristics:

The sliding average in the optoNCDT1700 can only be generated for up to a maximum of 128 values.

6.6.3 Recursive Average

Formula

$$M_{rek}(n) = \frac{MV_{(n)} + (N-1) \times M_{rek\,(n-1)}}{N}$$

MV = Measuring value
N = Averaging number
n = Measurement value index
M_{rek} = Average value respectively output value

Mode:

Each new measurement value MV(n) is added, as a weighted value, to the sum of the previous measurement values M_{rek} (n-1).

Standard values for N: The values N = 1, 4, 32, 128 are permanently stored in the sensor. For other permissible values for N, see Chap. 8.5.4 „Averaging“.

Characteristics:

The recursive average permits a high degree of smoothing of the measurement values. However, it requires extremely long transient recovery times for steps in measurement values. The recursive average shows low-pass behavior.

6.6.4 Median

The median is generated from a pre-selected number of measurement values. To do so, the incoming measurement values (3, 5, 7 or 9 measurement values) are resorted again after every measurement. The average value is then given as the median. In generating the median in the controller, 3, 5, 7 or 9 measurement values are taken into account, i.e. there is never a median of 1.

This permits individual interference pulses to be repressed, but the measurement value curve is not smoothed to any great extent.

Example: Average from five measurement values

... 0 1 [2 4 5 1 3] → Sorted measurement values: 1 2 [3] 4 5 Median $_{(n)}$ = 3

... 1 2 [4 5 1 3 5] → Sorted measurement values: 1 3 [4] 5 5 Median $_{(n+1)}$ = 4

6.7 Setting Masters

ⓘ IMPORTANT!
“Master“ is only available in “Switch mode“ and “Set mid-point“ is only available in “Error mode“, see Chap. 6.5.

“Master“ or “Set mid-point“ requires that an object to be measured is within the measurement range.

„Master“ has an influence on the analog and digital output.

“Mastering” enables the measurement values at the sensor output (analog/digital) to be compared with a known measurement object (master). This function is primarily used for comparison of mounting tolerances. The value which is given during measurement on the sensor output of the “mastering object“ is the “master value”. This involves the parallel displacement of the sensor´s characteristic curve.

Storing of the master value in the sensor:

This master value has to be inserted and stored in the sensor before mastering. Currently, there are two possibilities:

1. In the configuration program “ILD1700 Tool“, see Chap. 10..

2. Command „Set_LIMITS“, see Chap. 8.5.7, (Set limit values) as digital value in the „master value“. A detailed description of the calculation, see Chap. 7.3.

Therefore the master value is available even after a restart of the sensor. Detailed information, see Chap. 8.5.20 “Enable / Lock the Flash for Setting Masters and the Mid-Point”. In the case that the sensor configuration is set to „permanent in flash“, the master value can permanently be solved in the sensor in the ILD1700 tool.
The displacement of the characteristic curve reduces the usable measurement range of the sensor the further the master value is away from the master position.

Advice:

In the case of a new ILD1700 sensor 0.5 x measuring range is set as the master value. Resetting to factory settings also includes that the master value is set to 0.5 x measuring range.

The action „mastering“ can be activated in three different ways:

- Press the button `zero/select` on the sensor. Afterwards the red LED flashes “Zero”. The initial state is reached by a second press.
- External Low-Signal at the input “Zero”:
  Connect GND 0.5 … 3 s: SET (mastering),
  Connect GND 3 … 6 s: RESET (reset)
- At Firmware version 6.000 using the command “SETZero”, see Chap. 8.5.21.
  using parameters x = 1 ➯ setting ➯;
  using parameters x = 0 ➯ reset

Sequence	„Mastering“
Operation mode	switch-mode
Setpoint value	Programmed master value
Step 1	Move object to be measured and sensor to desired position relative to one another.
Step 2	Press `Zero` key once or connect the “Zero” input to GND for 0.5 up to 3 s or command „SetZero“ [1].
Output signals after “Mastering”	
Indicator	LED „zero“ lights up.
Analog value	$U_{out,\,M} = \frac{\text{Master value} \cdot 10\text{ V}}{\text{Measurement range}}$ $I_{out,\,M} = \frac{\text{Master value} \cdot 20\text{ mA}}{\text{Measurement range}}$
Digital value	D_A = Master value

Fig. 23 Sequence for mastering

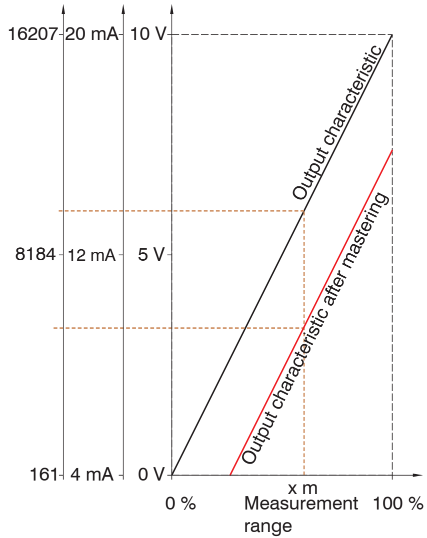


Fig. 22 Characteristic for mastering

Example:

Measurement range 50 mm, voltage output 0 ... 10 V
Master value 17 mm, related to the centre of the measurement range (MR) = 5 V,
Analog value during mastering: 3.4 V

After the mastering, the sensor gives new measurement values, related to the master value. The non-mastered condition applies by means of a reset.

1) Possible at Firmware version 6.0

6.8 Setting Mid-Point

The function „Setting mid-point“ displaces the analog measurement value to the value for the mid-point of the measurement range, so +5 V respectively 12 mA.

The action „set mid point“ can be activated in three different ways:
- Press the button `Zero/Select` on the sensor. Afterwards the red LED flashes “Zero”. The initial state is reached by a second press.
- External Low-Signal at the input “Zero”.
  Connect GND 0.5 ... 3 s: SET (mid-point)
  Connect GND 3 ... 6 s: RESET (reset)
  At firmware version 6.000 using the command “SETZero”, see Chap. 8.5.21
  using parameters x = 1 ➩ setting ➩;
  using parameters x = 0 ➩ reset

ⓘ IMPORTANT!
“Master“ is only available in “Switch mode“ and “Set mid-point“ is only available in “Error mode“, see Chap. 6.5.

“Master“ or “Set mid-point“ requires that an object to be measured is within the measurement range.

“Set Midpoint“ has an influence on the analog and digital [1] output.

Sequence	**„Set mid-point“**
Operation mode	error-mode
Setpoint value	Centre of the analog area
Step 1	Move object to be measured and sensor to desired position relative to one another.
Step 2	Press `Zero` key once or connect the “Zero” input to GND for 0.5 up to 3 s or command “SetZero” [1].
Output signals after ”Set mid-point”	
Indicator	„Zero“ LED lights up.
Analog values	U_A = 5 V or I_A = 12 mA
Digital value	D_A = 8184

Fig. 24 Sequence for setting the mid-point

1) Possible at Firmware version 6.0

Example:

Measurement range 50 mm, voltage output 0 ... 10 V
Mid-point is set at the position x_m = 10 mm
Set mid-point results in an output signal of 5 V.

Remaining measurement range respectively output range:

x_{max} = 35 mm

Out_{min} = 3 V respectively 8.8 mA

After setting mid-point the sensor gives new measurement values, related to the mid-point.

The condition before setting mid-point can be achieved by a reset.

Set mid-point (only error mode): no limit control

The displacement of the characteristic curve reduces the usable measurement range of the sensor.

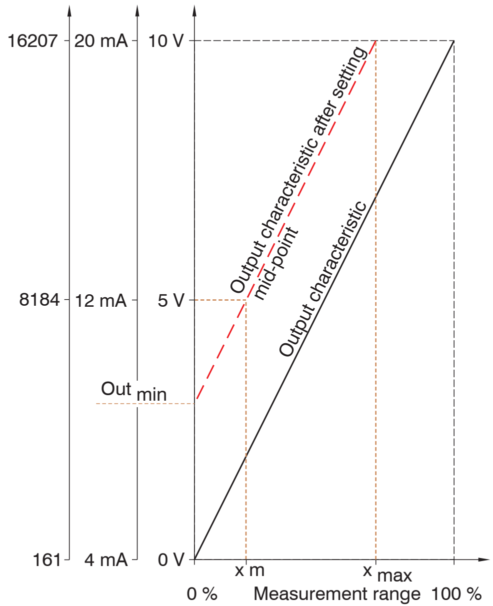


Fig. 25 Characteristic for setting the mid-point

6.9 Frequency and Output Rate

IMPORTANT!
Synchronized sensors must always be set to the same measurement frequency.

Please, see Chap. A 3.

Recommendations:
- Use a high measurement frequency for light colored and matt objects to be measured.
- Use a low measurement frequency for dark or shiny objects to be measured (e.g. surfaces covered in black lacquer), for better measurement results.

The measurement frequency defines the number of measurements performed by the sensor per second. The measurement frequency may be 2.5 kHz, 1.25 kHz, 625 Hz or 312.5 Hz. Details of how to change the measurement frequency, see Chap. 6.5.

The output rate gives the actual number of measurement values at the sensor output per second. The maximum output rate can never exceed the measurement frequency.

Output	Maximum output rate
Current	Measurement frequency
Voltage	Measurement frequency
RS422	Output rate Measurement frequency; Dependent on the transmission rate (baud rate) and data format (ASCII-Code).

The sensor continues to measure internally but holds back the output until the last measurement value has been issued in full. The next measurement value is the last valid value, with other values between being lost.

Fig. 26 Output rates for the output types

Calculation of the output rate using the RS422 serial interface:

Output rate = Measuring frequency n

n = int (b * 11 * MR / BR) + 1

The values are summarized, see Chap. A 3.

Abbreviations used:
n = Partial factor
int = Integral part of ( )
b = Byte/measurement value
(binary format b=2, ASCII b=6))
MR = Measurement frequency [Hz]
BR = Baud rate [Baud]

Example:

Measurement frequency = 1250 Hz, ASCII-Format (b=6), Baud rate = 19200 Baud

--> n = int (4.3) + 1 = 5

--> Output rate = 1.25 kHz / 5 = 250 Hz.

6.10 Operation Mode

6.10.1 Error Mode

(Error Control)

In error mode, the switching output 1 is used as an error output. The switching output 2 remains inactive. The error mode can be programmed using both the keypad and the programming interface.

The error output is activated (conducting to GND) when:

- the object to be measured is outside the measurement range, see Fig. 27,
- there is no object to be measured present, or
- if the object to be measured is unsuitable (too dark, polished metal, insufficiently reflective).

Transparent objects can be penetrated by the light of the laser and the laser spot unacceptably enlarged, resulting in unreliable measurements. This will also trigger the error output.

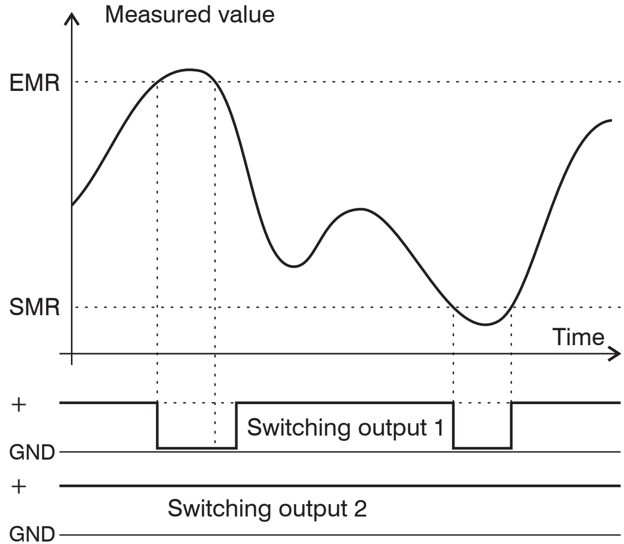


Fig. 27 Signal sequence for the switching outputs in the operation mode „Sync error“ and „Trigger error“

6.10.2 Switch Mode

(Limit Control)

In switch mode, both switching outputs are used as limit switches, see Fig. 28.
The individual limits can be programmed using the digital programming interface, see Chap. 8.5.7, see Chap. 8.5.8.

