MICRO-EPSILON

Instruction Manual

optoNCDT 22xx

ILD2200-2
ILD2200-10
ILD2200-20
ILD2200-40
ILD2200-50
ILD2200-100
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ILD2220-2
ILD2220-10
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Contents

1. Safety

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

1.1 Symbols Used

The following symbols are used in this instruction manual:

CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation which, if not avoided, may lead to property damage.
➡	Indicates a user action.
i	Indicates a user tip.

1.2 Warnings

Avoid unnecessary laser radiation to be exposed to the human body

➡ Switch off the controller for cleaning and maintenance.

➡ Switch off the controller for system maintenance and repair if the sensor is integrated into a system.

CAUTION

Caution - use of controls or adjustments or performance of procedures other than those specified may cause harm.

Connect the power supply and the display-/output device in accordance with the safety regulations for electrical equipment.

> Danger of injury

> Damage to or destruction of the sensor and/or the controller

NOTICE

Avoid shock and vibration to the sensor and the controller.

> Damage to or destruction of the sensor and/or the controller

The power supply may not exceed the specified limits.

> Damage to or destruction of the controller and/or the sensor

Protect the sensor cable against damage.
> Destruction of the sensor

> Failure of the measuring device

Avoid continuous exposure to fluids on the sensor and the controller.
> Damage to or destruction of the sensor and/or the controller

Operate sensor and controller only with the same serial number. A change of components among each other is not possible.
> Loss of the specified technical data

1.3 CE Compliance

The following applies to the optoNCDT 22xx:
- Regulation 2004/108/EC
- Regulation 2006/95/EC

Products which carry the CE mark satisfy the requirements of the EMC regulation 2004/108/EC 'Electromagnetic Compatibility' and the European standards (EN) listed therein. The EC declaration of conformity is kept available according to EC regulation, article 10 by the authorities responsible at

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The sensor is in compliance with the following standards
- EN 61326-1: 2006-10
- DIN EN 55011: 2007-11
- EN 61000-6-2: 2006-03

The sensor fulfills the specification of the EMC requirements, if the instructions in the operating manual are followed.

1.4 Proper Use

- The measuring system is designed for use in industrial areas.
- It is used
  - for measuring displacement, distance, position and elongation
  - for in-process quality control and dimensional testing
- The measuring system may only be operated within the limits specified in the technical data, see Chap. 3.3.
- The system should only be used in such a way that in case of malfunctions or failure personnel or machinery are not endangered.
- Additional precautions for safety and damage prevention must be taken for safety-related applications.

1.5 Proper Environment

- Protection class
  - Sensor: IP 65 (Only with sensor cable, supply/output cable connected)
  - Controller: IP 50
- 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
  DIN EN 55011: 2007-11
  EN 61000-6-2: 2006-03

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

2. Laser Class

The sensors operate with a semiconductor laser with a wavelength of 670 nm (visible/red). The laser is operated on a pulsed mode, the pulse frequency corresponding to the measuring frequency (for example f = 10 kHz). The duration of the pulse is regulated in dependency on the object to be measured and can form an almost permanent beam (for example t = 1 up to 80 μs). The maximum optical output is ≤ 1 mW. The sensors are classified in Laser Class 2 (II). Class 2 (II) lasers are not notifiable and a laser protection officer is not required either.

i Comply with all regulations on lasers!

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 may only be opened by the manufacturer. For repair and service purposes the sensors must always be sent to the manufacturer.** The following warning labels are attached to the cover (front and/or rear side) of the sensor housing. The laser warning labels for Germany have already been applied (see above). Those for other non German-speaking countries an IEC standard lable is included in delivery and 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. 3.4.

⚠ CAUTION

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 Standard

During operation of the sensor the pertinent regulations according to EN 60825-1 on „radiation safety of laser equipment" must be fully observed at all times.

FDA Norm

The sensor complies with all applicable laws for the manufacturer of laser devices. This system is classified by the Center for Devices and Radiological Health (CDRH) asa Class II laser device.

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

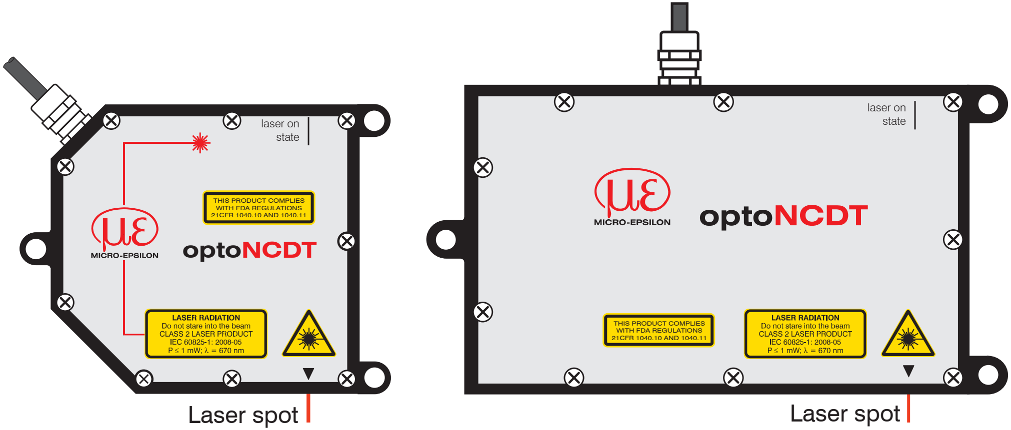


Fig. 1 True reproduction of the sensor with its actual location of the warning labels

3. Functional Principle, Technical Data

3.1 Short Description

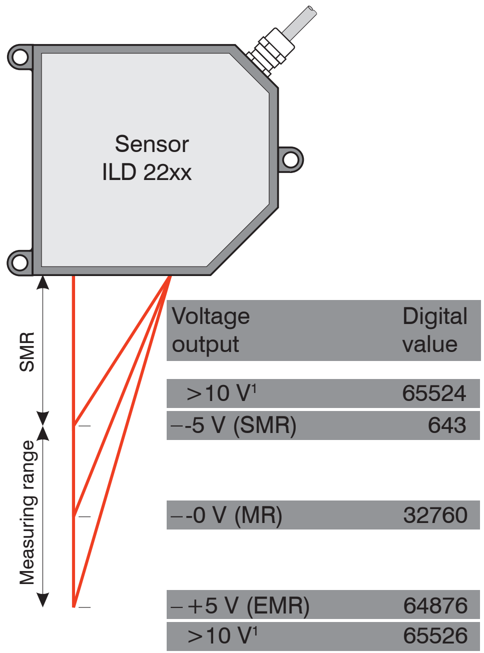
The system consists of an laser-optical sensor and a signal conditioning electronics.

The sensor uses the principle of optical triangulation, that is a visible, modulated point of light is projected onto the target surface.

i Sensor and controller are one unit.

Depending on the distance the diffuse fraction of the reflection of this point of light is then focussed on, to a position sensitive element (CCD-array) by the receiving lens, which is arranged at a certain angle with respect to the optical axis of the laser beam.

From the CCD signal the intensity of the diffuse reflection is determined in real time. This enables the sensor to compensate intensity fluctuations still during processing of a measured-value, which it does in a very wide reflection factor range (from almost complete absorption to almost total reflection).



1) Depending on the adjustment of the analog output by error, see Chapt. 6.8.

Fig. 2 Definition of terms, output signal

SMR = Start of measuring range

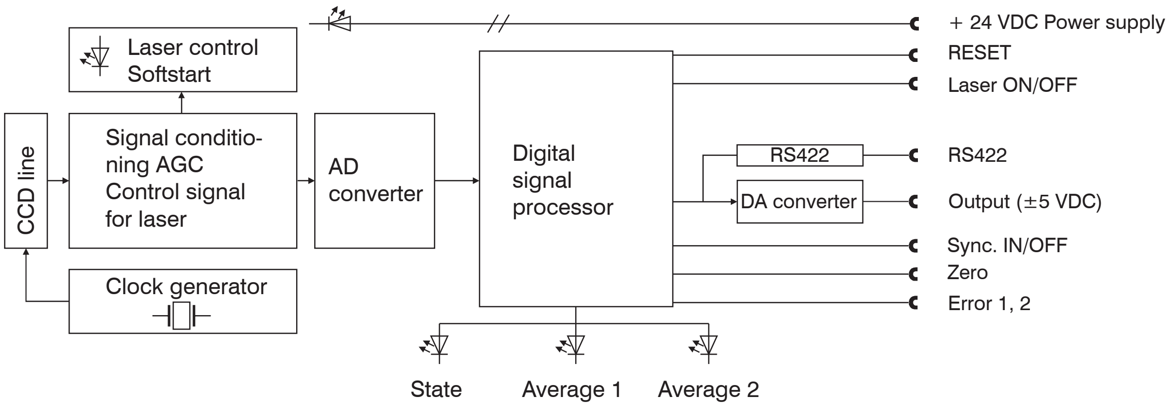
MMR = Midrange

EMR = End of measuring range

LEDs on the controller, see Chap. 3.4, see Chap. 6.1, signal:
- Out of Range (upper and lower range values), poor Target (unfit or no object)
- In range
- Mid range
- Laser ON/OFF
- Power on
- Actual average

LEDs on the sensor signal:
- Out of Range (upper and lower range values)
- Poor Target (unfit or no object)
- Mid range
- Laser ON/OFF

3.2 Block Diagram



3.3 Technical Data

Model	ILD 22xx -	2	10	20	40	50	100	200	500	ILD 2210-10	ILD 2210-20
Measuring principle		Laseroptical triangulation									
Measuring range	mm (“)	2 (.08)	10 (.39)	20 (.79)	40 (1.57)	50 (1.97)	100 (3.94)	200 (7.87)	500 (19.69)	10 (0.39)	20 (0.79)
Start of measuring range	mm (“)	24 (.94)	30 (1.18)	40 (1.57)	175 (6.89)	45 (1.77)	70 (2.76)	130 (5.12)	200 (7.87)	95 (3.74)	90 (3.54)
Midrange	mm (“)	25 (.98)	35 (1.38)	50 (1.97)	195 (7.67)	70 (2.76)	120 (4.72)	230 (9.06)	450 (17.72)	100 (3.94)	100 (3.94)
End of measuring range	mm (“)	26 (1.02)	40 (1.57)	60 (2.36)	215 (8.46)	95 (3.74)	170 (6.69)	330 (12.9)	700 (27.56)	105 (4.13)	110 (4.33)
Linearity	µm	±1	±3	±6	±12	±15	±30	±60	±400	±3	±6
		≤ ±0.05 % FSO	≤ ±0.03 % FSO						≤ ±0.08 % FSO	≤ ±0.03 % FSO	
Resolution (at 10 kHz)	µm	0.03	0.15	0.3	0.6	0.8	1.5	3	7.5	0.5	1
		0.0015 % FSO								0.005 % FSO	
Measuring rate [4]		10 kHz (ILD22xx), 20 kHz (ILD222x)								10 kHz	
Light source (Semiconductor laser)		670 nm, red (Wave length), 1 mW (Max. power), 2 (IEC), II (FDA) (Laser class)									
Permissible ambient light		30.000 lx									
Spot diameter [3]	SMR, µm	80	110	160	230	215	350	1300	1500	130	200
	MMR, µm	35	50	60	210	80	130	1300	1500	60	60
	EMR, µm	80	110	160	230	215	350	1300	1500	130	200
Protection class	Sensor	IP 65									
	Controller	IP 50									
Temperature stability		0.025 % FSO/K	0.01 % FSO/K								
Operating temperature		0 °C ... 50 °C (32 to 122 °F)									
Storage temperature		-20 °C ... 70 °C (-4 to 158 °F)									
Output	Analog	±5 V								±5 V (-10 V ... +10 V)	
	Digital	RS422/ 691.2 kBaud								RS422/ 687.5 kBaud	

Model	**ILD22xx**	**2**	**10**	**20**	**40**	**50**	**100**	**200**	**500**	**ILD 2210-10**	**ILD 2210-20**
Supply voltage		24 VAC (±15 %), max. 500 mA									
Sensor cable		Standard: 2 m (6 ft) - integral									
		Option: 5 m / 10 m (16 / 32 ft) [1]									
Controller		Functions: Zero / Averaging Dimensions: 143 x 145 x 52 mm									
Elektromagnetic compatibility (EMC)		according to EN 61326-1: 2006-10, DIN EN 55011: 2007-11, EN 61000-6-2: 2006-03									
Vibration [2]		2 g / 20 ... 500 Hz									
Shock [2]		15 g / 6 ms/ 3 axis									
Weight	Sensor	about 0.5 kg									
	Controller	about 1 kg									

The specified data apply for a diffusely reflecting matt white ceramic target.