Error mode: Setting mid-point only, no limit control

Switch mode: Mastering only, limit control

ⓘ IMPORTANT!
The limit control is based on the average.

The following four values are used:
- Upper limit (UL),
- Lower limit (LL),
- Upper hysteresis value (UH),
- Lower hysteresis value (LH).

If the upper limit is exceeded the assigned switching output 1 will be activated (conducting), and deactivated again with the follow-on shortfall on the upper hysteresis value. The same applies in principle to a shortfall on the lower limit and switching output 2, see Fig. 28.

Standard setting

Upper limit (UL):
101 % FSO / Digital value: 16365

Upper hysteresis value (UH):
100 % FSO / Digital value: 16207

Lower hysteresis value (LH):
0 % FSO / Digital value: 161

Lower limit (LL):
-1 % FSO / Digital value: 0

In switch mode, both switching outputs are activated when:
- the object to be measured is outside the measurement range, see Fig. 28,
- there is no object to be measured present, or
- if the object to be measured is unsuitable (too dark, polished metal, insufficiently reflective).

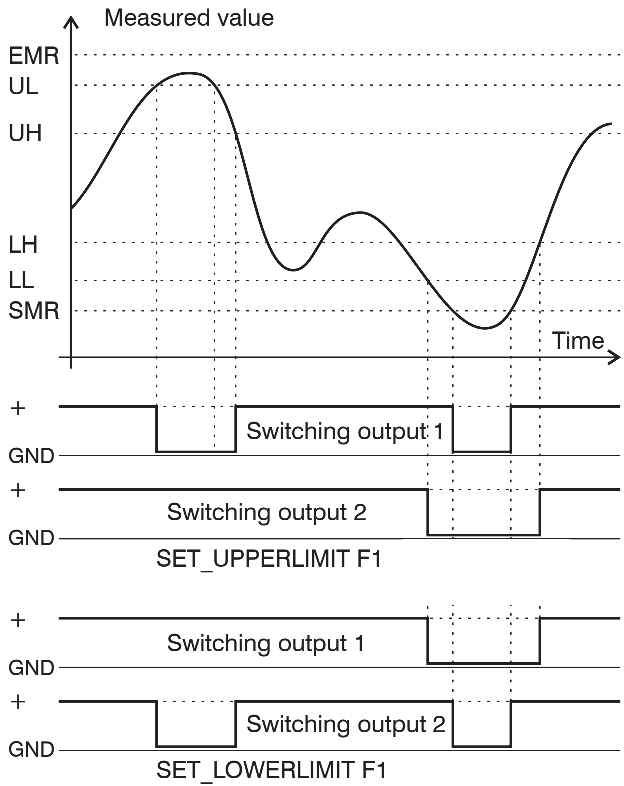


Fig. 28 Signal sequence for the switching outputs in operation mode „Sync switch“ and „Trigger switch“

6.10.3 Output Circuit for the Switching Outputs

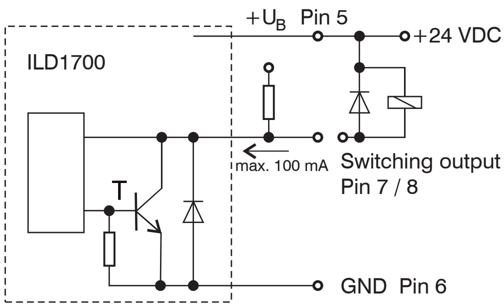


Fig. 29 Switching output: Examples of external protective circuit with pull-up resistor or relay with protective diode

In the active state the transistor T is conductive. The switch outputs are short-circuit-proof.
To reset the short-circuit protection:
- Clear the external short circuit
- Switch off the sensor and switch on again, or
- Send the software command "Reset" to the sensor.

The two limit outputs (Pin 7 and 8) may also be actuated in parallel as window comparator (OK/ Not OK separation).

WARNING!
Never connect the relay without a protective diode! Risk of damage to the switch output.

6.11 Synchronization of Sensors

If two sensors are used on a single object to be measured, they can be synchronized with each other. The optoNCDT1700 distinguishes between two types of synchronization, see Fig. 30.

IMPORTANT!
Synchronization requires that the master and slave sensors have the same measurement frequency.

Type		Used for
Simultaneous synchronization	Both sensors measure in the same cycle.	Measurement of differences (thickness, difference in height) on opaque objects. Here, Sensor 1 must be programmed as the "Master" and Sensor 2 as the "Slave".
Alternating synchronization	Both sensors measure alternately	Thickness measurements on translucent objects or measurements of difference on closely spaced measurement points. The alternating synchronization requires that the lasers are switched on and off alternately so that the two sensors do not interfere with each other optically.

Fig. 30 Characteristics of and uses for the different types of synchronization

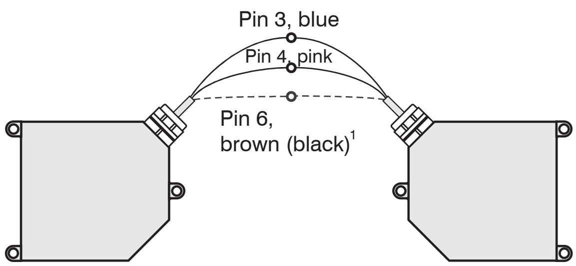
For alternating synchronization the master sensor has to be run in „Master alternating" mode, see Chap. 6.5.

ⓘ IMPORTANT!
The slave sensor should be operated unsynchronized as far as possible!

⚠ WARNING!
The synchronous terminals must never be connected to the operating voltage and/or GND, even momentarily. Risk of permanent damage from overloading!

1) Connect the ground connectors (GND, pin 6, black), of the sensors if the sensors are not operated on the same power supply.

Although this does not change the measurement frequency, the output rate is reduced by half in this mode. An unsynchronized slave switches the laser off, sends an accordant error signal.



Conductors twisted together in the cable must be used for synchronization. Terminals with the same polarity (Sync+ and Sync-) should be connected.

The optoNCDT1700 contains a terminating resistor, see Fig. 31, between pin 3 and 4 for line matching.

Fig. 31 Synchronization of two optoNCDT1700

Synchronization with external signal

If a sensor is synchronized with an external signal the levels of the signal must comply with the LVDS specifications (Low Voltage Differential Signals). Further information, see Chap. 6.14.3. The synchronization frequency is to maintain with a tolerance of ±1 % of the measurement frequency.

Triggering is done with an accordant hardware only. Use the optional available triggerBOX1700 from MICRO-EPSILON.

6.12 Exposure Time

At a maximum measurement frequency of 2.5 kHz the CCD element is exposed 2500 times per second. This gives a predefined maximum exposure time (laser exposure time) of 0.4 ms at this measurement frequency. The lower the measurement frequency, the longer the maximum exposure time.

The real-time control of the sensor reduces the exposure time in dependency on the amount of light hitting the CCD element and therefore compensates for reflection changes at the same time, e.g. caused by imprints on the surface of the object being measured.

6.13 Timing, Measurement Value Flux

The controller operates internally with real time cycles in a pipeline mode:

1. Exposure: Charging the image detector in the receiver (measurement).
2. Reading: Reading out of the imaging device and converting into digital data.
3. Computation: Measurement computation.
4. Controlling

The output through the analog and digital interface starts with the beginning of every new cycle. The analog value and digital switch outputs are updated immediately and the digital output starts with the start bit.

Each cycle takes 400 µs at a measuring rate of 2.5 kHz (speed=1). The measured value N is available after each cycle with a constant lag of four cycles in respect to the real time event. The delay between the input reaction and the signal output is therefore 1.2 up to 1.6 ms. The processing of the cycles occurs sequentially in time and parallel in space, see Fig. 32, pipelining). This guarantees a true constant real time data stream.

Cycle	1.	2.	3.	4.	5.
Time	400 µs	800 µs	1200 µs	1600 µs	2000 µs
1. Layer	Exposure N (Output N-4)	Reading N	Computation N	Controlling N	Exposure N+4 (Output N)
2. Layer	Controlling N-3	Exposure N+1 (Output N-3)	Reading N+1	Computation N+1	Controlling N+1
3. Layer	Computation N-2	Controlling N-2	Exposure N+2 (Output N-2)	Reading N+2	Computation N+2
4. Layer	Reading N-1	Computation N-1	Controlling N-1	Exposure N+3 (Output N-1)	Reading N+3

Fig. 32 Sensor timing

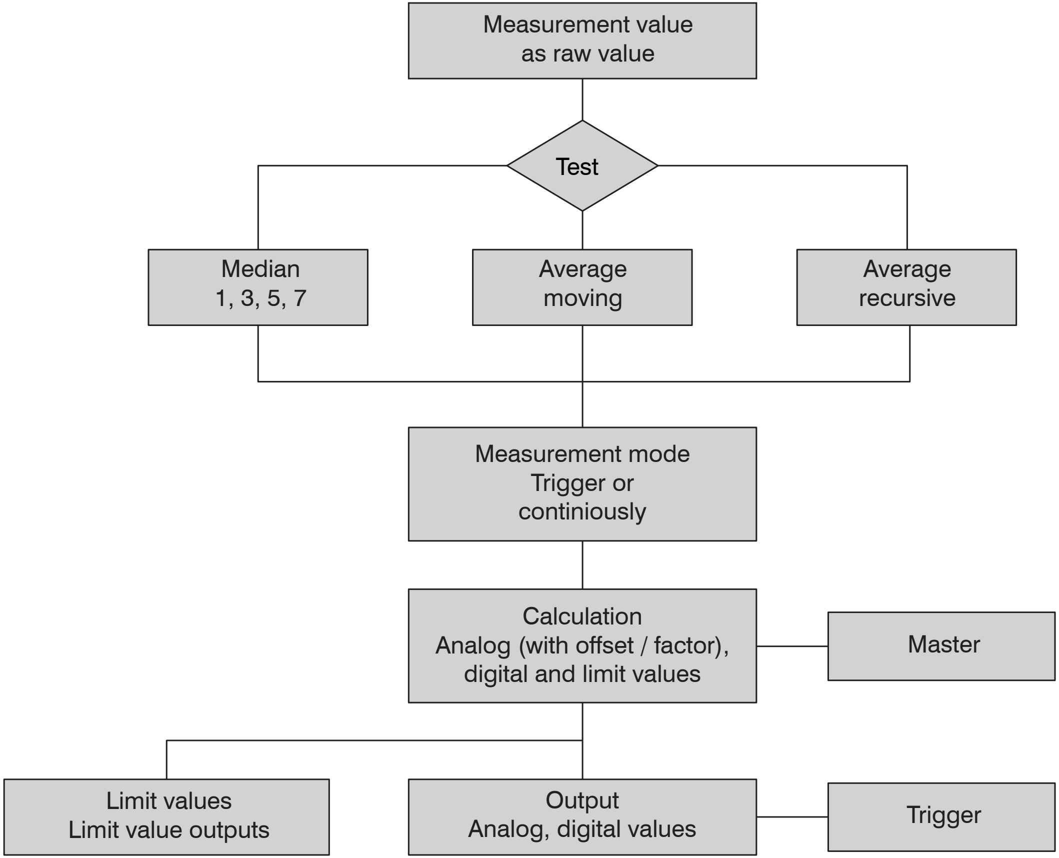


Fig. 33 Measurement value flux ILD 1700

ⓘ IMPORTANT!
Triggering is done with an accordant hardware only. Use the optional available triggerBOX1700 from MICRO-EPSILON.

6.14 Triggering

6.14.1 Basics

The optoNCDT1700 measurement output is controllable through an external signal (electrical signal or command). Thereby the analog or digital output is affected only. Triggering does not influence the measuring frequency respectively the timing, see Chap. 6.13, so that between the trigger event (level change) and the output reaction always lie 4 cycles.

The synchronization inputs are used for external triggering. So the sensors can alternatively be synchronized or triggered. The change between **synchronization** (default setting) and **triggering** is done with the keys, see Chap. 6.5, „Operation mode“ or the SET_ERROROUTPUT command, see Chap. 8.5.9.

ⓘ IMPORTANT!
The limit control is activated only in the operation mode „Trigger switch mode“.