FSO = Full Scale Output
SMR = Start of measuring range
MMR = Midrange
EMR = End of measuring range

1) Sensor and controller are calibrated to the respective cable length. Operation with this calibrated cable length only.
2) The data for the sensor are based on DIN EN 60028-2-6 (vibration) and DIN EN 60028-2-29 (shock).
3) Spezific values for sensors of ILD22xx-xLL series
4) Max. 5 kHz for sensors of ILD2202 series.

Sensors with large SMR

Model	Measuring rate	Start of measuring range
ILD2210-10	10 kHz	95 mm
ILD2210-20	10 kHz	90 mm
ILD2212-10	5 kHz	95 mm
ILD2212-50	5 kHz	550 mm

Spot diameter
ILD 2200-xLL, ILD 2220-xLL

	ILD22x0-2LL	ILD22x0-10LL	ILD22x0-20LL	ILD22x0-50LL
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

3.4 Operating State of the Controller

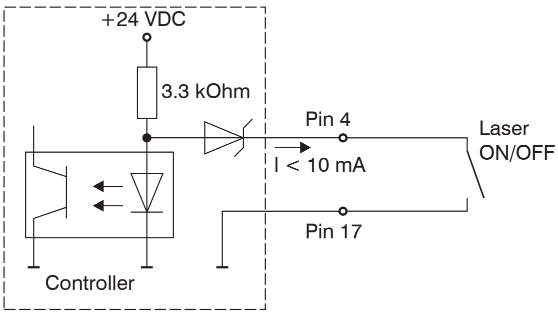
LED State	Color	
OK		green
Mid range		yellow
Poor target, out of range		red
Laser off, see Chap. 3.5	○	-

LED Power	
Power on	

3.5 Electrical Diagram of Remote Switch for Laser On/Off

The laser can be switched of with an external switch between the pins 4 and 17 for service jobs. Switching can be done with a transistor (for example open collector in an optocoupler) or a relay contact.

i If pin 4 and pin 17 (D-SUB female connector) are not connected, the laser is off.



In switched on mode the current through pin 4 and 17 is at total less than 10 A. The residual voltage should be less 0.1 V at the same time.

Reaction Time for Laser-On: Correct measuring data are sent by the sensor approximately 11 ms after signal for Laser-On, see Chap. 7.15.

Fig. 3 Electrical wiring for laser on/off

4. Delivery

4.1 Unpacking

1 Sensor ILD 22xx

1 Controller

1 Instruction manual

1 CD with demo program

1 Rubber feet kit for controller

1 25 pin Sub-D male connector with screened cable clamps

➡ 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 to +70 °C (-4 to +158 °F)
Humidity:	15 - 95 % (no condensation)

5. Installation

The ILD 22xx is an optical sensor for measurements with micrometer accuracy. Make sure it is handled carefully when installing and operating. MICRO-EPSILON recommends the use of protective housings if the sensor operates in a dirty environment or higher ambient temperature, see Chap. 14.2.

Fig. 4 System with sensor, sensor cable, controller and power supply and output cable

Cable	Continuous high flex cable	Bending radius (min, permanent)
CE1800-x	•	50 mm
PC1800-x	•	60 mm

Optional Accessory:
CE1800-x Sensor cable extension
PC1800-x Power supply and output cable

x = cable length in m

Sensor cables with 5 m length or more must be included into the system calibration.

5.1 Mounting and Dimensions of the Sensor

5.1.1 ILD22xx

The sensor is mounted by means of 3 screws type M4.

i The laser beam must be directed perpendicular onto the surface of the target. Misalignment will create measuring errors (indication of bigger distances).

Handle optical sensors with care!

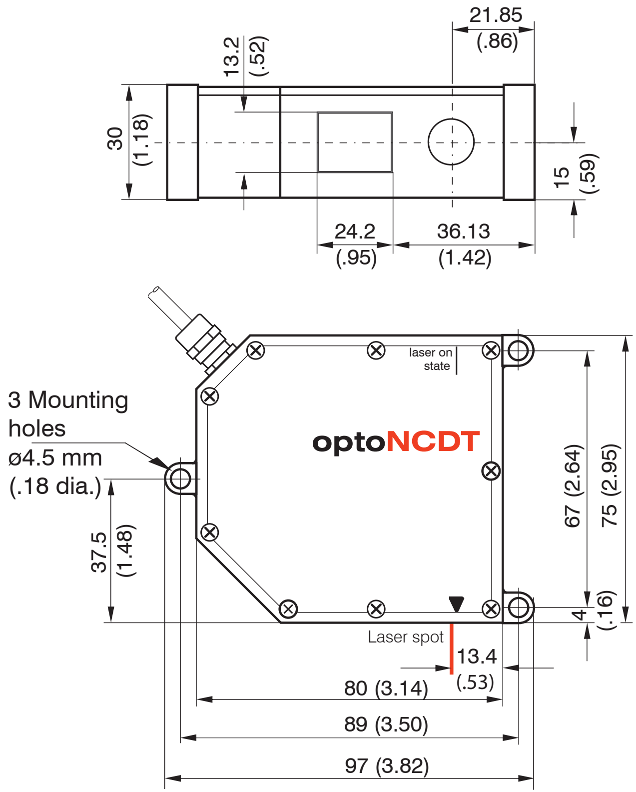


Fig. 5 Sensor dimensions, measuring ranges: 2/10/20/50/100 mm, dimensions in mm (inches), not to scale

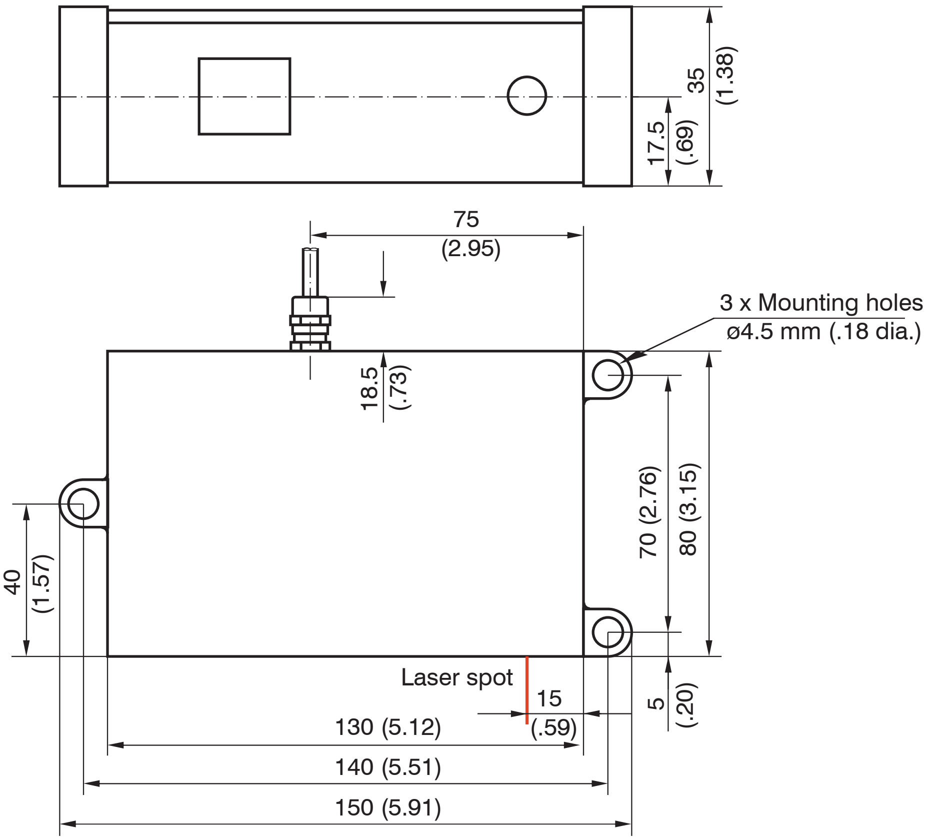
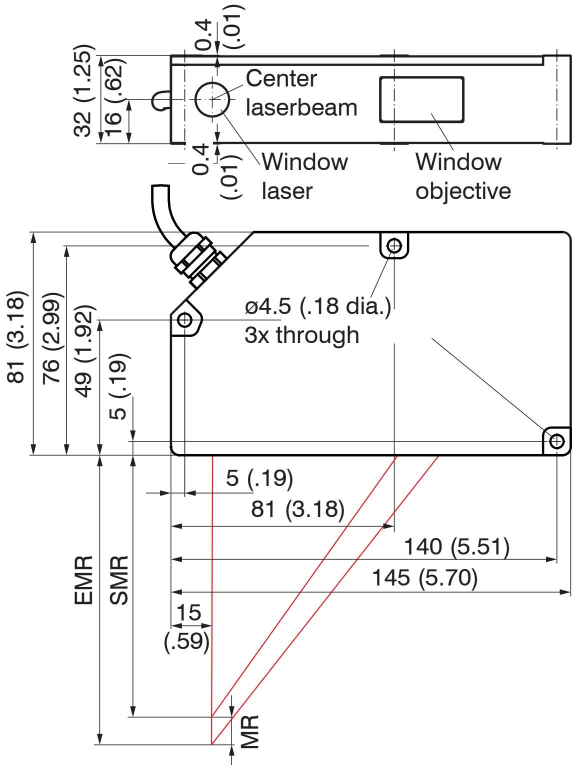


Fig. 6 Sensor dimensions, measuring ranges: 40/200/500 mm, dimensions in mm (inches), not to scale

5.1.2 ILD2210

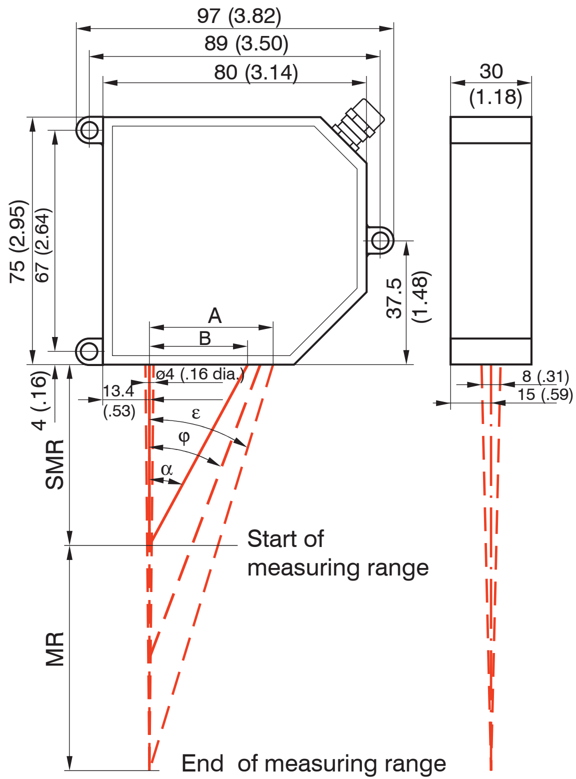


	ILD 2210-10	ILD 2210-20
MR	10	20
SMR	95	90
EMR	105	110

Fig. 7 Sensor dimensions ILD 2210, measuring ranges: 10/20 mm, dimensions in mm (inches), not to scale