6.14.2 Trigger Modes

The measurement output in trigger mode can be controlled with the **edge** as well as the **level** of the trigger signal. Implemented trigger conditions:

- Rising edge,
- Falling edge,
- High level or
- Low level.

Set the trigger conditions (edge or level) with the keys, see Chap. 6.5, „Synchronization“ or the SET_TRIGGERMODE command, see Chap. 8.5.13.

Edge triggering

The analog output is updated after a trigger edge. If the digital output is selected only a single digital value, see Fig. 34, is transmitted through the RS422 interface. Between the analog output is temporarily stopped (“Sample and hold“), see Fig. 35.

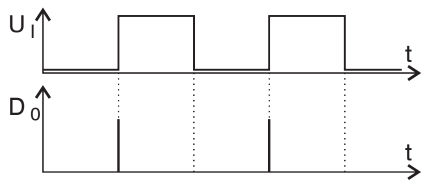


Fig. 34 Rising trigger edge (above) and digital output signal (below)

Level Triggering

So long measurements are transmitted as the trigger condition is fulfilled.

The GET_MEASVALUE command, see Chap. 8.5.19, supplies the specified amount of digital measurements which must be defined in the related parameter. Digital measurements are output in binary, see Chap. 8.2.1 or ASCII format, see Chap. 8.2.2, in trigger mode.

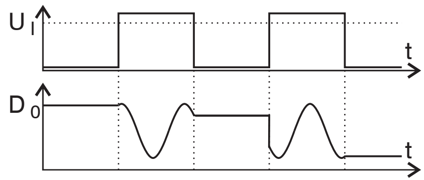


Fig. 35 High trigger level (above) and analog output signal (below)

6.14.3 Trigger Signal Levels

The inputs (Trig+, Trig-;, see Fig. 40) are used for external triggering. The necessary signal levels comply to the LVDS (Low Voltage Differential Signals) specification. Thus only LVDS driver circuits with 3.3 V operation voltage are used for triggering.

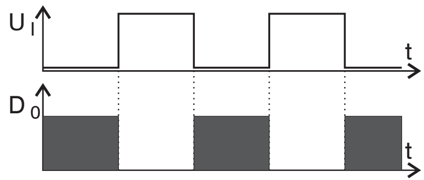


Fig. 36 Low trigger level (above) and digital output signal (below)

The difference between both input signals Trig+ (pin 3) and Trig- (pin 4) must be according to amount greater than 100 mV. Each individual signal may lie in the range between 0 V and +2.9 V related to GND. The sensor detects a high level, see Fig. 37, if the voltage on Trig+ is greater than on Trig-. The optoNCDT1700 contains a terminating resistor, see Fig. 38, between pin 3 and 4 for line matching.

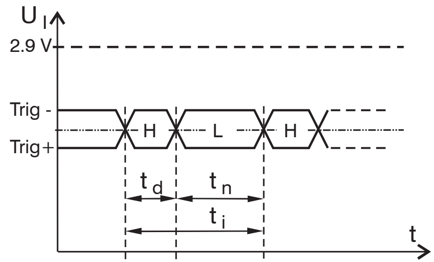


Fig. 37 Timing trigger signal

t_d Pulse duration
t_n Non-pulse period
t_i Pulse interval
U_l Input signal level

6.14.4 Trigger Pulse

The trigger pulse duration td must be one cycle time (= 1 / measuring frequency) at least. Shorter measuring frequencies need a longer trigger pulse duration
(e.g. from t_d = 400 µs with speed = 1 up to t_d = 3.2 ms with speed = 1/8).

IMPORTANT!
Exceeding the maximum trigger frequency leads in measuring inaccuracy shown by the flashing zero LED and the set error output (if operation mode trigger/error is selected).

IMPORTANT!
Triggering is done with an accordant hardware only. Use the optional available triggerBOX1700 from MICRO-EPSILON.

IMPORTANT!
Connect the trigger source ground with the sensor ground (GND, pin 6) before sending trigger signals.

Edge triggering

The pulse interval t_i between two trigger pulses must be at minimum four cycles. Then the triggered measurement is issued before a new trigger edge arrives. This results in a maximum trigger frequency of 625 Hz for a measuring frequency of 2.5 kHz.

Level triggering

If the trigger level has changed, all measurements must be issued before a new trigger lever can be identified. The sensor requires a non-pulse period t_n of 4 cycles. The minimum pulse interval amounts therefore 5 cycles ($t_i = t_d + t_n$), see Fig. 39. This results in a maximum trigger frequency of 500 Hz for a measuring frequency of 2.5 kHz.

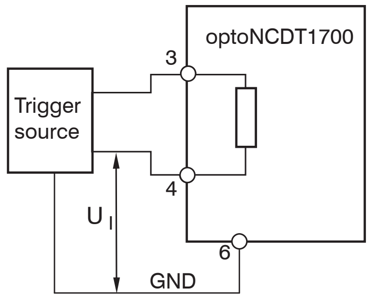


Fig. 38 Trigger wiring

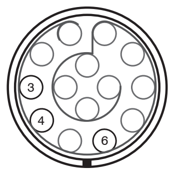
Trigger mode	Edge triggering	Level triggering
Pulse duration t_d	1 Cycle = 400 μs	1 Cycle = 400 μs
Non-pulse period t_n	3 Cycles = 1.2 ms	4 Cycles = 1.6 ms
Pulse interval t_I	4 Cycles = 1.6 ms	5 Cycles = 2.0 ms
Trigger frequency f_T	$f_T = f_M / 4$ = 625 Hz	$f_T = f_M / 5$ = 500 Hz

f_M = Measurement frequency

Fig. 39 Minimum pulse values and maximum trigger frequency for speed = 1

6.14.5 Pin Assignment for External Trigger Signal

Pin	Input	Characteristics	Color sensor cable PC1700-x
3 4	Trigger+ Trigger -	Differential input	blue pink
6	GND	System ground	black



View on solder-pin side male cable connector, insulator

Fig. 40 Pin assignment for external trigger signal

7. Measurement Value Output

A 10 nF ceramic capacitor between analog output and AGND of subsequent devices reduces high frequency interferences.

The optoNCDT1700 can issue the measurement values either via the analog output or the RS422 serial interface. The two different types of output cannot be used concurrently. The analog output can be programmed for use as a current output or a voltage output.

7.1 Voltage Output

Range for measurement voltages	-0.1 V ... +10.1 V
Output amplification $\triangle U_{OUT}$	10.0 V = 100 % Measuring range
Error value:	10.2 V (±10 mV)

Calculation of a measurement value x in mm from analog voltage:

$$x\,[mm] = U_{OUT} * \frac{MR\,[mm]}{10.0\,[V]}$$

Reference value: SMR

$$x\,[mm] = U_{OUT} * \frac{MR\,[mm]}{10.0\,[V]} - MR/2$$

Reference value: MMR

Example: Measuring range = 10 mm, U_{OUT} = 4.6 V; Result: x = 4.6 mm respectively x = -0.4 mm

SMR = Start of measuring range

MMR = Midrange

EMR = End of measuring range

MR = Measuring range

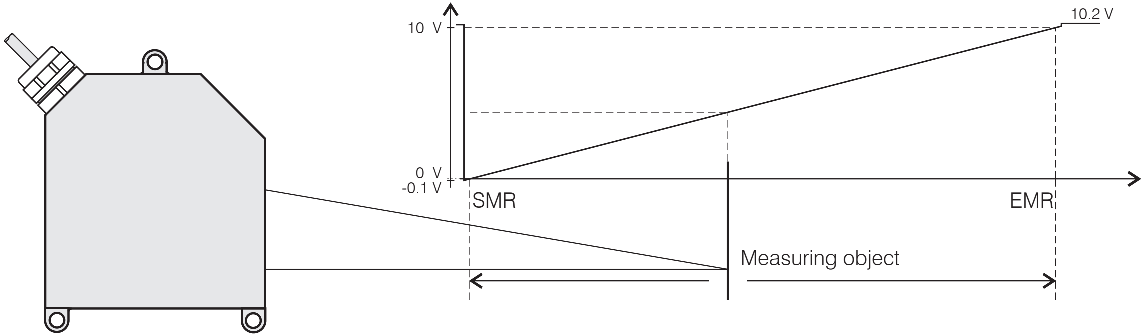


Fig. 41 Voltage output signal

7.2 Current Output

Max. range	4 mA ... 20 mA
Output amplification $\triangle I_{OUT}$	16 mA = 100 % Measuring range
Error value:	3 mA (±3 µA)

Calculation of measurement value x in mm from analog current

Reference value SMR:

$$x\,[mm] = (I_{OUT} - 4\,mA) * \frac{MR\,[mm]}{16\,[mA]}$$

Reference value MMR:

$$x\,[mm] = (I_{OUT} - 4\,mA) * \frac{MR\,[mm]}{16\,[mA]} - MR/2$$

Example: Measuring range = 10 mm, I_{OUT} = 12 mA; Result: x = 5 mm respectively x = 0 mm

7.3 Digital Value Output

The digital measurement values are issued as unsigned digital values (raw values).

Digital value	Used for
0 ... 16367	Value range
0 ... 160	SMR back-up (1 %)
161 ... 16207	Measurement range

Digital value	Used for
16208 ... 16367	EMR back-up (1 %)
16370 ... 16383	Error codes

Calculation of a measurement value in mm from digital output

Reference value SMR:

$$x\,[mm] = (digital_{OUT} * \frac{1.02}{16368} - 0.01) * MR\,[mm]$$

Reference value MMR:

$$x\,[mm] = (digital_{OUT} * \frac{1.02}{16368} - 0.51) * MR\,[mm]$$

Example: MR =10 mm, Reference value = SMR

Digital value	Conversion	Measurement value	
8184	(8184 * 6.23167e-5 - 0.01) * 10 mm	= 5 mm	(=MMR)
10261	(10261 * 6.23167e-5 - 0.01) * 10 mm	= 6.294 mm	
161	(161 * 6.23167e-5 - 0.01) * 10 mm	= 0 mm	(=SMR)

Note: A digital value can be calculated from a measurement value (millimeter) as follows:

$$digital_{OUT} = \left[\frac{x\ [mm]}{MR\ [mm]} + 0.01 \right] * \frac{16368}{1.02}$$

This formula can be used, for example, in the programming of switching thresholds, see Chap. 8.5.7.

7.4 Digital Error Modes

Digital error codes are issued in the same way as measurement values.
Value range for error codes:
16370 ... 16383 (digital OUT)

F1 bad object	16370	No object detected
F2 out of range -	16372	Too close to sensor
F3 out of range +	16374	Too far from sensor
F4 poor target	16376	Object cannot be evaluated
F5 Laser off	16378	external laser off
	16380	Sensor in trigger mode Trigger pulses come to fast.

8. Serial Interface RS422

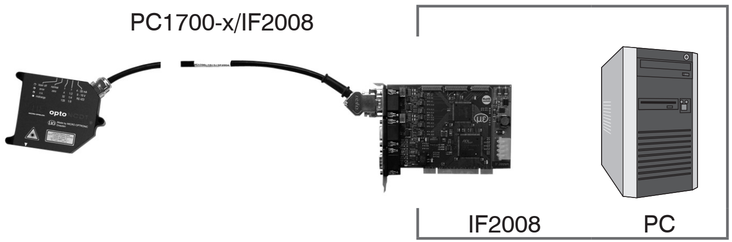


Fig. 42 System structure to operate the interface card IF2008

	Pin	Signal	Signal	Pin	
Sensor 1 14-pol. ODU-connector	5	24 V	24 V supply [1]	10	IF2008, X1 and X2, 15-pol. Sub-D
	12	Rx + (Input)	Sensor 1/3 TxD+	2	
	11	Rx - (Input)	Sensor 1/3 TxD -	1	
	1	Tx + (Output)	Sensor 1/3 RxD+	4	
	2	Tx - (Output)	Sensor 1/3 RxD -	3	
	3	Sync +	TRG +	6	
	4	Sync -	TRG -	7	
	6	GND	GND	15	
When using 3 sensors apply the optional available Y-adapter cable IF2008-Y.					
Sensor 2 14-pol. ODU connector	5	24 V	24 V supply [1]	10	
	12	Rx +	Sensor 2/4 TxD+	12	
	11	Rx -	Sensor 2/4 TxD -	11	
	1	Tx +	Sensor 2/4 RxD+	14	
	2	Tx -	Sensor 2/4 RxD -	13	
	3	Sync +	TRG +	6	
	4	Sync -	TRG -	7	
	6	GND	GND	15	

Required cables and program routines

- IF2008
  RS422 interface card, for 1 to 4 laser-optic sensors from the ILD1700 series and 2 encoders, including MEDAQlib programming interface.

- PC1700-x/IF2008
  Power supply and output cable, x = length with 3, 6 or 8 m.

Alternatively, data can be transferred with the demo software (ILD1700 Tool) and a RS422 converter to USB, see Chap. 10..

Fig. 43 Pin assignment for two PC1700-x/IF2008 and IF2008

1) Supply voltage for the connected sensors and encoders, output current 1.25 A max.

8.1 Interface Parameters

The optoNCDT1700 comes with a RS422 serial interface to enable the sensor to be operated from a standard computer and measurement values and error codes to be transferred.

Data format: 8 Data bits, no parity, one stop bit (8,N,1)

The factory-set baud rate is 115.2 kBaud but it can be programmed to a different value, see Chap. 6.5. The maximum measurement frequency is 2.5 kHz.

8.2 Data Format for Measurement Values and Error Codes

8.2.1 Binary Format

The data word is comprised of two consecutive bytes (H-byte/L-byte). One flag bit in each byte differentiates a high from a low byte.

Start	1	7 Bit MSB	Stop	Start	0	7 Bit LSB	Stop

Conversion of the binary data format:

For conversion purposes the high and low bytes must be identified on the basis of the first bit (flag bit), the flag bits deleted and the remaining 2 x 7 bits compiled into 14 bit data word.

Reception:

H-Byte	1	D13	D12	D11	D10	D9	D8	D7
L-Byte	0	D6	D5	D4	D3	D2	D1	D0

Result of conversion

0	0	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Conversion must be done in the application program.

Example:
Digital value: 2099 (= 0x0833 = 0b0010000 0110011) 14 Bit

Binary format

H-Byte: Transfer 0x90 (0b10010000)	with flag bit	8 Bit
-> converted 0x10 (0b0010000)	without flag bit	7 Bit
L-Byte: Transfer 0x33 (0b00110011)	with flag bit	8 Bit
-> converted 0x33 (0b110011)	without flag bit	7 Bit

Flag bits deleted and compiled: 0x833

8.2.2 ASCII Format

Output of 5 characters (digits) in ASCII code for the digital value + 1 tag „CR“ (= 0x0D), i.e. a total of 6 characters. Digital values with just 3 or 4 digits are preceded by blank characters.

Example: Digital value 2099
Transfer: “_2099“ (preceded by 1 blank character) „CR“

ASCII-Code (Hex.)	0x20	0x32	0x30	0x39	0x39	0x0D
Characters	SP	2	0	9	9	CR

Advices:
ASCII characters can be easily shown using a terminal program.

The output rate in ASCII format is reduced automatically by skipping individual measurement values, see Chap. 6.9.

8.3 Set-up of the Commands

The commands for the sensors are comprised of command data which are transmitted in full duplex mode. Each command packet is comprised of a whole number multiple of 32 bit words, see Fig. 44.

	31	24	23	16	15	8	7	0
1	Header							
2	(ID)							
3	Command (16 Bit)				Package length (16 Bit)			
4	Data 1							
5	...							
6	Data (n)							

Contents	
Start word	Command header (2 words)
Sensor identifier e.g. „ILD1“	
Command code	Data word quantity n+2
1st Data word (4 Bytes)	
...	
nth Data word (4 Bytes)	

Fig. 44 Structure of a command packet

ⓘ IMPORTANT!
The sensor continues to deliver measurement values to the analog output even while communicating with the sensor.

Since most serial interfaces use an 8 bit data format, 4 consecutive bytes are combined into a 32 bit word. Each command packet has a header consisting of two 32 bit words followed by the command and, if required, other data as well. The top two bits (No. 31 and 30) are always “0“ in the transmitted command.

Example:

Command **SET_AVX**. Sets the averaging number N for the moving and recursive average.
Command: 0x2075
Averaging number: N = 1024, therewith X = log2 1024 = 10 (= 0xA)
Data word: n = 1
Package length: 3

For further informations on this command, see Chap. 8.5.4.

Format:

31	24	23	16	15	8	7	0	hex	Contents	
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D	Start word	
„I“		„L“		„D“		„1“		0x494C4431	Identifier ID „ILD1“	
0x20		0x75		0x00		0x03		0x20750003	Command (0x2075) 2 top bits = 0	Package length = 3
0x00		0x00		0x00		0x0A		0x0000000A	Data word 1 (X = 0xA)	

8.4 Command Reply

8.4.1 Communication without Error

No start word is transmitted, if the sensor replies to a command. The 1st word then is the sensor identifier. The second word is the command with set MSB (Bit 31 = 1, corresponding an OR operation of the command with 0x8000) and the new package length, if there was no error during communication. With longer answers (e.g. GET_INFO) the package length is larger according to the quantity of data words to be transmitted. A firm 32 bit word 0x20200D0A forms the conclusion of the answer. The conclusion word is not a data word.

Example: Sensor reply (without error) to the SET_AVX command.

31	24	23	16	15	8	7	0	hex	Contents	
„I“		„L“		„D“		„1“		0x494C4431	Identifier ID „ILD1“	
0xA0		0x75		0x00		0x02		0xA0750002	0x2075 OR 0x8000 (MSB = 1)	Package length (2)
0x20		0x20		0x0D		0x0A		0x20200D0A	Conclusion word	

Wait until the sensor reply, before you send a new command to the sensor.

8.4.2 Communication with Error

If the sensor detects an error during the execution of a command, the second highest bit (bit 30) of the command is also set (the command is OR operated with 0xC000). Additionally a command error code is transferred as data word, see Fig. 45. The resulting package length amounts to now 3 data words. The reply is finished with a 32 bit word 0x20200D0A (2 blank characters + CR + LF).

Error-Code X	Description
1	Command unknown
2	Incorrect parameter value
3	Invalid parameter
4	Time out
5	Command failed
6	Warning for averaging type and averaging number [1]

Fig. 45 Command error codes

Example: Sensor operates in the average mode “Median“. The command SET_AVX is not possible in this averaging mode and leads to the following answer.

31	24	23	16	15	8	7	0	hex	Contents	
„I“		„L“		„D“		„1“		0x494C4431	Identifier ID „ILD1“	
0xE0		0x73		0x00		0x03		0xE0730003	0x2075 OR 0xC000 (2 top bits = 1)	Package length = 3
0x00		0x00		0x00		0x05		0x00000005	Command error code: 5 „Command failed“	
0x20		0x20		0x0D		0x0A		0x20200D0A	Conclusion word	

The sensor continues to deliver measurement values to the analog output even while communicating with the sensor. The measurement value output on the digital interface is momentarily interrupted.

1) , see Chap. 8.5.5.

8.5 Commands

8.5.1 Overview

ⓘ IMPORTANT!
Wait until the sensor reply, before you send a new command to the sensor.

Information commando		
0x20490002	GET_INFO	Shows sensor data
0x204A0002	GET_SETTINGS	Shows sensor settings
Average		
0x20700002 0x20710002 0x20720002 0x20730002 0x20750003	SET_AV0 SET_ AV1 SET_ AV2 SET_ AV3 SET_ AVX	Sets Average 0 = 1 (Median 3) Sets Average 1 = 4 (Median 5) Sets Average 2 = 32 (Median 7) Sets Average 3 = 128 (Median 9) Average X = $\log_2$ (MV)
0x207D0003	SET_AV_T	Selects average type
Measurement value output		
0x20770002	DAT_OUT_ON	Permanent measurement value output
0x20760002	DAT_OUT_OFF	Stops measurement value output
0x202C0003	GET_MEASVALUE	Reduced measurement value output (polling)
Fixed points and limits		
0x207E0007	SET_LIMITS	Sets limits, hysteresis and master
0x20830002	SET_UPPERLIMIT_F1	Assignment OG -> Limit 1
0x20840002	SET_LOWERLIMIT_F1	Assignment UGt -> Limit 1
Error and measurement value autputs		
0x20950003	SET_ERROROUTPUT	Error mode and switchmode for synchronization or triggering
0x20900003	SET_OUTPUTTYP	Measurement value output : Current, Voltage, RS422
Speed		
0x20850003	SET_SPEED	Measurement frequency: 2.5 kHz; 1.25 kHz; 625 Hz; 312.5 Hz
0x20800003	SET_BAUDRATE	Baudrate: 115.2/ 57.6/19.2/9.6 kBaud

Error output (Analog output)		
0x20810003	SET_ERRORHANDLER	In case of error: Keep / do not keep last valid measurement value
Synchron or trigger mode		
0x20820003	SET_SYNCMODE SET_TRIGGERMODE	Master / Slave, on, off, alternating; triggering
Switching off the laser (external)		
0x20870002	LASER_ON	Switches the laser on
0x20860002	LASER_OFF	Switches the laser off
Measurement value data format		
0x20880003	ASCII_OUTPUT	Options: ASCII / Binary
Key lock		
0x20600003	SET_KEYLOCK	Options: Keys enables or locked
Reset		
0x20F10002	SET_DEFAULT	Reset to default factory settings
0x20F00002	RESET_BOOT	Reboot the sensor
Lock Flashwrite		
0x20610003	WriteFlashZero	Lock the Flashwriting for setting masters and the mid-point
Setting Masters, Setting Mid-Point		
0x20660003	SET_ZERO	Start setting masters measurement respectively relative measurement

8.5.2 Reading out the Sensor Parameters

Name: Get_Info

Description: Supplies the info string. This shows all parameters currently stored in the sensor.

IMPORTANT!
If initialization has been finished, the sensor transmits the info string once in ASCII format. The initialization including the info string transmission takes up to 10 seconds. Within this period, the sensor neither executes nor replies commands.

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x49	0x00	0x02	0x20490002

Reply:

<table>
<tr><td>31   24</td><td>23   16</td><td>15   8</td><td>7   0</td><td>hex</td></tr>
<tr><td>„I“</td><td>„L“</td><td>„D“</td><td>„1“</td><td>0x494C4431</td></tr>
<tr><td>0xA0</td><td>0x49</td><td>0x00</td><td>0x70</td><td>0xA0490070</td></tr>
<tr><td colspan="4">Info string in the form of a readable ASCII character string:</td><td rowspan="2"></td></tr>
<tr><td colspan="2">ILD 1700 : Standard
output : RS422err
frequency : 2500 Hz
average-number : 1
syncmode [1]: M S off
keylock: no
range: 10
option : 0
date: 06/03/09
sw type: 0</td><td colspan="2">Softwareversion : 5.005
speed : 1
average-type : moving
hold value : yes
ASCII-output: no
Flash enable: yes
serialnumber: 1234568
articlenumber : 4120088
bootloaderversion: 1.52</td></tr>
<tr><td>0x20</td><td>0x20</td><td>0x0D</td><td>0x0A</td><td>0x20200D0A</td></tr>
</table>

1) Depends on operation mode settings (synchronization or trigger). Options with synchronization: Master sync. off, master sync. on, slave, master alternating. Options with trigger: Edge LH, edge HL, level H, level L

8.5.3 Reading out the Sensor Settings

Name: Get_Settings

Description: Supplies the current sensor settings

These are as follows:

Average: Integer in hex form of the exponents as the base 2 of the average number for the moving and recursive veraging types. For **Median:**
0 = 3
2 = 5
5 = 7
7 = 9

Upper limit: Integer in hex form (count value)
Lower limit: Integer in hex form (count value)
Upper hysteresis value: Integer in hex form (count value)
Lower hysteresis value: Integer in hex form (count value)
Master value: Integer in hex form (count value)

Master and mid-point value set (M):
0 = Not mastered in switch mode, mid-point value not set in error mode
1 = Mastered in switch mode, mid-point value not set in error mode
2 = Not mastered in switch mode, mid-point value set in error mode
3 = Mastered in switch mode, mid-point value set in error mode

Flag for hold last value:
0 = Do not keep last measurement value
1 = Keep last measurement value

Assignment of the limits to the error outputs
1 = upper limit > F1, lower limit > F2
0 = upper limit > F2, lower limit > F1

Synchron mode [1]:
0 = Master synch off
1 = Mast synch on
2 = Slave
3 = Master synch alternating

Average type:
0 = Recursive
1 = Moving
2 = Median

Baud rate:
0 = 115.200 Baud
1 = 57.600 Baud
2 = 19.200 Baud
3 = 9.600 Baud

ASCII output
0 = Binary format
1 = ASCII format

Laser status
0 = Laser off
1 = Laser on

Trigger mode [1]:
0 = Edge LH
1 = Edge HL
2 = Level high
3 = Level low

Output type:
0 = Current
1 = Voltage
2 = digital

Measurement speed:
0 = 1
1 = 1/2
2 = 1/4
3 = 1/8

Operation mode:
0 = Sync. error
1 = Sync. switch
2 = Trigger error
3 = Trigger switch

1) Depends on operation mode settings (synchronization or trigger).