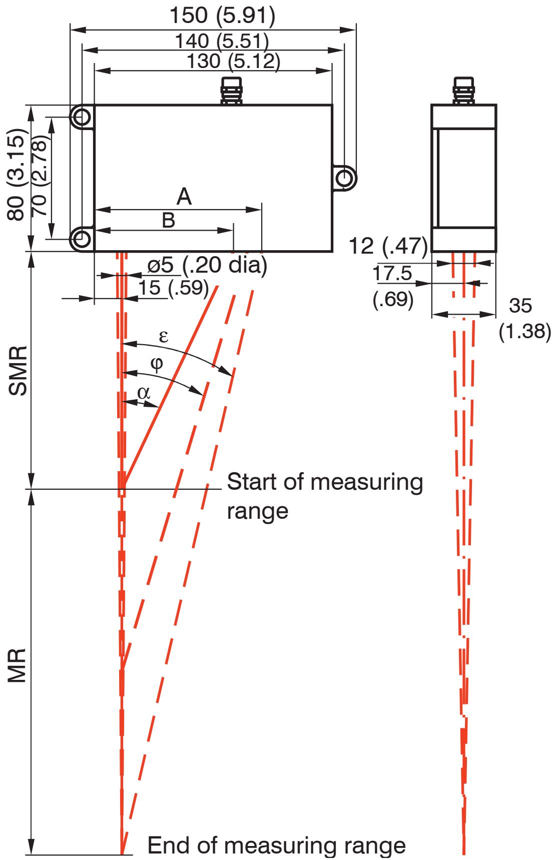
5.2 Free Space of Optics

5.2.1 ILD22xx



MR	SMR	α	φ	ε	A	B
2 (.08)	24 (.94)	35.0 °	40.0 °	44.8 °	25.8 (1.02)	16.8 (.66)
10 (.39)	30 (1.18)	34.3 °	35.2 °	35.6 °	28.7 (1.13)	20.5 (.81)
20 (.79)	40 (1.57)	28.8 °	27.5 °	26.7 °	30.1 (1.19)	22.0 (.87)
50 (1.97)	45 (1.72)	26.5 °	23.0 °	18.3 °	31.5 (1.24)	22.5 (.89)
100 (3.94)	70 (2.76)	19.0 °	15.4 °	10.9 °	32.6 (1.28)	24.1 (.95)

Fig. 8 Free space for measuring ranges 2/10/20/50/100 mm, dimensions in mm (inches), not to scale



MR	SMR	α	φ	ε	A	B
40 (1.57)	175 (6.89)	22.1 °	21.9 °	21.8 °	101 (3.98)	86 (3.39)
200 (7.87)	130 (5.12)	25.1 °	16.7 °	13.1 °	91.6 (3.61)	76 (2.99)
500 (19.96)	200 (7.87)	19,3 °	9,8 °	7,0 °	101 (3.98)	85 (3.35)

Fig. 9 Free space for measuring ranges 40/200/500 mm, dimensions in mm (inches), not to scale

5.2.2 ILD2210

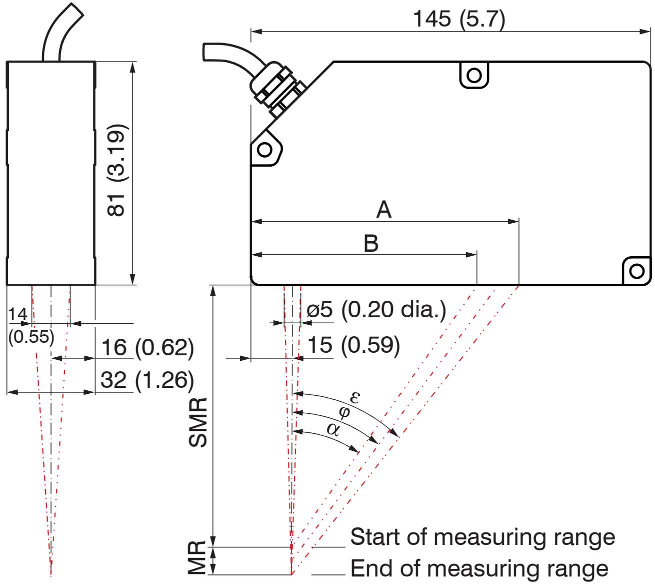


Fig. 10 Free Space for the ILD2210,
10 and 20 mm, dimensions in mm (inches), not to scale

MR	MBA	α	φ	ε	A	B
10 (0.39)	95 (6.89)	34.6 °	36.9 °	38.8 °	99.4 (3.91)	80.6 (3.17)
20 (0.79)	90 (5.12)	36.1 °	36.9 °	37.5 °	99.4 (3.91)	80.6 (3.17)

5.2.3 ILD22xxLL

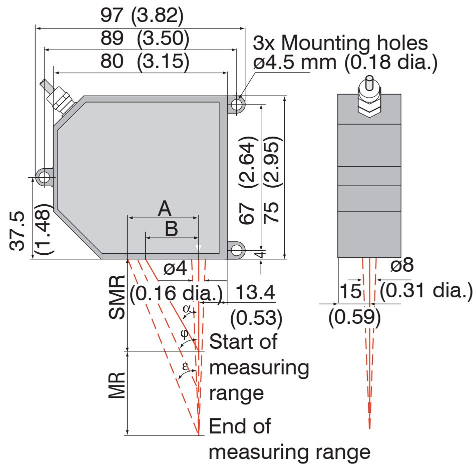


Fig. 11 Free Space for the LL,
2/10/20/50 mm, dimensions in mm (inches), not to scale

MB	MBA	α	φ	ε	A	B
2 (0.08)	24 (0.94)	35.0 °	40.0 °	44.8 °	25.8 (1.02)	16.8 (0.66)
10 (0.39)	30 (1.18)	34.3 °	35.2 °	35.6 °	28.7 (1.13)	20.5 (0.81)
20 (0.79)	40 (1.57)	28.8 °	27.5 °	26.7 °	30.1 (1.19)	22 (0.87)
50 (1.97)	45 (1.77)	26.5 °	23.0 °	18.3 °	31.5 (1.24)	22.5 (0.89)

5.3 Sensor Cable

- Never bend the sensor cable by more than the bending radius of 60 mm.
- Never lay signal leads next to or together with power cables or pulse-loaded cables (for example for drive units and solenoid valves) in a bundle or in cable ducts. Always use separate ducts.

If you extend the sensor cable subsequently, this requires a re-calibration of the complete measuring system. Ask our sale specialists to clarify the necessary steps.

5.4 Mounting and Dimensions of the Controller

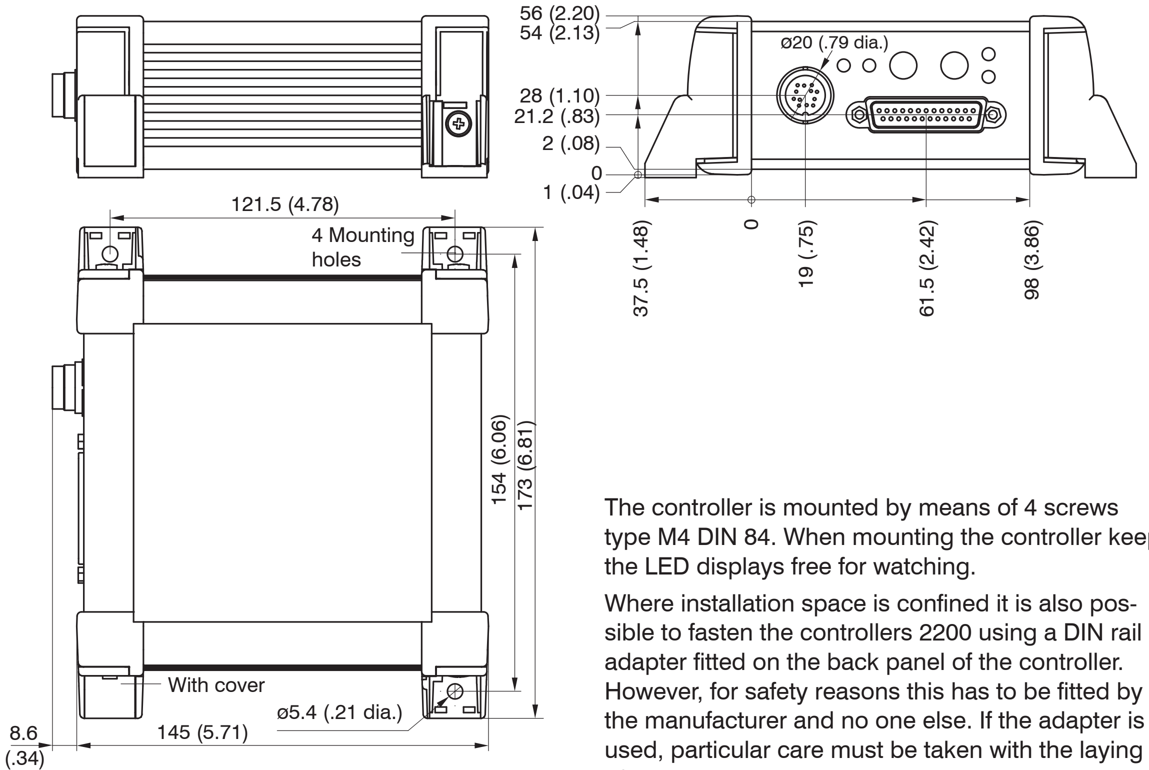


Fig. 12 Controller dimensions with mounting angle, dimensions in mm (inches), not to scale

The controller is mounted by means of 4 screws type M4 DIN 84. When mounting the controller keep the LED displays free for watching.

Where installation space is confined it is also possible to fasten the controllers 2200 using a DIN rail adapter fitted on the back panel of the controller. However, for safety reasons this has to be fitted by the manufacturer and no one else. If the adapter is used, particular care must be taken with the laying of the cables and with the cable holder because an excessive leverage effect will lead to the adapter becoming damaged beyond repair.

5.5 Cable Requirement

Power supply:

Controller 2200:

- 24 VDC (±15 %, max. 500 mA)
- screened cable, screen connected with the plugbody

➡ Connect the screen of the power cable with the safety earth conductor.

Voltage output:

Max. length 10 m (32 ft), the electromagnetic field may cause measurement uncertainty on the signal if you work with cables longer then 10 m (32 ft). MICRO-EPSILON recommends to terminate the end of the cable with 10 nF to avoid noise voltages.

- Twisted wires
- Screened cable, screen connected with the plug body

➡ Connect the screen with the safety earth conductor

Error output and synchronization:

- Twisted wires
- Screened cable, screen connected with the plug body

i When using power supply units, always use devices which are VDE-conform and tested!
For controller with integrated power supply unit:

- Only use a power cable with a protective circuit connection (inlet connector for non-heating appliances)!
- Connection to a socket outlet with an earthing contact required!