Measurement range:
Integer in hex form in mm

Key lock:
0 = Keys enabled
1 = Keys locked

Digital data output:
0 = Data output switched off
1 = Data output switched on

Enable Flash:
0 = Flashwrite locked
1 = Flashwrite enabled

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x4A		0x00		0x02		0x204A0002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x4A		0x00		0x17		0xA04A0017
Output type								
0x00		0x00		0x00		0x0X		0x0000000X
Measurement speed								
0x00		0x00		0x00		0x0X		0x0000000X
Averaging number								
0x00		0x00		0x00		0x0X		0x0000000X

Flag hold last value				
0x00	0x00	0x00	0x0X	0x0000000X
Synchron mode				
0x00	0x00	0x00	0x0X	0x0000000X
Averaging type				
0x00	0x00	0x00	0x0X	0x0000000X
Operation mode				
0x00	0x00	0x00	0x0X	0x0000000X
Baud rate				
0x00	0x00	0x00	0x0X	0x0000000X
ASCII / Binary output				
0x00	0x00	0x00	0x0X	0x0000000X
Upper limit				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Upper limit				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Upper hysteresis value				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Lower Hysteresis value				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Master value				
0x00	0x00	0xXX	0xXX	0x0000XXXX

Master and mid-point value set				
0x00	0x00	0x00	0x0X	0x0000000X
Measuring range				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Assignment of the limits to the switching outputs				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Key lock				
0x00	0x00	0x00	0x0X	0x0000000X
Data output digital				
0x00	0x00	0x00	0x0X	0x0000000X
Laser status				
0x00	0x00	0x00	0x0X	0x0000000X
0x20	0x20	0x0D	0x0A	0x20200D0A
Enable Flash				
0x00	0x00	0x0X	0x0X	0x0000000X
0x20	0x20	0x0A	0x0A	0x20200D0A

8.5.4 Set Average Number

ⓘ IMPORTANT!
The “avg“ LED shows the current status after the command SET_AVO...3 on.

Name: SET_AV0

Description: Sets the averaging number to 1 for moving and recursive averages, and to 3 for median.

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x70	0x00	0x02	0x20700002

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x70	0x00	0x02	0xA0700002
0x20	0x20	0x0D	0x0A	0x20200D0A

Name: SET_AV1

Description: Sets the averaging number to 4 for moving and recursive averages, and to 5 for median.

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x71	0x00	0x02	0x207130002

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x71	0x00	0x02	0xA0710002
0x20	0x20	0x0D	0x0A	0x20200D0A

Name: SET_AV2

Description: Sets the averaging number to 32 for moving and recursive averages, and to 7 for median.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x72		0x00		0x02		0x20720002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x72		0x00		0x02		0xA0720002
0x20		0x20		0x0D		0x0A		0x20200D0A

Name: SET_AV3

Description: Sets the averaging number to 128 for moving and recursive averages, and to 9 for median.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x73		0x00		0x02		0x20730002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x73		0x00		0x02		0xA0730002
0x20		0x20		0x0D		0x0A		0x20200D0A

ⓘ IMPORTANT!
SET_AVX is not available for the **median**!

The maximum value for N for the moving average is 128.

Note: The “avg“ LED goes off after SET_AVX.

Name: SET_AVX

Description: Sets the averaging number N for the moving and recursive averages to N=2^X.
Value range for X : 0...15 (0x00...0x0F). This command is not available for the median. If attempted, the sensor issues the message „Command failed“.

Format:	31	24	23	16	15	8	7	0	hex
	„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
	„I“		„L“		„D“		„1“		0x494C4431
	0x20		0x75		0x00		0x03		0x20750003
	0x00		0x00		0x00		0x0X		0x0000000X

Reply:	31	24	23	16	15	8	7	0	hex
	„I“		„L“		„D“		„1“		0x494C4431
	0xA0		0x75		0x00		0x02		0xA0750002
	0x20		0x20		0x0D		0x0A		0x20200D0A

$X = \log_2 (N)$ N = averaging number

This results in the following values for the averaging number N:

N	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
X	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Advice: If the existing averaging number is higher than that permitted for the new averaging type, the averaging number will be set to the upper limit for the new average type.

Overview:	Command	Averaging number N		
		recursive average	moving average	Median
	SET_AV 0...3	1, 4, 32, 128	1, 4, 32, 128	3, 5, 7, 9
	SET_AVX	1 ... 32767	1 ... 128	Command failed

Example:

Average 8 $X = \log_2 (8) = 3$

Average 512 $X = \log_2 (512) = 9$

8.5.5 Set Average Type

Name: SET_AV_T

Description: Sets the type of average.

Options:
- moving average for 1 to 128 measurement values
- Recursive average for 1 to 32768 measurement values
- Median for 3, 5, 7 or 9 measurement values

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x7D		0x00		0x03		0x207D0003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x7D		0x00		0x02		0xA07D0002
0x20		0x20		0x0D		0x0A		0x20200D0A

Parameter:
- X = 0 --> recursive average
- X = 1 --> recursive average
- X = 2 --> Median

8.5.6 Starting and Stopping the Measurement Value Output

Start command

Name: DAT_OUT_ON

Description: Switches on the digital data output for the measurement values. The output channel (output type) must also be set to the digital output, otherwise the measurement data cannot be received by the sensor.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x77		0x00		0x02		0x20770002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x77		0x00		0x02		0xA0770002
0x20		0x20		0x0D		0x0A		0x20200D0A

Stop command

Name: DAT_OUT_OFF

Description: Switches off the digital output for the measurement values. This has no effect on communication with the sensor via the digital interface. This command has a higher priority than GET_MEASVALUE in trigger mode.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x76		0x00		0x02		0x20760002

Advice: The sensor sends digital measurement values again when the operating voltage has been switched on again.

i IMPORTANT!
The STOP command is volatile and is lost if the power supply is switched off or the RESET_BOOT command is sent.

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x76		0x00		0x02		0xA0760002
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.7 Set Limit Values

Name: SET_LIMITS

Description: Sets limits and hysteresis values in the operation mode „Sync. switch mode“ respectively „Trigger switch mode“ (upper/lower limit, upper/lower hysteresis value).

Note: The hysteresis values have the effect of resetting the assigned switch outputs when the measurement values return to the target range.

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x7E		0x00		0x07		0x207E0007
Upper limit value								
0x00		0x00		0xXX		0xXX		0x0000XXXX
Lower limit value								
0x00		0x00		0xXX		0xXX		0x0000XXXX
Upper hysteresis value								
0x00		0x00		0xXX		0xXX		0x0000XXXX
Lower hysteresis value								
0x00		0x00		0xXX		0xXX		0x0000XXXX
Master value								
0x00		0x00		0xXX		0xXX		0x0000XXXX

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x7E		0x00		0x02		0xA07E0002
0x20		0x20		0x0D		0x0A		0x20200D0A

Note: All values are absolute values; Input as an integer value (whole number count value) of 2 bytes, completed by two advance bytes with the value “0“ to a total length of 32 bits.

8.5.8 Assignment of the Limits to the Switch Outputs

Name: SET_UPPERLIMIT_F1

Description: Assigns the upper limit to switching output 1 and the lower limit to switching output 2.

Standard setting:
Switching output 1
Upper limit,

Switching output 2
Lower limit

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x83		0x00		0x02		0x20830002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x83		0x00		0x02		0xA0830002
0x20		0x20		0x0D		0x0A		0x20200D0A

Name: SET_LOWERLIMIT_F1

Description: Assigns the upper limit to switching output 2 and the lower limit to switching output 1.

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x84	0x00	0x02	0x20840002

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x84	0x00	0x02	0xA0840002
0x20	0x20	0x0D	0x0A	0x20200D0A

8.5.9 Operation Mode

Name: SET_ERROROUTPUT

Description: Sets the use on synchron mode or trigger mode. Both modes exclude each other as the input lines are used for synchronisation or triggering. Additionally the use of the switching outputs is set. In error mode, switching output 1 is used as the error output. In switch mode, both outputs are used as limit outputs.

Standard setting:
Sync error
Options:
X = 0 > Snyc error
X = 1 > Snyc switch
X = 2 > Trigger error
X = 3 > Trigger switch

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x95	0x00	0x03	0x20950003
0x00	0x00	0x00	0x0X	0x0000000X

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x95	0x00	0x02	0xA0950002
0x20	0x20	0x0D	0x0A	0x20200D0A

8.5.10 Set the Measurement Value Output Type

Name: SET_OUTPUTTYP

Description: Sets the output type for the measurement values.

Options:
X = 0 > Current (4..20 mA)

X = 1 > Voltage (0..10 V)

X = 2 > RS422

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x90		0x00		0x03		0x20900003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x90		0x00		0x02		0xA0900002
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.11 Set Measurement Frequency (Speed)

Name: SET_SPEED

Description: Sets the measurement frequency

Options:
X = 0 > 2.5 kHz
X = 1 > 1.25 kHz
X = 2 > 625 Hz
X = 3 > 312.5 Hz

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x85		0x00		0x03		0x20850003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x85		0x00		0x02		0xA0850002
0x20		0x20		0x0D		0x0A		0x20200D0A

Name: SET_BAUDRATE

Description: Sets the transmission rate

Options:
X = 0 > 115200 Baud
X = 1 > 57600 Baud
X = 2 > 19200 Baud
X = 3 > 9600 Baud

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x80		0x00		0x03		0x20800003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x80		0x00		0x02		0xA0800002
0x20		0x20		0x0D		0x0A		0x20200D0A

The sensor still sends the reply with the old baud rate and only switches to the new baud rate once the reply has been sent. The output rate reduces automatically when the baud rate is changed because individual measurement values are skipped.

8.5.12 Error Output (Analog Output)

Name: SET_ERRORHANDLER

Description: Switches on the flag for keep / do not keep the last measurement value

This flag only affects the analog output. If set to X = 1 the last valid measurement value will continue to be issued if an error occurs (no object, invalid object, object outside the measurement range or laser turned off). If set to X = 0 an error signal will be generated for the current output that has an error value of 3 mA and for the voltage output that has a value of 10.2 V.

Options:
X = 0 > Do not hold the last value

X = 1 > Hold last value

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x81	0x00	0x03	0x20810003
0x00	0x00	0x00	0x0X	0x0000000X

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x81	0x00	0x02	0xA0810002
0x20	0x20	0x0D	0x0A	0x20200D0A

8.5.13 Synchronous and Trigger Mode

Options:
X = 0 > Synchronous master off
X = 1 > Synchronous master on
X = 2 > Slave
X = 3 > Alternating synchronous master

Name: SET_SYNCMODE/TRIGGERMODE

Synchron mode: This command can be used for synchronizing two (or more) sensors with each other. One sensor functions as the master, the other as the slave. Master and Slave alternately measure in alternating mode to avoid interference of each other when measuring on transparent objects.

Advice: The same measurement frequency (speed) must be set for the master and the slave, otherwise there is a risk of unreliable measurements.

Trigger mode: The synchron lines are used as trigger inputs. Four trigger types are available:

Options:
X = 0 > edge LH,
X = 1 > edge HL,
X = 2 > level high,
X = 3 > level low.

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x82	0x00	0x03	0x20820003
0x00	0x00	0x00	0x0X	0x0000000X

Reply:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x82	0x00	0x02	0xA0820002
0x20	0x20	0x0D	0x0A	0x20200D0A

8.5.14 Switching off the Laser (External)

Name: LASER_OFF

Description: Switches off the laser.

IMPORTANT!
The command LASER_OFF is volatile. This means that the laser is switched on again if the power supply was switched off or the sensor was rebooted by means of the RESET_BOOT command and pin 9 is connected with GND.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x86		0x00		0x02		0x20860002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x86		0x00		0x02		0xA0860002
0x20		0x20		0x0D		0x0A		0x20200D0A

Name: LASER_ON

Description: Switches the laser on

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x87		0x00		0x02		0x20870002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x87		0x00		0x02		0xA0870002
0x20		0x20		0x0D		0x0A		0x20200D0A

The command LASER_ON is effective only if pin 9 is connected with GND.

8.5.15 Switching the Data Format

Name: ASCII_OUTPUT

Description: Switches the data format for the measurement value output via the digital interface.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x88		0x00		0x03		0x20880003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x88		0x00		0x02		0xA0880002
0x20		0x20		0x0D		0x0A		0x20200D0A

Options:

X = 0 > Binary output (2 Byte)

X = 1 > ASCII output (6 Byte)

8.5.16 Key Lock

Name: SET_KEYLOCK

Description: Locks or enables the membrane keys. The set status is not volatile.

Options:
X = 0 > Enable keys

X = 1 > Lock keys

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x60		0x00		0x03		0x20600003
0x00		0x00		0x00		0x0X		0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0x60		0x00		0x02		0xA0600002
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.17 Set Factory Setting

Name: SET_DEFAULT

Description: Resets the set parameters to the default settings (factory settings).

This concerns:

- Output type (current)
- Measurement frequency
- Averaging number (1)
- Hold last measurement value,
- Synchronization (no synchronization),
- Averaging type (moving),
- Operation mode (sync error),
- Baud rate (115200 baud),
- Binary output,
- Laser (on),
- Data output (on),
- Assignment of the switching outputs (upper limit > F1, lower limit > F2),
- Default values for master, offset, limit and hysteresis values
- Keys enabled
- Flash enabled

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0xF1		0x00		0x02		0x20F10002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0xF1		0x00		0x02		0xA0F10002
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.18 Reset Sensor

Name: RESET_BOOT

Description: Starts the sensor’s initialization phase. The set parameters are retained. The short-circuit protection for the switch outputs is also reset in the process.

IMPORTANT!
The volatile commands Laser_off and DAT_ UT_ OFF are lost after the RESET command.
This means that the laser is switched on again and the sensor sends measurement values again.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0xF0		0x00		0x02		0x20F00002

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xA0		0xF0		0x00		0x02		0xA0F00002
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.19 Reading out the Measurements

Name: GET_MEASVALUE

Description: The command is used for polling measurements in trigger mode. The amount of measurements which the sensor should supply must be specified in the parameter. The command DAT_OUT_OFF resets the amount of possible measurements to be transferred to 0.

Format:

31	24	23	16	15	8	7	0	hex
„+“		„+“		„+“		0x0d („CR“)		0x2B2B2B0D
„I“		„L“		„D“		„1“		0x494C4431
0x20		0x2C		0x00		0x03		0x202C0003
0xXX		0xXX		0xXX		0xXX		0xXXXXXXXX

Measurements are output in binary, see Chap. 8.2.1 or ASCII format, see Chap. 8.2.2, in trigger mode.

Reply:

31	24	23	16	15	8	7	0	hex
„I“		„L“		„D“		„1“		0x494C4431
0xE0		0x2C		0x00		0x03		0xE02C0003
0x00		0x00		0x00		0x05		0x00000005
0x20		0x20		0x0D		0x0A		0x20200D0A

8.5.20 Enable / Lock the Flash for Setting Masters and the Mid-point

Name: WriteFlashZero

Description: This command enables or locks saving the master values into the flash.

Parameter:

X = parameter value (0; 1) 0 = lock Flash 1 = enable Flash

Format:

31 … 24	23 … 16	15 … 8	7 … 0	hex
„+“	„+“	„+“	0x0d („CR“)	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494C4431
0x20	0x61	0x00	0x03	0x20610003
0x00	0x00	0x00	0x0X	0x0000000X

The factory setting: “Flash enabled“

Reply:

31 … 24	23 … 16	15 … 8	7 … 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x61	0x00	0x02	0xA0610002

Advices:

The command WriteFlashZero should be used by applications, which set before every measuring process mastering and mid-point automatically through the external input line, see Chap. 6.7, see Chap. 6.8. It will do, that the command “Lock Flash“ will be sent once.

The values for master and mid-point are saved at “Lock Flash“ only in the RAM of the sensor and get lost by switching-off the sensor. When switching-on the before saved master and mid-point values or the factory setting, see Chap. A 2, are loaded. The command “WriteFlashZero“ itself is non-volatile. The setup “Lock Flash“ also survive after switching-off.

The command “WriteFlashZero“ only influences the setting masters and mid-point. All the others flash operations were applied as before.

8.5.21 Mastering or Setting Mid-point

Name: Set_Zero

Description: The command “SetşZero“ enables to

- set the sensor to mid-point in the operation mode “Error-Mode“ or
- mastering the sensor in the operation mode “Switch-Mode“

For sensors with software versions prior to 6,000 mid-point setting and mastering is possible with the sensor button “select/zero“ or the digital “Zero“ input.

Parameter X:

0 = Undo set mid-point or mastering 1 = Set mid-point or mastering

Format:

31 24	23 16	15 8	7 0	hex
„+“	„+“	„+“	0x0D	0x2B2B2B0D
„I“	„L“	„D“	„1“	0x494c4431
0x20	0x66	0x00	0x03	0x20660003
0x00	0x00	0x00	0x0X	0x0000000X

Reply, no error:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xA0	0x66	0x00	0x02	0xA0660002
0x20	0x20	0x0D	0x0A	0x20200D0A

Reply, with error:

31 24	23 16	15 8	7 0	hex
„I“	„L“	„D“	„1“	0x494C4431
0xE0	0x66	0x00	0x03	0xA0660002
0x00	0x00	0x00	0x0X	0x0000000X
0x20	0x20	0x0D	0x0A	0x20200D0A

Error code X: Detailed information, see Chap. 8.4.2.

Example: X = 5 (“Command failed“), e.g. if no target is within the sensor measuring range.

Notes from version 6,000:

- With version 6,000 you can set the serial output (RS422 interface) to mid-point in the operation mode “Error-Mode“ (Sync/error or Trigger/error). Mid-point means to set the analog or digital output on mid-range, see Chap. 7..
- If you use the digital input “Zero“ for mid-point setting or mastering, you need no long pulse to undo it before you do mid-point setting or mastering again. With each short pulse (0.5 ... 3 s) mid-point setting or mastering is done always again. This also applies to the command Set_Zero with the parameter value = 1.

9. Instruction for Operating

9.1 Reflection Factor of the Target Surface

In principle the sensor evaluates the diffuse part of the reflected laser light, see Fig. 46.

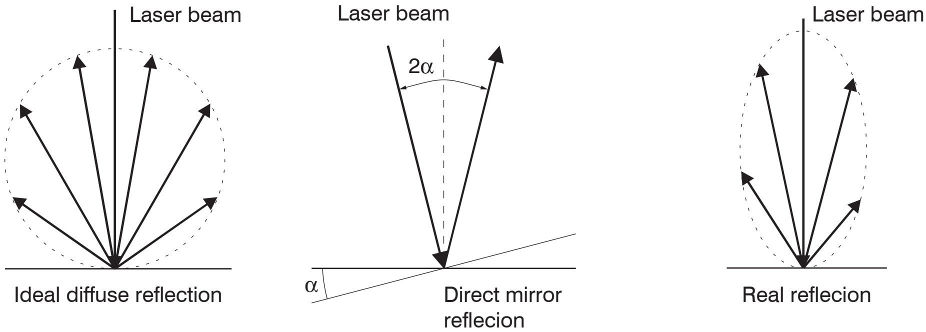


Fig. 46 Reflection factor of the target surface

A statement concerning a minimum reflectance is difficult to make, because even a small diffuse fraction can be evaluated from highly reflecting surfaces. This is done by determining the intensity of the diffuse reflection from the CCD array signal in real time and subsequent compensation for intensity fluctuations, see Chap. 3.2.

Dark or shiny objects being measured, e.g. black rubber, may require longer exposure times. The exposure time is dependent on the measurement frequency and can only be increased by reducing the sensor's measurement frequency.

9.2 Error Influences

9.2.1 Light from other Sources

Thanks to their integrated optical interference filters the optoNCDT1700 sensors offer outstanding performance in suppressing light from other sources. However, this does not preclude the possibility of interference from other light sources if the objects being measured are shiny and if lower measurement frequencies are selected. Should this be the case it is recommended that suitable shields be used to screen the other light sources. This applies in particular to measurement work performed in close proximity to welding equipment.

9.2.2 Color Differences

Because of intensity compensation, color difference of targets affect the measuring result only slightly. However, such color differences are often combined with different penetration depths of the laser light into the material. Different penetration depths then result in apparent changes of the measuring spot size. Therefore color differences in combination with changes of penetration depth may lead to measuring errors.

9.2.3 Temperature Influences

When the sensor is commissioned a warm-up time of at least 20 minutes is required to achieve uniform temperature distribution in the sensor. If measurement is performed in the micron accuracy range, the effect of temperature fluctuations on the sensor holder must be considered. Due to the damping effect of the heat capacity of the sensor sudden temperature changes are only measured with delay.

9.2.4 Mechanical Vibration

If the sensor should be used for resolutions in the µm to sub-µm range, special care must be taken to ensure stable and vibration-free mounting of sensor and target.

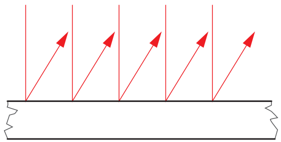
9.2.5 Movement Blurs

If the objects being measured are fast moving and the measurement frequency is low it is possible that movement blurs may result. Always select a high measurement frequency for high-speed operations, therefore, in order to prevent errors.

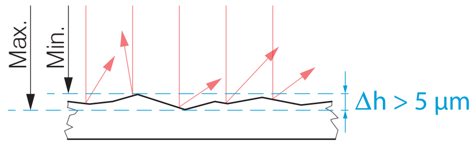
9.2.6 Surface Roughness

Laser-optical sensors detect the surface using an extremely small laser spot. They also track slight surface unevenness. In contrast, a tactile, mechanical measurement, e.g. using a caliper, detects a much larger area of the measurement object. In case of traversing measurements, surface roughnesses of 5 µm and more lead to an apparent distance change.

Suitable parameters for the averaging number may improve the comparability of optical and mechanical measurements.



Ceramic reference surface



Structured surface

Recommendation for parameter choice:

- The averaging number should be selected in such a way that a surface area the size of which is comparable to those with mechanical measurements is averaged.

9.2.7 Sensor Tilting

Tilt angles of the sensor in diffuse reflection both around the X and the Y axes of less than 5 ° only have a disturbing effect with surfaces which are highly reflecting. Tilt angles between 5 ° and 15 ° lead to an apparent distance change of approximately 0.12 ... 0.2 % of the measuring range, see Fig. 47.

Tilt angles between 15 ° and 30 ° lead to an apparent distance change of approximately 0.5 % of the measuring range. These influences must be considered especially when scanning structured surfaces. In principle the angle behavior in triangulation also depends on the reflectivity of the target.