6. Measuring Setup and Commissioning

6.1 Getting Ready for Operation, Power Supply

- Install sensor ILD 2200 and controller according to the mounting options, see Chap. 5.
- Interconnect the sensor and the controller with the sensor cable.
- Interconnect the controller output with display or signal processing electronics.
- Connect the power cable to the controller.

Cable	Color	Assignment	Pin, 25-pin Sub-D
PC1800-x and PC1800-3/10/RS485	red	+24 V	1
PC2200-3/10/RS485 and PC2200-x	blue	0 V	14

Fig. 13 Conductor color for power supply, controller 22xx

i When commissioning please observe the notes on the laser class, see Chap. 2. Operate sensor and controller only with the same serial number. A change of components among each other is not possible.

The laser is off if pin 4 and 17 are not connected on the D-Sub connector.

- Switch on the power supply voltage.

Use the power supply unit for measurement instruments only, and not for drive units or similar sources of pulse interference at the same time.

If a well reflecting target, for example a white paper, is positioned within the measuring range the following displays appear: LED “state” is active (green or yellow color) and LED “power” is active. Warm-up time for reliable measurements is 20 minutes.

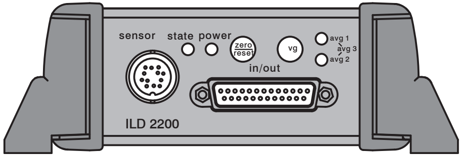


Fig. 14 Front view controller

After switching-on of the supply voltage the sensor runs through an initialization sequence. This is indicated by the momentary activation of all the LEDs and the two switching outputs. If initialization has been finished, the sensor transmits the info string once in ASCII format via the serial interface. The initialization and the info string transmission takes up to 5 seconds. Within this period, the sensor neither executes nor replies commands.

6.2 Control and Display Elements on the Controller

The front panel of the controller contains the „zero/reset“ and „avg“ keys as well as the LEDs „state“, „power“,“avg1“ and „avg2“, see Fig. 14.

The „avg“ key is used to change the averaging numbers in the controller. The LED‘s „avg1“ and „avg2“ display the selected number of averaging, see Chap. 6.3.

The key „zero/reset“ sets the analog output to 0 V. Press the „zero/reset“ key longer than 5 sec. to return to the initial value, see Chap. 6.4.

If a well reflecting target, for example a white paper,
is positioned within the measuring range the LED “state” is active (green, yellow or red):

- green > Measurement is okay
- yellow > Target in midrange
- red > Target out of range, unfit or no object

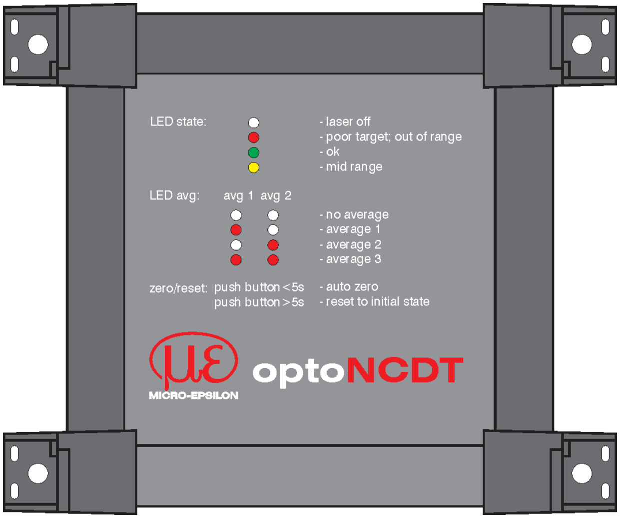


Fig. 15 Top view controller

6.3 Average Setting

The controller is supplied ex factory with the default setting „moving averaging, number of averaging N = 1“ (no averaging activated). Averaging has no effect on linearity.

The controller is capable of the following different averaging methods:
- Moving average
- Recursive average
- Median

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

Controller	Change averaging	Change number of averaging [1]
Booting	**AVG** key, see Chap. 6.3.6.	No
Operation	Serial interface, see Chap. 7.	**AVG** key, see Chap. 6.3.6.
		Press and hold **Zero**/**Reset** (> 5 s), to set the number of averaging N = 1 (for the median N = 3).

i The preset average type and the number of averaging are saved after switching off.

6.3.1 Averaging Number N

The number of averaging N indicates the number of successive measurement values for which averages are to be generated before the measured values are to be output. You select the averaging count by pressing the **AVG** key [1].

The selected number of averaging is indicated by the
- LEDs “AVG1” and “AVG2”.
- Once selected the averaging count remains saved after switching off.

1) When the number of averaging is changed, an error will continue to be sent until the required number of measurement values for the selected averaging count have been reached (logged). For a number of averaging of 128, the maximum time required is 13 ms (128 x 0.1 ms = 12.8 ms).

After completion of the measuring cycle (every 0.1 ms for a measuring frequency of 10 kHz) the internal average is calculated again and outputted. For digital outputs, averaging has no effect on the measuring frequency/data frequency. Further numbers of averaging can be programmed using the digital interface, see Chap. 7. Pressing and holding (> 5 secs) the **Zero**/**Reset** key will set the number of averaging to N = 1 (for the median N = 3).

Averaging mode	Number of averaging	LED	Status	
Moving	1 (no averaging)	AVG 1	OFF	○
Recursive	1 (no averaging)			
Median	3	AVG 2	OFF	○
Moving	4	AVG 1	ON	☀
Recursive	4			
Median	5	AVG 2	OFF	○
Moving	32	AVG 1	OFF	○
Recursive	32			
Median	7	AVG 2	ON	☀
Moving	128	AVG 1	ON	☀
Recursive	128			
Median	9	AVG 2	ON	☀

Fig. 16 Setting the averaging number

6.3.2 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 = Number of averaging
k = Running index
M_{gl} = Average value or output value

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 values
	↓	↓	
	$\frac{2+2+1+3}{4} = M_{gl}(n)$	$\frac{2+1+3+4}{4} = M_{gl}(n+1)$	Output value

The first average value is output when N measurement values have been reached. The output frequency stays constant at 10 kHz. Standard values for N: 1, 4, 32, 128 (window width).

6.3.3 Recursive Average

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

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

MV = Measurement value
N = Number of averaging
n = Measurement value index
M_{rek} = Average value or output value

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 behaviour. The output frequency stays constant at 10 kHz. Standard values for N: 1, 4, 32, 128 (window width).

6.3.4 Median

The median is generated from a preset number of measurement values. Here the inputted measurement values (3, 5, 7,or 9 measurement values) are resorted after each measurement. The average value is then outputted as the median. When the median is generated in the controller only 3, 5, 7 or 9 measurement values are taken into account, that is a 0 median is not possible. This means that individual interference pulses can be suppressed. The measurement value curve is not smoothed to a great extent.

Example:
Average from five measurement values

... 0 1 [2 4 5 1 3] ⟶ Sorted measurements: 1 2 [3] 4 5 $Median_n = 3$

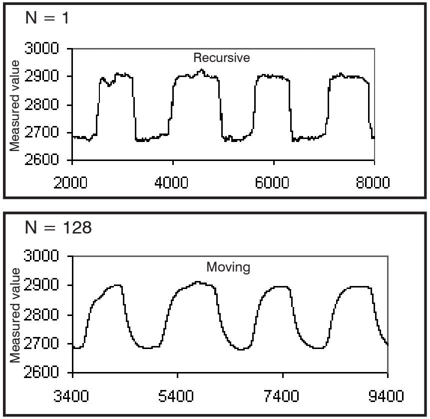
... 0 2 [4 5 1 3 5] ⟶ Sorted measurements: 1 3 [4] 5 5 $Median_{n+1} = 4$

6.3.5 Comparison and Impact of Averaging

The effect of internal averaging in the controller is to provide an improvement in the output signal for:
- Measurement objects with much less backscattering than the reference material
- Measurement objects with structured surfaces, that is sheet metal or scratched surfaces

Although this does not offer any influence on linearity, it does improve the resolution and stability of the measurements on the aforementioned surfaces. The following diagrams illustrate the impact of the different internal averaging methods:

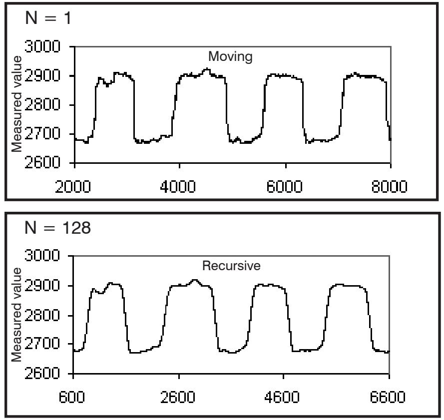
Example 1: Toothed belt disc, rotating measurement object, fixed sensor



Recursive averaging

Impact: Smoothing of surface noise, deformation of the tooth structure

Applications: Measurements on non-profiled belt-type materials



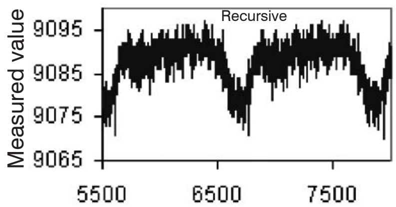
Moving averaging

Impact: Smoothing of surface noise, maintaining of the tooth structure

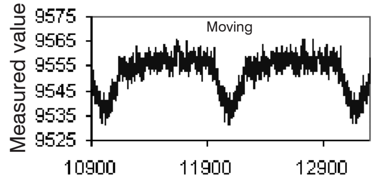
Applications: Measurements on metal profiles

Example 2: Metal part with unbalance

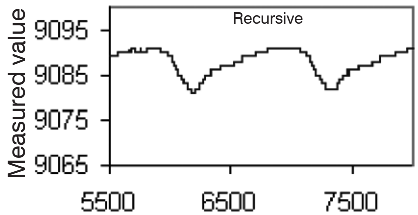
N = 1



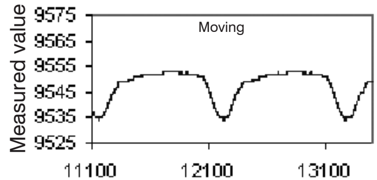
N = 1



N = 128



N = 128



Recursive averaging

Impact: Reduction in surface noise and vibration amplitude

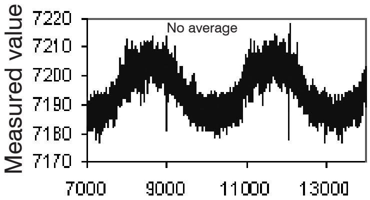
Applications: Measurements on non-profiled belt-type materials

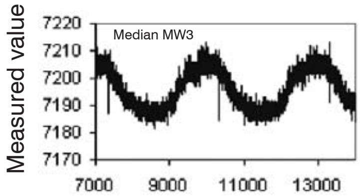
Moving averaging

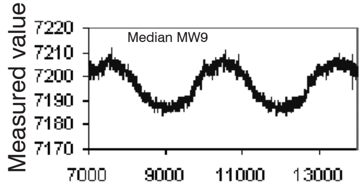
Impact: Reduction in surface noise but retention of the vibration amplitude

Applications: Measurements on metal profiles, vibration measurements

Example 3: Averaging with median
Measurement object: Rotating metal part with low unbalance and slight scratching







Non-averaged output signal:
In the adjacent diagram both the background noise (speckles) and individual spikes (scratches) are identifiable in the measurement curve.

Averaging:
N = 3 (Number of averaging)
The measurement curve is smoothed without any reduction in the vibration amplitude.

Averaging:
N = 9 (Number of averaging
Individual interference from scratches is suppressed.

Applications (Examples)

- Measurement of profiled metal parts where the profile structure is of importance
- Vibration measurements
- Unbalance measurements

6.3.6 Setting the Average Mode

➡ Press and hold the **AVG** key on the controller.

➡ Switch on the controller.

Averaging mode	LED	Status	
Moving	AVG 1	ON	☼
	AVG 2	OFF	○
Recursive	AVG 1	ON	○
	AVG 2	OFF	☼
Median	AVG 1	ON	☼
	AVG 2	ON	☼

Front view of the controller

Fig. 17 Selection of the averaging method

After switching on, the various averaging modes will be enabled internally in cycle and each one indicated via the LEDS avg1 and avg2 for 1 second each:

➡ Release the **AVG** key when the required averaging method is indicated.

The averaging mode is then saved. For verification purposes the selected combination (avg1/avg2) will flash again for a moment. Following this the controller will start up (boot) as normal, indicated by the momentary illumination of the other LEDs. The controller is then ready in measuring mode with the selected averaging method.

When the controller is switched on again the next time, the last selected averaging method will be indicated during booting by the momentary illumination of the LEDs avg1/avg2:

LED sequence					Averaging method
AVG 1	☼	then	AVG 1	○	Moving
AVG 2	○		AVG 2	☼	
AVG 1	○	then	AVG 1	☼	Recursive
AVG 2	☼		AVG 2	○	
AVG 1	☼				Median
AVG 2	☼				

Fig. 18 Averaging mode during booting

6.4 Adjustment of Zero-Point

When delivered the zero point of the analog signal is adjusted to zero. Adjustment range of zero: ±5 V. To set an actual analog output value to zero (0 V) press the **zero**/**reset**-key less then 5 sec. Re-adjustment of delivery situation is made by pressing the **zero**/**reset**-key more then 5 sec.

i The zero-point setting will be saved if you power-down your system. Zero setting will be done only if a measuring object is inside the measuring range of the sensor.

6.5 Pin Assignment 25-pin. Sub-D Connector

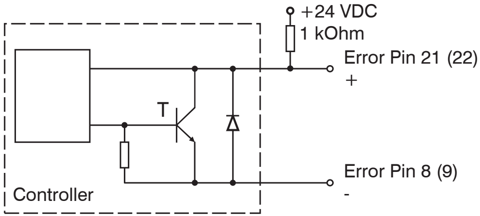
Pin	Assignment	Comment	Color		
			PC2200-x	PC1800-3	PC1800-3/10/RS485
1	+24 VDC	Supply voltage is galvanically insulated from the system	red		
14	Supply ground		blue		
2	GND	Ground	---		
15	GND		---		
3	Analog signal	R_i, appr. 100 Ohm, R_L 1 MOhm, $C_L \leq 47$ nF	green		
16	Signal ground		inner screen		
4	Laser OFF (+)	Optocoupler input both pins are connected: laser on pins open: laser off	violet		
17	Laser OFF (-)		black		
5	Zero (+)	Optocoupler input both pins are connected (< 5 sec): Zero both pins are connected (> 5 sec): Reset	pink		
18	Zero (-)		grey		
6	GND	Ground	---		
19	Sync Out	3.3 VDC CMOS-output	---		
20	Sync In (+)	Optocoupler input	---		
7	Sync In (-)		---		
21	Error 1 (+)	Optocoupler output 30 V / 100 mA	white		
8	Error 1 (-)		brown		
22	Error 2 (+)	Optocoupler output 30 V / 100 mA	grey/pink		
9	Error 2 (-)		blue/red		
10	RS422 S	RS422 output -	white	---	3
23	RS422 $\overline{S}$	RS422 output +	brown	---	4
11	RS422 $\overline{R}$	RS422 input +	yellow	---	2
24	RS422 R	RS422 input -	green	---	1
25	GND	Ground	grey	---	---

6.6 Error Output Circuit

The error messages Error 1 and Error 2 are sent for example if there is low reflection or high penetration depth of the laser light into the target.

It applies the following allocation:

	Pin on Sub-D	
Error 1	21 (+) 8 (-)	POOR Target (unfit or no object)
Error 2	22 (+) 9 (-)	OUT OF RANGE (upper and lower range values)



Status:

No error: T closed (locked)
Error: T open

Fig. 19 Error output, wiring with pull-up resistor

6.7 Synchronization

For thickness measurement with two sensors it is essential that the two sensors measure at the same time. A time delay during the recording of the measurement corresponds to a displacement of the measurement object, that means the sensors measure at different positions. The validity of the thickness measurement object is then questionable.

If two or more optoNCDT 22xx measure against the same target, the controller can be synchronized.

➡ Connect the output **Sync out** of controller 1 with the input **Sync in** of controller 2.

The controller 1 (master) synchronizes the controller 2.
Other systems can be added by cascading them.

All synchronization inputs are DC decoupled with optocouplers.

➡ Use screened cables for synchronization.

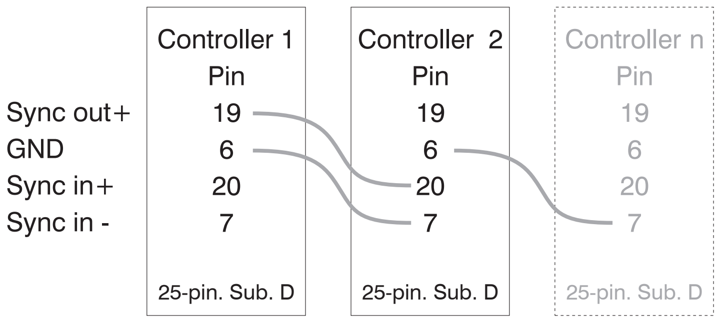


Fig. 20 Synchronization of optoNCDT's

Controller 1	Controller 2	Controller 3	Controller n
PC1800-3/10/RS485(05)	PC1800-3/10/RS485(06)		
PC1800-3(05)	PC1800-3(06)		
PC1800-3/10/RS485(05)	PC1800-3/10/RS485(07)	PC1800-3/10/RS485(06)	
PC1800-3(05)	PC1800-3(10)	PC1800-3(06)	
PC1800-3/10/RS485(05)	PC1800-3/10/RS485(07)	PC1800-3/10/RS485(07)	PC1800-3/10/RS485(06)
PC1800-3(05)	PC1800-3(10)	PC1800-3(10)	PC1800-3(06)
PC2200-x	PC2200-x	PC2200-x	PC2200-x
Master	Slave	Slave	Slave

Fig. 21 Required cables to synchronize two, three or more controllers.

Alternatively, a synchronization with the interface card IF2008 and PC2200-x/IF2008 is possible.

6.8 Responses of the Analog Output to Errors

Responses of the analog output to errors:

- Save the last valid measurement value (standard) or
- Analog voltage greater than 10 VDC

You can change the responses of the analog output to errors as follows:

➡ Press and hold the **Zero**/**Reset** key on the controller

➡ Switch the controller on.

After switching on, the output response alternatives will be enabled internally in cycle and each one indicated via the LEDS avg1 and avg2 for 1 second each, see Fig. 22:

Output response	LED	Status	
Output voltage greater than 10 VDC	AVG 1	ON	
Save last valid reading	AVG 2	ON	

Fig. 22 Selection output behavior

Front view of the controller

➡ Release the Zero/Reset key when the required output response is shown.

The output response is then saved. For verification purposes the selected combination (avg1/avg2) will flash again for a moment. Following this the controller will start up (boot) as normal, indicated by the momentary illumination of the other LEDs. The controller is then ready in measuring mode with the selected output response.

The selected output response also remains saved after switching off but is not shown again when the controller is switched on again. If both keys (**Zero**/**Reset** and **AVG**) are inadvertently pressed simultaneously when the controller is switched on, the **Zero**/**Reset** key will override the other key, that means the output option will be selected again.

Functions of the **Zero**/**Reset** key in measuring mode:

➡ Press the **Zero**/**Reset** key shortly to set the analog output momentarily to 0 V, see Chap. 6.4.

➡ Press and hold the **Zero**/**Reset** key for longer (> 5 secs) to cancel the zero shift (offset) and to set the number of averaging to N = 1 (for the median N = 3).

6.9 Timing

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 and calibration in the DSP (digital signal processor).

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

Each cycle takes 100 μs (= 1 / measuring rate) with a measuring rate of 10 kHz respectively 50 μs with a measuring rate of 20 kHz. The measured value N is available after each cycle with a constant lag of three cycles in respect to the real time event. The delay between the exposure and the signal output is therefore 300 μs. The processing of the cycles occurs sequentially in time and parallel in space, see Fig. 23. This guarantees a constant real time data stream.

Cycle Time	1. 100 µs (50 µs)	2. 200 µs (100 µs)	3. 300 µs (150 µs)	4. 400 µs (200 µs)
1. Layer	Exposure N (Output N-3)	Reading N	Computing N	Output N (Exposure N + 3)
2. Layer	Computing N-2	Exposure N+1 (Output N-2)	Reading N+1	Computing N+1
3. Layer	Reading N-1	Computing N-1	Exposure N+2 (Output N-1)	Reading N+2

Fig. 23 Controller timing, data in brackets apply to the ILD222x

6.10 Pin Assignment for RS422 Connection

Cross the lines for connections between sensor and PC.

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

Controller 25-pin Sub-D Connector			**Terminal (USB converter) 9-pin Sub-D**
Pin	**Assignment**	**Comment**	**Pin**
10	RS422 S	RS422 output -	4
23	RS422 S	RS422 output +	3
11	RS422 R	RS422 input +	2
24	RS422 R	RS422 input -	1
Pin Assignment PC2200-x/x/USB/IND			

For cable lengths over 20 m, we recommend an additional ground connection.

7. Serial Interface RS422

Fig. 24 System structure to operate the interface card IF2008

The controller has a digital interface (RS485). The system can be operated with a PC through the interface unit IF2008 (available as an option).

	Pin	Signal	Signal	Pin	
Controller 1 25-pin. Sub-D	24	Rx - (Input)	Sensor 1/3 TxD -	1	IF2008, X1 and X2, 15-pin. Sub-D
	11	Rx + (Input)	Sensor 1/3 TxD +	2	
	10	Tx - (Output)	Sensor 1/3 RxD -	3	
	23	Tx + (Output)	Sensor 1/3 RxD +	4	
	1	$+U_B$	+24 V supply	10	
	14	0 V	0 V supply	5	
	20	Sync In +	Sync In +	6	
	7	Sync In -	GND	15	
Use the cable **IF2008-Y** (available as an option) if you operate 3 sensors.			NC	7	
			NC	8	
			NC	9	
Controller 2 25-pin. Sub-D	1	$+U_B$	+24 V supply	10	
	14	0 V	+0 V supply	5	
	24	Rx -	Sensor 2/4 TxD -	11	
	11	Rx +	Sensor 2/4 TxD +	12	
	10	Tx -	Sensor 2/4 RxD -	13	
	23	Tx +	Sensor 2/4 RxD +	14	
	20	Sync In +	Sync In +	6	
	7	Sync In -	GND	15	

Required cables and program routines

- IF2008 RS422 interface card, for 1 to 4 laser-optic sensors from the ILD2200 series and 2 encoders, including MEDAQlib programming interface.

- PC2200-x/IF2008 Power supply and interface cable

Alternatively, data can be transferred with the demo software (ILD2200 Tool) and a RS422 converter to USB, see Chap. 10.

Fig. 25 Pin assignment PC2200-x/IF2008 *and IF2008*

7.1 Data Format

The RS422 module uses the RS422 standard for serial communication.

Data rate:	20.000 measurement data/s
Bit rate:	691.2 kBaud
Data format:	8 Data bits, no parity, one start/stop bit

A data word consists of three bytes (L-Byte/M-Byte/H-Byte), which are sent directly one after the other with the identifier bit.