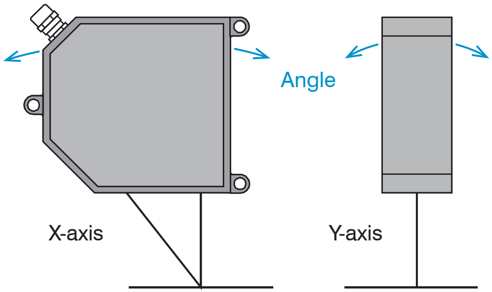
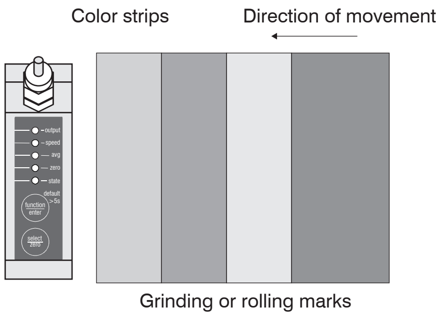


Fig. 47 Angle influences

Angle	X-axis %	Y-axis %
±5 °	typ. 0.12	typ. 0.12
±15 °	typ. 0.2	typ. 0.2
±30 °	typ. 0.5	typ. 0.5

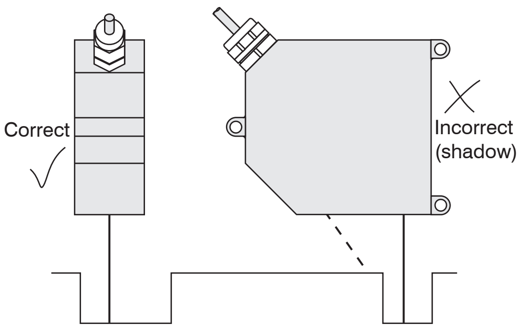
Fig. 48 Measurement errors through tilting with diffuse reflection

9.3 Optimizing the Measuring Accuracy



In case of rolled or polished metals that are moved past the sensor the sensor plane must be arranged in the direction of the rolling or rinding marks. The same arrangement must be used for color strips, see Fig. 49.

Fig. 49 Sensor arrangement in case of ground or striped surfaces



In case of bore holes, blind holes, and edges in the surface of moving targets the sensor must be arranged in such a way that the edges do not obscure the laser spot, see Fig. 50.

Fig. 50 Sensor arrangement for holes and ridges

9.4 Protective Housing

Model types:

- SGH size S
  SGH size M:
  without air purging (with inlet and exhaust for cooling) and
- SGHF size S
  SGHF size M:
  with air purging.

The protective housing are designed to be used especially if the sensor operates in a dirty environment or higher ambient temperature. It is available as an accessory. If these protective housings are used, the linearity of the sensors in the complete system may deteriorate. For the sole purpose of protection against mechanical damage a simple protective shield with sufficiently large opening is therefore more advantageous. Installation of the sensors in the protective housings should be performed by the manufacturer, because especially in case of short reference distances the protective window must be included in the calibration.

ⓘ IMPORTANT!
The protection class is limited to water (no penetrating liquids or similar)!

The following guidelines must be observed if the sensors are operated in a protective housing:

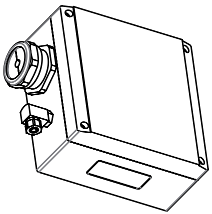
- The maximum ambient temperature within the protective housing is 45 °C.
- The requirements for compressed-air are:
  - Temperature at the inlet < 25 °C
  - The compressed-air must be free of oil and water residues. It is recommended to use two oil separators in series arrangement.
- With a flow rate for example 240 l/min ($2.5 * 10^5$ Pa) the maximum outside temperature is 65 °C.
- For higher ambient temperatures it is recommended to use an additional water-cooled carrier and cover plates outside the protective housing.
- No direct heat radiation (including sunlight!) on the protective housing. In case of direct heat radiation additional thermal protective shields must be installed.
- It is recommended that the protective window is cleaned from time to time with a soft alcohol-soaked cloth or cotton pad.

The delivery includes:

The rotatable plug-nipple glands type LCKN-1/8-PK-6 (FESTO) for the compressed-air tubes with a inner diameter of 6 mm, the air plate (SGHF) and the sensor fastening accessories are included in the delivery of the protective housing.

SGH/SGHF size S

Dimension in mm (inches), not to scale



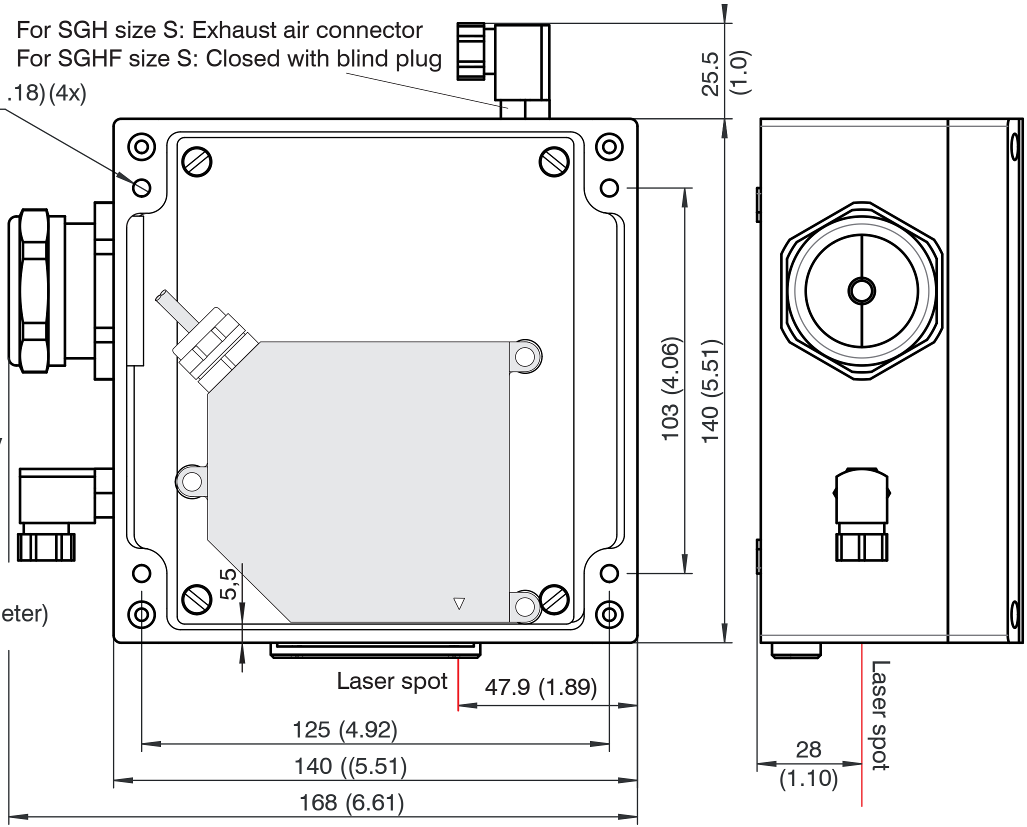
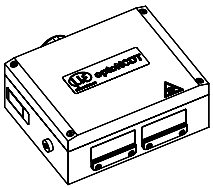


Fig. 51 Protective housing for measuring ranges 10/20/50/100/200/250 mm

SGH/SGHF size M

Dimensions in mm (inches), not to scale



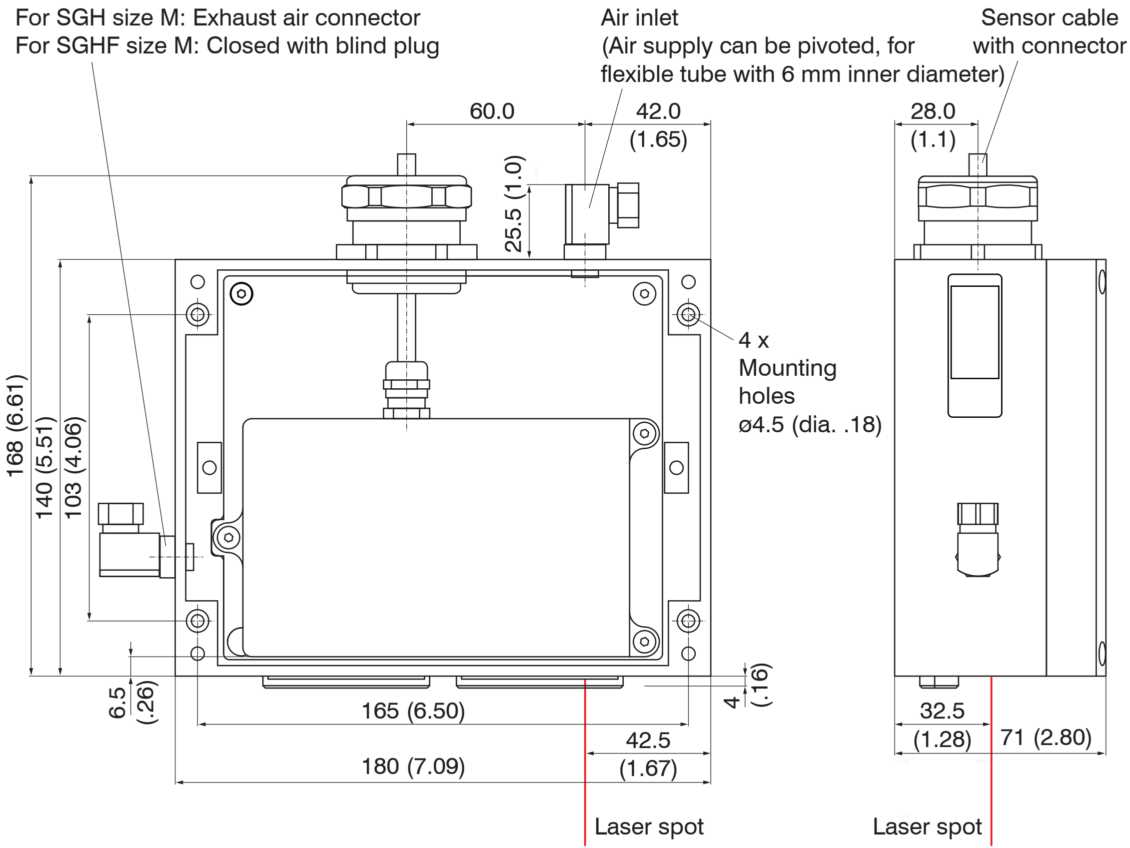


Fig. 52 Protective housing for measuring ranges 40/500/750 mm

10. ILD1700 Tool

The software ILD1700 Tool
- transfers and reads sensor parameters and
- reads and displays measuring results in a diagram.

All data are transmitted through a RS422 interface and can be saved on demand.

i Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

10.1 Installation and Preparation for Measurements

10.1.1 System Requirements

The following system requirements are recommended:
- Windows 2000, Windows XP or Windows 7 / Pentium III ≥ 1 GHz / 1 GB RAM
- Free USB port or IF2008

10.1.2 Cable and Program Routine Requirements

- PC1700-x/USB/IND Sensor cable with RS422-USB converter and 24 V power supply
- ILD1700 Tool Configuration and measurement program
- RS422/USB converter, inclusive CD with driver

PC1700-x/USB/IND	
Pin	Signal
1	RX -
2	Rx+
3	TX+
4	TX -
5	GND

Pin assignment, 9-pol. D SUB

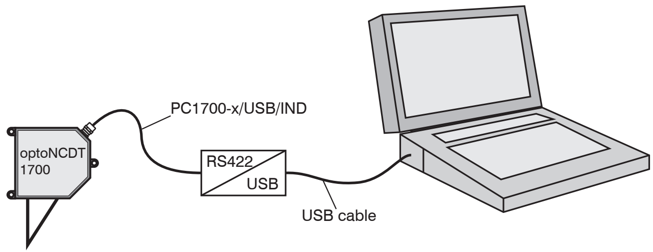


Fig. 53 Setup of the system for the demonstration software

You will find the actual drivers respectively program routines under:

www.micro-epsilon.com/link/opto/1700

You will find details to the driver installation in the mounting instructions „Converter RS422 to USB“.