Start	0	0	6 Bit	Stop	Start	0	1	6 Bit	Stop	Start	1	0	6 Bit	Stop

16 bits are used for the measuring data.
Conversion of the binary data:
Reception

L-Byte	0	0	D5	D4	D3	D2	D1	D0
M-Byte	0	1	D11	D10	D9	D8	D7	D6
H-Byte	1	0			D15	D14	D13	D12

Result of the conversion:

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

For the data transfer with a PC the MICRO-EPSILON IF2008 PCI BUS interface card is suitable. This can be connected to the controller via the PC2200-x/IF2008 interface cable, which is also available as an option. The IF2008 combines the three bytes for the data word and saves them in the FIFO. The 16 bits are used for measurement values and error values.

As standard, the IF2008 interface card is suitable for connecting two or (via a Y intermediate cable available as an option) up to four controllers plus two additional incremental encoders. For further information, please refer to the descriptions of the IF2008 interface card and associated MEDAQlib driver program.

You will find the latest program routine at: www.micro-epsilon.com/link/software/medaqlib.

7.2 Setup of the Commands

The commands for the sensor are transmitted in full duplex mode. Each commando packet is made of integer multiple 32 bit words. 4 consecutive bytes are combined to a 32 bit word as most of the serial interfaces use a data format of 8 bits.

Each instruction has a head (32 bit words), the command and data if required.

31 … 24	23 … 16	15 … 8	7 … 0
Head			
ID			
Command			
Data 1			
Data (n)			

Contents	
Start word	Command header (2 words)
Sensor identifier for example “ILD1“	
Command code	Data word quantity n + 2
1^{st} Data word (4 Bytes)	
...	
n^{nd} Data word (4 Bytes)	

Fig. 26 Setup of a command

The first word contains the head to identify a connection towards the sensor. The ID word indentifies the transmitter. The third word contains the command whereby bit 31 and bit 30 have a logical „0“.

The sensor returns a command with set MSB (bit 31), if the sensor receives a command. Bit 30 is set if the sensor detects an error during instruction processing. The sensor transmits no head if he returns a command.

Example:

Command **AVGn**. Sets the averaging number N for the moving and recursive average.

Command: 0x2075

Averaging number: N = 1024, therewith X = $\log_2$ 1024 = 10 (= 0xA)

Data word: n = 1

Package length: 3

You will find further informations on this command, see Chap. 7.6.

Format, Example:

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)	

Information command		
0x20490002	INFO	Shows sensor data
Zero command		
0x20660002	ZERO	Sets offset like the „Zero/Reset"-key
Avg command		
0x20700002	AVG 0	Sets Average 0 = 0
0x20710002	AVG 1	Sets Average 1 = 0
0x20720002	AVG 2	Sets Average 2 = 32
0x20730002	AVG 3	Sets Average 3 = 128
0x20750003	AVG n	Average n = $\log_2$ (N)
AVG method		
0x207D0003	AVGTYP	Changes averaging method
Reset and boot command		
0x20F00002	RESET	Reset and boot again
Start command		
0x20770002	START	Output of data is on
Stop command		
0x20760002	STOP	Output of data is stopped
Read sensor settings		
0x204A0002	Get_Setings	Supplies sensor settings
Laser OFF		
0x20860002	LASER_OFF	Switches the laser of
Laser ON		
0x20870002	LASER_ON	Switches the laser on
Lock keys		
0x2060003	SET_TASTENSPERRE	Locks the keys at the controller

Fig. 27 Instruction set of the controller

7.2.1 Command Reply, 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 (for example GET_INFO) the package length is larger according to the quantity of data words to be transmitted. A firm 32 bitword 0x20200D0A forms the conclusion of the answer. The conclusion word is not a data word.

Example: Sensor reply (without error) to the AVGn 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	

7.2.2 Command Reply, 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. 29. 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	Incorrrect parameter value
3	Invalid parameter
4	Time out
5	Command failed
6	Warning for averaging type and averaging number [1]

Fig. 28 Command error codes

Example: Sensor operates in the average mode “Median“. The command AVGn is not possible in this operation 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.

7.3 Information Command

Name INFO

Description: Sensor data are sent in ASCII format when the command is returned.

Format:

31 24	23 16	15 8	7 0	hex
hex	“+“	“+“	0x0D	0x2B2B2B0D
“I“	“L“	“D“	“1“	0x494C4431
0x20	0x49	0x00	0x02	0x20490002

Response:

31 24	23 16	15 8	7 0	hex
“I“	“L“	“D“	“1“	0x494C4431
0xA0	0x49	0x00	0x20	0xA0490020
0x20	0x20	0x0D	0x0A	0x20200D0A

ILD22xx: STD +/-5 V 10.0
Range: 10
Option: 003
SerialN: 01299123
Average: 0001
Modul RS422: detect
Modul voltage: det.

7.4 Zero Command

Name ZERO

Description: Sets the analog output on 0.0 V. Function like the „Zero/Reset“- key format:

Format:

31 24	23 16	15 8	7 0	hex
“+“	“+“	“+“	0x0D	0x2B2B2B0D
“I“	“L“	“D“	“1“	0x494c4431
0x20	0x66	0x00	0x02	0x20660002

Response:

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

i Zero setting will be done only if a measuring object is inside the measuring range of the sensor.

7.5 Average Command 0..3

Name AVG 0..3

Description: Averaging and the LED‘s are set

	Moving or recursive	Median
AVG 0	No average	Median 3
AVG 1	Average 4	Median 5
AVG 2	Average 32	Median 7
AVG 3	Average 128	Median 9

Format:

31 24	23 16	15 8	7 0	hex
“+“	“+“	“+“	0x0D	0x2B2B2B0D
“I“	“L“	“D“	“1“	0x494C4431
0x20	z [1]	0x00	0x02	0x207y000 [2]

Response:

31 24	23 16	15 8	7 0	hex
“I“	“L“	“D“	“1“	0x494C4431
0xA0	z [1]	0x00	0x02	0xA07y0002 [2]
0x20	0x20	0x0D	0x0A	0x20200D0A

1) z = 0x70 AVG0
0x71 AVG1
0x72 AVG2
0x73 AVG3

2) y = 0 AVG0
1 AVG1
2 AVG2
3 AVG3

7.6 Average Command n

Name AVG n

Description: Averaging is set and the LED‘s are off.

Format:

31 24	23 16	15 8	7 0	hex
“+“	“+“	“+“	0x0D	0x2B2B2B0D
“I“	“L“	“D“	“1“	0x494C4431
0x20	0x75	0x00	0x03	0x20750003
0x00	0x00	0x00	n	0x0000000n

Response:

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

n = $\log_2$ (value)

Note: The values for averaging can be only a multiple of 2 ($N = 2^n$).

Example: Average 8 $n = \log_2 (8)$ = 3

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

This results in the following values:

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

Range of values for number of average N

Command	**Average N**		
	Recursive average	Moving average	Median
AVG 0...3	1, 4, 32, 128	1, 4, 32, 128	3, 5, 7, 9
AVG n	1 ... 32768	1 ... 128	Command without action

7.7 Change Average Method

Name AVGTYP

Description: Selects an averaging type:

- Recursive Average
- Moving Average (Standard)
- Median

Parameter value X: 0 = Recursive average
1 = Moving average (Standard)
2 = Median

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0D	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x7d	0x00	0x03	0x207D0003
0x00	0x00	0x00	0x0X	0x0000000X

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x7d	0x00	0x02	0xA07D0002
0x20	0x20	0x0D	0x0A	0x20200D0A

Value for X (0, 1, 2)

7.8 Reset Command

Name RESET

Description: The sensor makes a software reset. The standard settings for averaging and zero are used. The response is sent before the reset is done.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0D	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0xF0	0x00	0x02	0x20F00002

Response:

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

7.9 Start Command

Name START

Description: Output of data via serial output is started.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0D	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x77	0x00	0x02	0x20770002

Response:

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

Note: When switching the sensor on Stop (data output) is on. The „stop“ command is transient and will be lost when switching off the power supply or when sending the reset command.

7.10 Stop Command

Name STOP

Description: Output of data via serial output is stopped

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0D	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x76	0x00	0x02	0x20760002

Response:

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

7.11 Get Sensor Settings

Name Get_Settings

Description: Reads out the sensor settings

- **Measuring frequency**
  0 = 10 kHz
  1 = 5 kHz
  2 = 2.5 kHz
  3 = 20 kHz
- **Average number** is an integer in hexadecimal code for moving and recursive average.
  Note: The values for averaging can be only a multiple of ($N = 2^n$).
  For Median:
  0 = 3
  2 = 5
  5 = 7
  7 = 9
- Flag **Hold Last Value**
  0 = hold last value not
  1 = hold last value
- **Averaging method**
  0 = recursive
  1 = moving
  2 = Median
- **Offset value**
  Supplies the absolute value in the moment zero setting was done
- **Zero point**
  0 = absolute measurements
  1 = relative measurements
- **Measuring range** is an integer in hexadecimal code in mm
- **Lock keys**
  0 = keys enabled
  1 = keys locked
- **Digital data output**
  0 = data output off
  1 = data output on
- **Laser state**
  0 = Laser off
  1 = Laser on

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	CR	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x4A	0x00	0x02	0x204A0002

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x4A	0x00	0x0C	0xA04A000C
Measuring frequency				
0x00	0x00	0x00	0x0X	0x0000000X
Averaging number				
0x00	0x00	0x00	0x0X	0x0000000X
Flag: Hold last value				
0x00	0x00	0x00	0x0X	0x0000000X
Averaging method				
0x00	0x00	0x00	0x0X	0x0000000X
Offset value				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Zero point				
0x00	0x00	0x00	0x0X	0x0000000X
Measuring range				
0x00	0x00	0xXX	0xXX	0x0000XXXX
Lock keys				
0x00	0x00	0x00	0x0X	0x0000000X
Digital data output				
0x00	0x00	0x00	0x0X	0x0000000X
Laser state				
0x00	0x00	0x00	0x0X	0x0000000X
0x20	0x20	0x0D	0x0A	0x20200D0A

7.12 Laser off

Name LASER_OFF
Description: Switch off the laser

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0D	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x86	0x00	0x02	0x20860002

Response:

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

7.13 Laser on

Name LASER_ON
Description: Switch on the laser

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	CR	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x87	0x00	0x02	0x20870002

Response:

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

7.14 Lock Keys

Name SET_TASTENSPERRE
Description: Locks the keys on the front of the controller or enables it. The command is non-volatile.

Format:

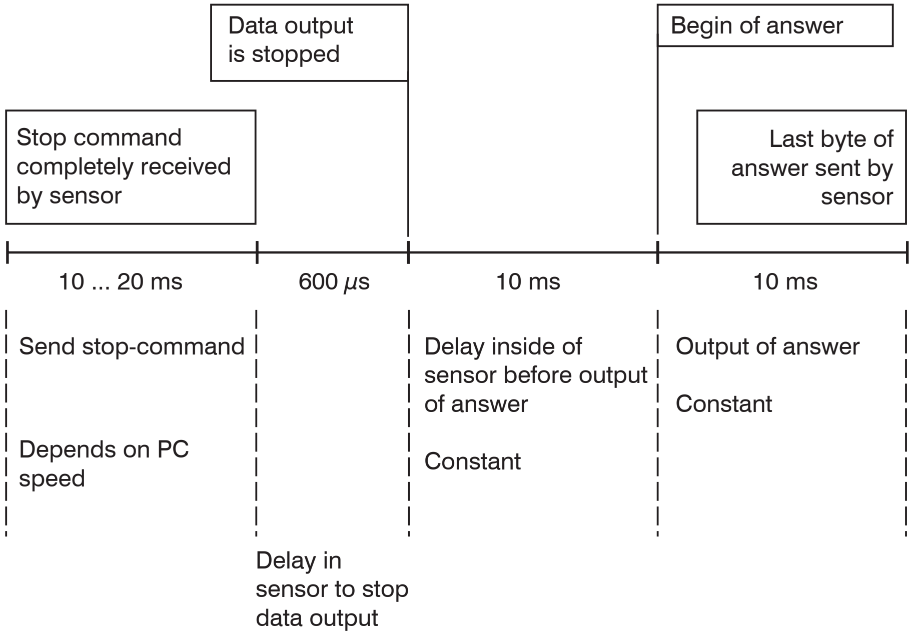
31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	CR	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x60	0x00	0x03	0x20600003
0x00	0x00	0x00	0x0X	0x0000000X

Response:

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

- X = 0 > Enables keys
- X = 1 > Lock keys

7.15 Reaction Time



8. Instructions for Operating

8.1 Reflection Factor of the Target Surface

In principle the sensor evaluates the diffuse part of the reflected laser light, see Fig. 29. 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. To use the sensor on transparent or reflective objects, manufacturer pretesting is necessary.

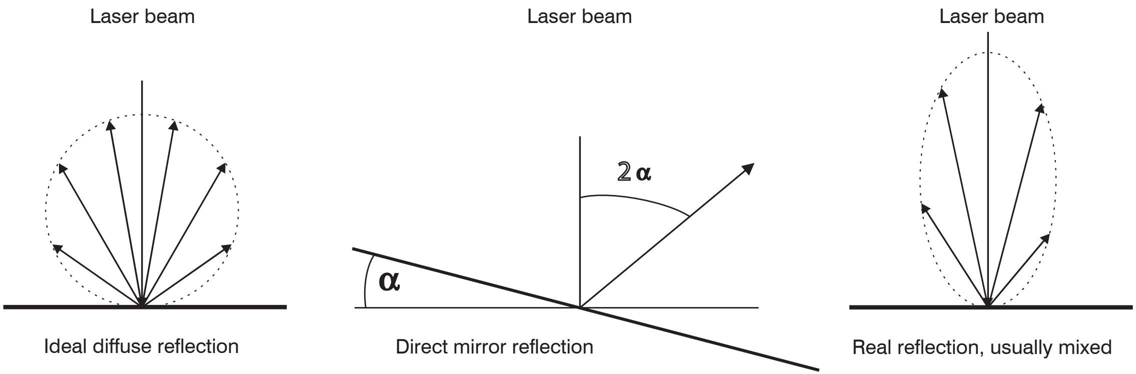


Fig. 29 Reflection factor of the target surface

8.2 Error Influences

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. This fact also affects the linearity behaviour of the sensor, if it has been adapted for white, diffusely reflecting reference material, and is then used to measure black material.

If, however, the sensor is optimized for the black material, a clearly improved linearity behaviour is achieved again.

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.

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.

Surface roughness

In case of traversing measurements surface roughnesses of 5 μm and more lead to an apparent distance change (also-called surface noise). However, they can be dampened by averaging, see Chap. 6.3.

Angle influence

Tilt angles of the target both around the X and the Y axis 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. 30.

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 behaviour in triangulation also depends on the reflectivity of the target.

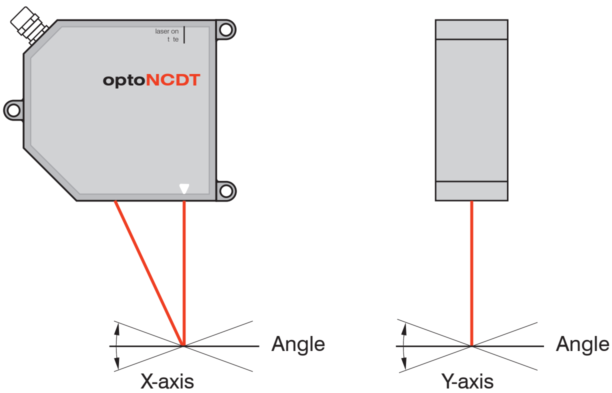


Fig. 30 Angle influence

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

Optimising the measuring accuracy by means of special sensor arrangement

- 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 grinding marks. The same arrangement must be used for color strips, see Fig. 31.

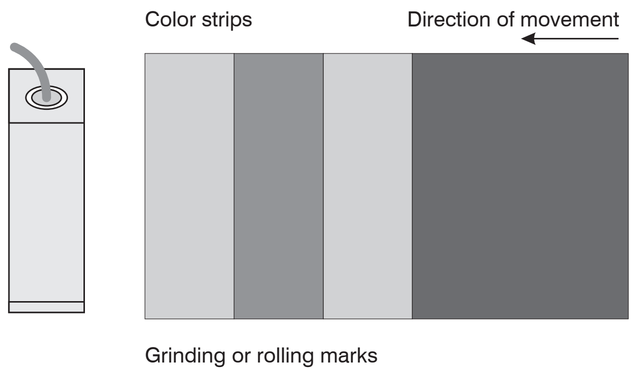


Fig. 31 Sensor arrangement in case of ground or striped surfaces

- 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. 32.

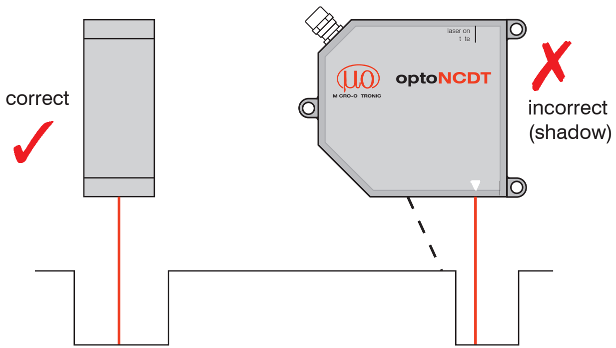


Fig. 32 Sensor arrangement for holes and ridges

8.3 Cleaning the Protective Glasses

A periodically cleaning of the protective housings is recommended.

Dry cleaning

This requires a suitable optical antistatic brush or blow off the panels with dehumidified, clean and oil free compressed air.

Wet cleaning

Use a clean, soft, lint-free cloth or lens cleaning paper and pure alcohol (isopropanol) for cleaning the protective housing.

Do not use commercial glass cleaner or other cleansing agents.

9. Value Output

9.1 Analog Value Output

Max. range (with offset)	-10.0 V ... +10.0 V
Output amplification ΔU_{OUT}	10.0 V = 100 % measuring range
Output voltage without offset	-5.0 V ... +5.0 V

Calculation of a value: [1]

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

Example: U_{OUT} = 4.6 V
Measuring range = 10 mm
Value = 4.6 mm

9.2 Digital Value Output, Conversion

Value range	0	...	65519	16 Bit - 16
	0	...	642	SMR reserves
	643	...	64876	Measuring range
	64877	...	65519	EMR reserves

Calculation of a value: [1]

$$x[mm] = \left(\text{digital}_{OUT} * \frac{1.02}{65520} - 0.51\right) * \text{Measuring range [mm]}$$

Example:

32760	(32760	* 15.5677E-6 - 0.51)	* 10 mm	=	0 mm	(Midrange)
16758	(16758	* 15.5677E-6 - 0.51)	* 10 mm	=	-2.49115 mm	
643	(643	* 15.5677E-6 - 0.51)	* 10 mm	=	-4.99989 mm	(Start of measuring range)

9.3 Digital Error Codes

Value range 65520 ... 65535 (digital $_{OUT}$)

F1 bad objekt	65522
F2 out of range -	65524
F3 out of range +	65526
F4 poor target	65528
F5 Laser off	65530

1) Based on midrange

10. Software

10.1 Demo Software

The software
- transfers sensor parameter to the sensor and
- transmits measuring results and represent them in a diagram.

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

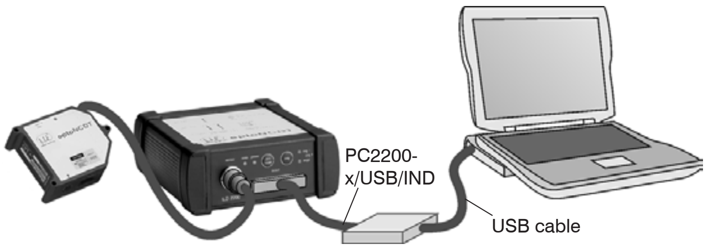
i Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

10.1.1 System Requirements

The following system requirements are recommended:
- Windows 2000, Windows XP or Windows 7
- Pentium III ≥ 300 MHz
- 256 MB RAM
- Free USB port

10.1.2 Cable and Program Routine Requirements

- PC2200-x/USB/IND Sensor cable for supply (soldered ends) and 9-pin SUB D connector for RS422 interface (useable with IF/RS422/USB)
- RS422/USB converter Interface converter RS422 to USB, useable with cable PC2200-x/USB/IND inclusive driver.



PC2200-x/USB/IND	
Pin	Signal
2	Rx+
1	Rx-
3	Tx+
4	Tx-
Pin assignment 9-pin D SUB	

Fig. 33 System structure to operate the demo software

10.1.3 Measurement

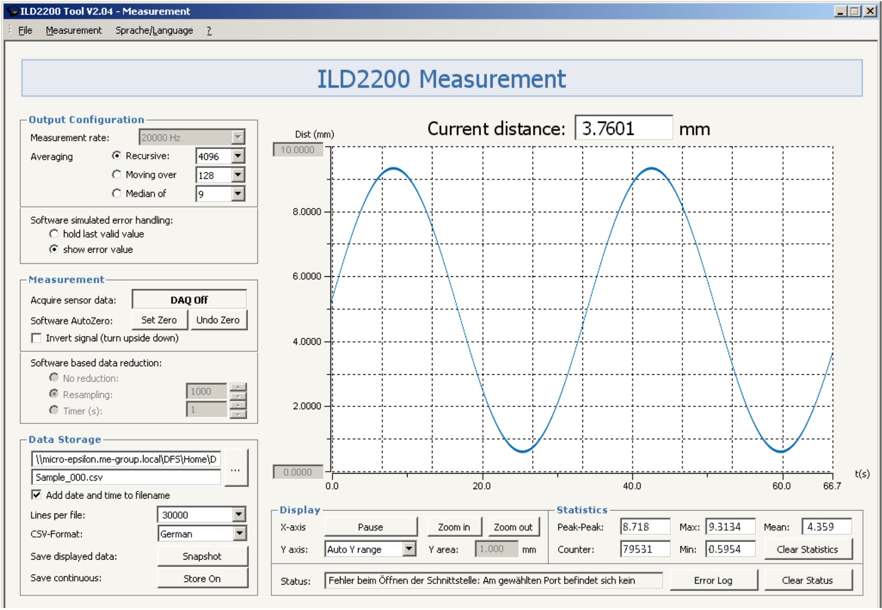


Fig. 34 Start screen of the measurement program

This sub program can be used to acquire, evaluate and store data.

i You will find the latest driver /program routine at:
www.micro-epsilon.com/link/opto/2200

10.2 Software Support with MEDAQLib

MEDAQLib offers you a documented driver DLL. Therewith you embed optoNCDT laser sensors, in combination with

- the RS422/USB converter, see Chap. 14.1 and a suitable PC2200-x/USB/IND cable or
- the PCI interface card IF 2008 and the PC2200-x/IF2008 cable, see Chap. 7.,

into an existing or a customized PC software.