10.2 Measurement

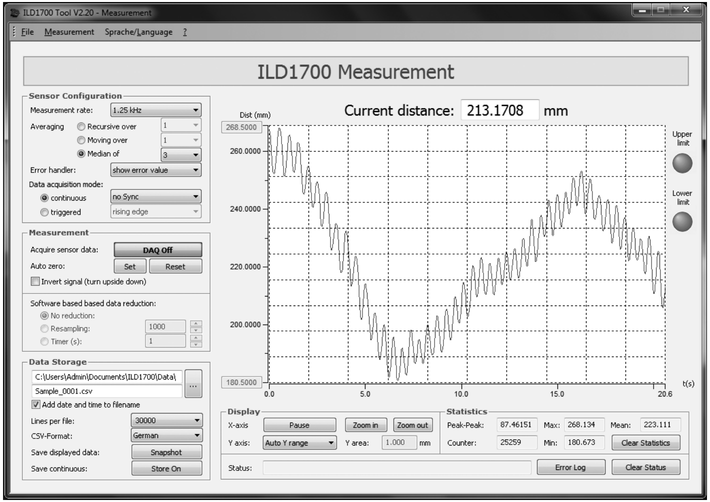


Fig. 54 Start screen of the measurement program

> **i** If the sensor's analog output is to be used after termination of the ILD1700 tool, it previously has to be defined as output version. Do not forget to save the settings made.

This sub program can be used to acquire, evaluate and store data from an ILD1700 sensor.

11. Software Support with MEDAQLib

The Micro-Epsilon Data Acquisition Library offers you a high level interface library to access optoNCDT laser sensors from your Windows application in combination with

- RS422/USB converter (optional accessory) and a suitable PC1700-x/USB/IND cable or
- IF2008 PCI interface card and PC1700-x/IF2008 cable

into an existing or a customized PC software.

You need no knowledge about the sensor protocol to communicate with the individual sensors. The individual commands and parameters for the sensor to be addressed will be set with abstract functions. MEDAQLib translates the abstract functions in comprehensible instructions for the sensor.

MEDAQLib

- is a DLL/LIB usable for C, C++, VB, Delphi and many other Windows programming languages,
- supports functions to talk to the sensor
- hides the details on how to talk to the communication interface (RS232,RS422,USB,TCP)
- hides the details of the sensor protocol
- converts the incoming data to „expected data values“
- provides a consistent programming interface for all Micro-Epsilon sensors
- provides many programming examples many different programming languages
- the interface is documented in a large *.pdf file

You will find the latest MEDAQLib version at:

www.micro-epsilon.com/download

www.micro-epsilon.com/link/software/medaqlib

12. Liability for Material Defects

All components of the device have been checked and tested for functionality at the factory. However, if defects occur despite our careful quality control, MICRO-EPSILON or your dealer must be notified immediately. The liability for material defects is 12 months from delivery. Within this period, defective parts, except for wearing parts, will be repaired or replaced free of charge, if the device is returned to MICRO-EPSILON with shipping costs prepaid. Any damage that is caused by improper handling, the use of force or by repairs or modifications by third parties is not covered by the liability for material defects. Repairs are carried out exclusively by MICRO-EPSILON.
Further claims can not be made. Claims arising from the purchase contract remain unaffected. In particular, MICRO-EPSILON shall not be liable for any consequential, special, indirect or incidental damage. In the interest of further development, MICRO-EPSILON reserves the right to make design changes without notification.

For translations into other languages, the German version shall prevail.

13. Service, Repair

If the sensor or sensor cable is defective:
- If possible, save the current sensor settings in a parameter set, see ILD1700 Tool, Measurement / Configuration menu, to reload them into the sensor after the repair.
- Please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

MICRO-EPSILON Optronic GmbH
Lessingstr. 14
01465 Langebrück / Germany

Tel. +49 (0) 35201 / 729-0
Fax +49 (0) 35201 / 729-90
optronic@micro-epsilon.com
www.micro-epsilon.com

14. Decommissioning, Disposal

➡ Remove the power supply cable and output cable from the sensor.

Incorrect disposal may cause harm to the environment.

➡ Dispose of the device, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.

Appendix

A 1 Accessory

PC1700-3	Power supply and output cable, 3 m long, cable carriers suitable; cable diameter 6.8 mm ± 0.2 mm		
PC1700-10	Power supply and output cable, 10 m long, cable carriers suitable; cable diameter 6.8 mm ± 0.2 mm		
PC1700-x/IF2008	Interface and supply cable		
PC1700-x/USB/IND	USB power supply and output cable, 3 m, 10 m or 20 m long, including power supply unit (90 ... 235 VAC)		
RS422/USB converter	Interface converter RS422 to USB (useable with cable 1700-x/USB/IND inclusive driver)		
IF2001/USB	1-Channel RS422/USB converter		
PC1700-x/x/USB/OE/IND	Like PC1700-x/USB, with additional open leads for analog output		
PS2010	Power supply 24 V for mounting on DIN-rail (input 230 VAC, output 24 VDC/2.5 A)		
IF2008	The IF2008 interface card enables the synchronous capture of 4 digital sensor signals series optoNCDT1700 or others and 2 encoders. In combination with the IF2008E a total of 6 digital signals, 2 encoder signals, 2 analog signals and 8 I/O signals can be acquired synchronously.		
SGH size S, M	Without air purging (with inlet and exhaust for cooling)		
SGHF size S, M	With air purging for the protective window		
Assembly aid	Stock no.	Sensor	Aluminum device for easy mounting of a sensor in direct reflection.
20.0 °	2555059	ILD1700-2DR	
17.6 °	2555060	ILD1700-10DR	
11.5 °	2555061	ILD1700-20DR	

A 2 Factory Setting

Name	Setting		
LED	Level 1	Level 2	Level 3
output	Current	Hold last value	Sync/Error
speed	2.5 kHz	Master Synch off	115.2 KBaud
avg	1 (3)	Moving average	Binary format (no ASCII)
zero	off	...	...

Master value: 0.5 x measurement range

Upper limit: 101 % FSO / Digital value: 16365

Upper hysteresis value: 100 % FSO / Digital value: 16207

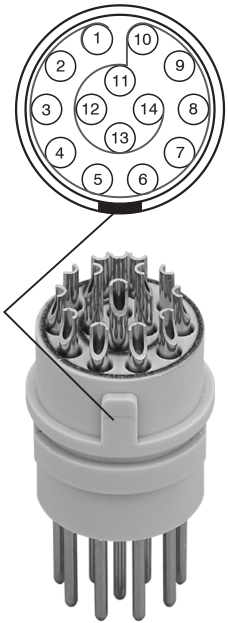
Lower hysteresis value: 0 % FSO / Digital value: 161

Lower limit: -1 % FSO / Digital value: 0

Press the „function/enter“ key 5 seconds to activate the factory settings if the sensor is in measurement mode (the “state“ LED is illuminated).

A 3 Output Rate optoNCDT1700

		Baud rate	**115200**	**57600**	**19200**	**9600**	
Measurement frequency	LED speed	Bytes	Synchron mode: Master on, Slave synchronized, Master off				
2.5 kHz	1	2	2500	2500	833.33	416.66	Binary output
1.25 kHz	1/2	2	1250	1250	625	416.66	
625 Hz	1/4	2	625	625	625	312.5	
312.5 Hz	1/8	2	312.5	312.5	312.5	312.5	
2.5 kHz	1	6	1250	833.33	277.77	138.88	ASCII output
1.25 kHz	1/2	6	1250	625	250	138.88	
625 Hz	1/4	6	625	625	208.33	125	
312.5 Hz	1/8	6	312.5	312.5	156.25	104.16	
			Synchron mode: Master alternating, Slave synchronized (alternating)				
2.5 kHz	1	2	1250	1250	625	416.66	Binary output
1.25 kHz	1/2	2	625	625	625	312.5	
625 Hz	1/4	2	312.5	312.5	312.5	312.5	
312.5 Hz	1/8	2	156.25	156.25	156.25	156.25	
2.5 kHz	1	6	1250	625	250	138.88	ASCII output
1.25 kHz	1/2	6	625	625	208.33	125	
625 Hz	1/4	6	312.5	312.5	156.25	104.16	
312.5 Hz	1/8	6	156.25	156.25	156.25	78.12	



View: Solder-pin side male cable connector, insulator

A 4 Pin Assignment Sensor Cable

Pin	Designation	Characteristics	Color Sensor Cable PC1700-x
5	$+U_B$	Power supply (11 ... 30 VDC)	red
6	GND	System ground for power supply switch signals (Laser on/off, Mid-point, Limits)	black
13	Analog output	Current 4 ... 20 mA or Voltage 0 ... 10 V	Coaxial inner conductor, white, see Fig. 55
14	AGND	Reference potential for analog output	Coaxial screening, black, see Fig. 55
9	Laser on/off	Switching input Laser ON / OFF	red and blue
10	Zero	Switching input for reset	white and green
8	Switching output 1	Error or limit output	gray and pink
7	Switching output 2	Limit output	violet
3 4	Sync + [1] Sync - [1]	Symmetrical synchron output (Master) or input (Slave)	blue pink
1 2	Tx + Tx -	RS422 - Output (symmetric)	green brown
12 11	Rx + Rx -	RS422 - Input (symmetric)	gray yellow

Plug connector:

ODU MINI-SNAP, 14-pin, series B, Dimension 2, Code 0, IP 68
More information on www.odu.de

1) Used as trigger inputs in mode “Triggering“, see Chap. 6.14.

ⓘ IMPORTANT!
Don’t cut the coaxial inner cable (pin 13 / white) and the coaxial screening (pin 14 / black). Twist the outer braid, (pin 14), otherwise the analog output cannot be connected to the terminals of the customer electronics.

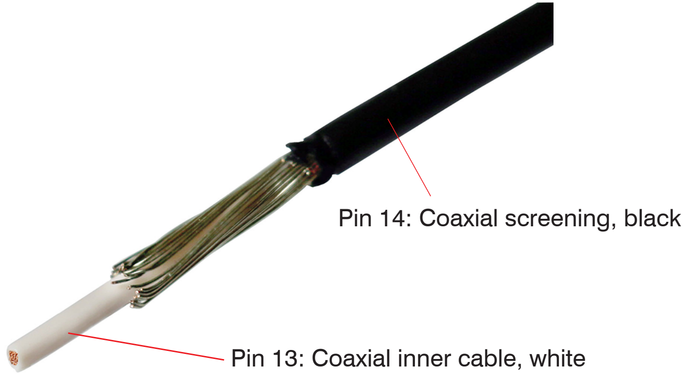


Fig. 55 View on pin 13 / pin 14

A 5 Pin Assignment RS422 Connection

ⓘ IMPORTANT!
The system ground must be connected with the terminal ground (USB converter, pin 5) before connecting the Rx and Tx lines.

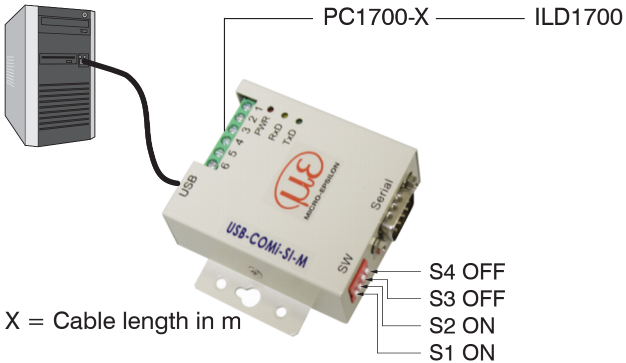


Fig. 56 Principle setup

Cross the lines for connections between sensor and PC.

ILD1700		Converter	
Signal	Color PC1700	Signal	Pin
RX-	yellow	TX-	1
RX+	gray	TX+	2
TX+	green	RX+	3
TX-	brown	RX-	4
GND (Pin 6)	black	ground	5

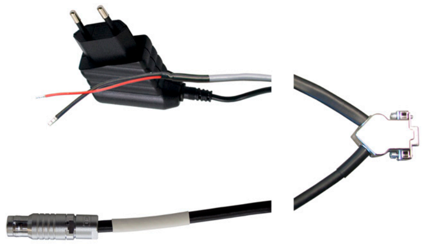
Fig. 57 Pin assignment and wiring

ⓘ IMPORTANT!
Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

A 6 Pin Assignment PC1700-x/x/USB/OE/IND

9-pin Sub-D	Pin	Assignment
	1	Tx -
	2	Tx +
	3	Rx +
	4	Rx -
	5	GND

2-pin cable	Color	Assignment
	white (red)	4 ... 20 mA or 0 ... 10 V
	brown (black)	AGND



The PC1700-x/x/USB/OE/IND includes open leads for analog output signal and power supply unit for 90 ... 235 VAC. Length x = 3 or 10 m.

1) No longer available!

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