MEDAQLib

- contains a DLL, which can be imported into C, C++, VB, Delphi and many additional programs,
- makes data conversion for you,
- works independant of the used interface type,
- features by identical functions for the communication (commands),
- provides a consistant transmission format for all MICRO-EPSILON sensors.

For C/C++ programmers MEDAQLib contains an additional header file and a library file,

You will find the latest driver / program routine at:

www.micro-epsilon.com/download

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

11. Warranty

All components of the device have been checked and tested for perfect function in the factory. In the unlikely event that errors should occur despite our thorough quality control, this should be reported immediately to MICRO-EPSILON. The warranty period lasts 12 months following the day of shipment. Defective parts, except wear parts, will be repaired or replaced free of charge within this period if you return the device free of cost to MICRO-EPSILON.

This warranty does not apply to damage resulting from abuse of the equipment and devices, from forceful handling or installation of the devices or from repair or modifications performed by third parties.
MICRO-EPSILON will specifically not be responsible for eventual consequential damages.

No other claims, except as warranted, are accepted. The terms of the purchasing contract apply in full.
MICRO-EPSILON always strives to supply the customers with the finest and most advanced equipment. Development and refinement is therefore performed continuously and the right to design changes without prior notice is accordingly reserved. For translations in other languages, the data and statements in the German language operation manual are to be taken as authoritative.

12. Service, Repair

In the event of a defect on the sensor, sensor cable or controller:

- If possible, save the current sensor settings in a parameter set, see ILD2200 Tool, Measurement / Configuration menu, in order to load the settings back again into the controller after the repair.
- Please send us the effected parts for repair or exchange.

In the case of faults the cause of which is not clearly identifiable, the whole measuring system must be sent back to:

MICRO-EPSILON Optronic GmbH
Lessingstraße 14
D-01465 Langebrück
Telefon: 035201 / 729 - 0
Fax: 035201 / 729 - 90

optronic@micro-epsilon.de
www.micro-epsilon.com

13. Decommissioning, Disposal

➡ Disconnect the power supply and output cable on the controller.

➡ Disconnect the sensor cable between sensor and controller.

The optoNCDT22xx is produced according to the directive 2002/95/EC („RoHS“).
The disposal is done according to the legal regulations (see directive 2002/96/EC).

14. Appendix

14.1 Accessories, Service

PS2020	Power supply 24 V for mounting on DIN-rail, input 230 VAC, output 24 VDC/2.5
IF2008	Interface card with RS422 interface for up to 4 sensors ILD22xx and two encoders
SGH 1800	Protection housing with glass window for sensors ILD22xx-2 / 10 / 20 / 50 / 100
SGHF 1800	Protection housing with glass window and air cleaning of the glass window for sensors ILD22xx-2 / 10 / 20 / 50 / 100
SGH 2200-200	Protection housing with glass window for sensor ILD22xx-40 / 200
SGHF 2200-200	Protection housing with glass window and air cleaning of the glass window for sensor ILD22xx-40 / 200
CE1800-x	Extension cable, 3 or 8 m long [1]
PC1800-3	Power supply and output cable, 3 m long
PC1800-3/10/RS485	Power supply and output cable,10 m long, with RS485
PC1800-3/5/RS485	Power supply and output cable, 5 m long, with RS485
PC2200-x	Power supply and output cable, 3 or 5 m long, analog and digital signals, 25-pin. Sub-D connector respectively tinned ends
PC2200-x/USB/IND	Sensor cable for supply and 9-pin Sub-D connector for RS422 interface (useable with RS422/USB converter. Inclusive power supply unit connector (90 ... 235 VAC) for power supply
RS422/USB converter	Interface converter RS422 to USB (useable with cable 2200-x/USB/IND inclusive driver)
IF2008-Y adapter cable	Adapter cable, Y-type, 100 mm long, to connect two interface cables on the same RS485 port of a IF2008
PC2200-x/IF2008	Sensor cable for supply and RS422 interface, useable with IF2008

Service

Functional test and new matching test of all components and new matching of a complete measuring channel, inclusive test report, with calibration.

1) Extension cable are available for all ILD22xx. If you use an extension cable, calibration of the whole measuring system is necessary. Please define the type of extension cable with your order.

14.2 Protective Housing

The SGH 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.

The protective housing are offered in two versions:
- SGH without air purging (with inlet and exhaust for cooling) and
- SGHF with air purging.

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

1. The maximum ambient temperature within the protective housing is 45 °C.
2. 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.
3. With a flow rate for example 240 l/min (2.5 bar) the maximum outside temperature is 65 °C.
4. For higher ambient temperatures it is recommended to use an additional water-cooled carrier and cover plates outside the protective housing.
5. No direct heat radiation (including sunlight!) on the protective housing. In case of direct heat radiation additional thermal protective shields must be installed.
6. 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.
7. 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.

The delivery includes no screws for fastening the protective housing (for example 4 pieces M4 x 20).

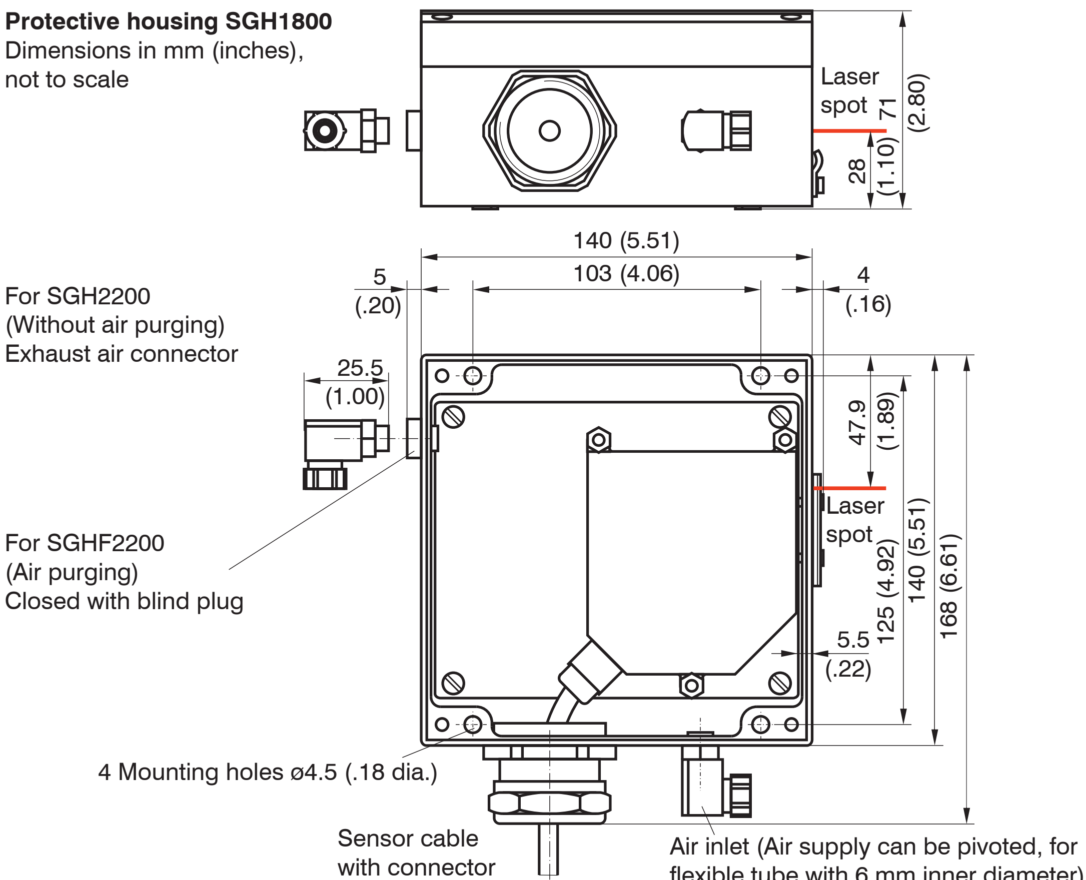


Fig. 35 Protective housing for measuring ranges 2/10/20/50/100

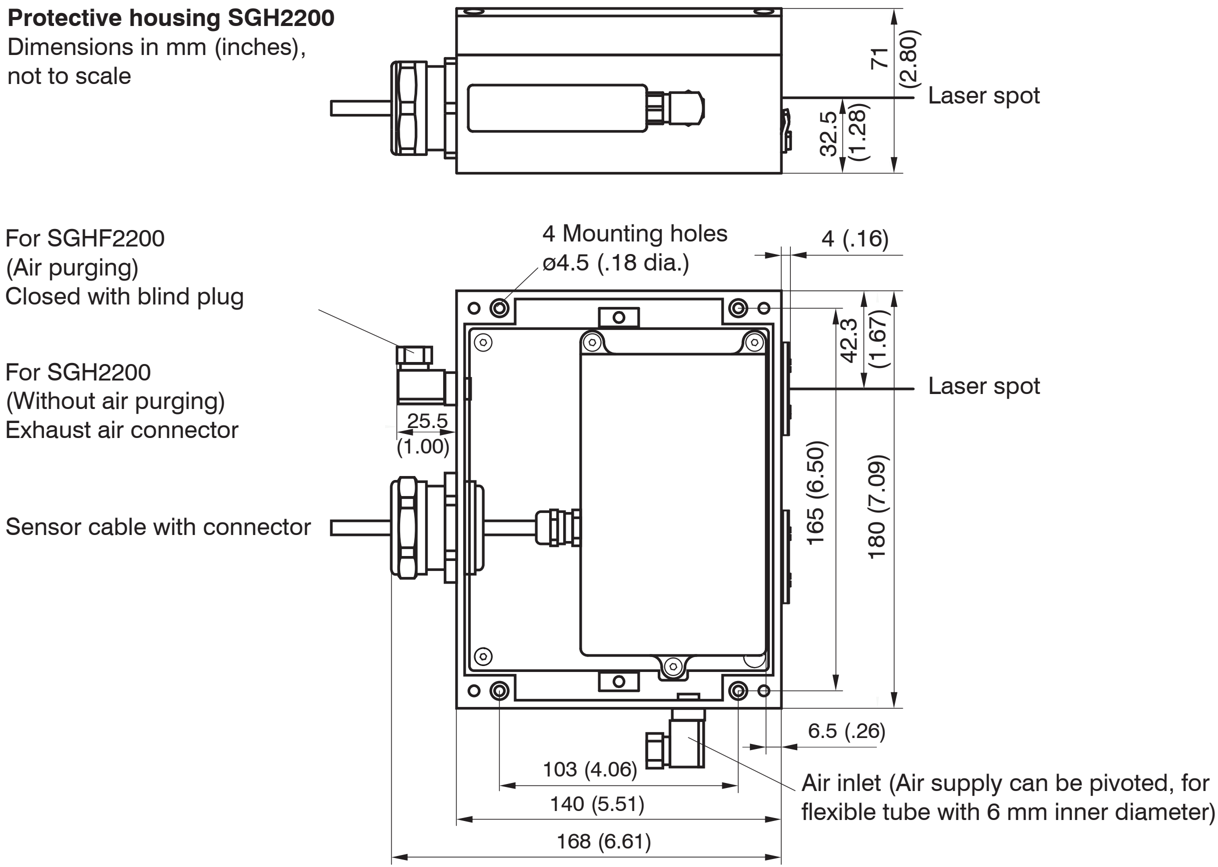


Fig. 36 Protective housing for measuring range 40 and 200 mm

14.3 Factory Setting

Press the key “zero/reset“ for about 5 seconds to restore the factory settings.

Name/Function	Setting	Chapter
Averaging	Moving average, averaging number N = 1, without averaging	Chap. 6.3
Responses of the analog output to errors	Save the last valid measurement value	Chap. 6.8

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