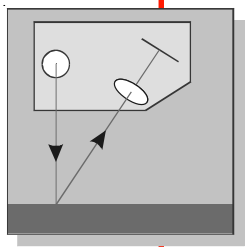
SENSORS & SYSTEMS

Authority in Displacement Measurement

MICRO-EPSILON

INSTRUCTION MANUAL

MICRO EPSILON



Laser Optical Displacement Sensor with high speed CCD-System

Instruction Manual

optoNCDT1800, 1801

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CE

Certified in compliance with
DIN EN ISO 9001: 2000

MICRO-EPSILON

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:

DANGER! - imminent danger

WARNING! - potentially dangerous situation

IMPORTANT! - useful tips and information

1.2 Warnings

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

- 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.

- Avoid **banging** and **knocking** 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

- **Power supply** and the **display-/output** device must be connected in accordance with the safety regulations for electrical equipment
  > Danger of injury
  > 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 **spray** on the sensors and the controller
  > Damage to or destruction of the controller and/or the sensor

- Operate sensor and controller only with the same serial number
  > Loss of the specified technical data

- The housing of the series 1801 controller housing may only be opened by authorised persons.
  > Danger of injury through mains voltage
  > Damage to or destruction of the controller

DANGER!
Do not open series 1801 controller housing!

1.3 Notes on CE Identification

The following applies to the measuring system series 1800, 1801:

EC regulation 89/336/EEC
EC regulation 73/23/EEC (Series 1801 only)

Products which carry the CE mark satisfy the requirements of the EC regulation EC 89/336/EEC '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 system is designed for use in industry and to satisfy the requirements of the standards
- EN 50 081-1 Spurious emission
- EN 61 000-6-2 Resistance to disturbance

The systems satisfy the requirements if they comply with the regulations described in the operating manual for installation and operation.

1.4 Proper Use

- The series 1800/1801 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 (chap. 3.2).
- The system should only be used in such a way that in case of malfunctions or failure personnel or machinery are not endanged.
- 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)
- Protection class 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: acc. EN 50 081-1 Spurious emission
  EN 61 000-6-2 Resistance to disturbance

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

2. Laser Class

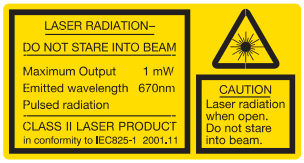
The opto 1800/1801 sensors operate with a semiconductor laser with a wavelength of 670 nm (visible/red). The laser is operated on a pulsed mode, the pulse frequency corresponding to the measuring frequency. The duration of the pulse is regulated in dependency on the object to be measured and can form an almost permanent beam.

The maximum optical 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.

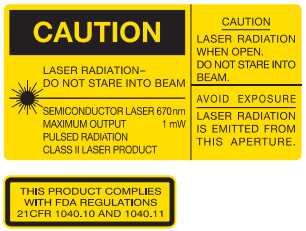
WARNING!
Never deliberately look into the laser beam! Consciously close your eyes or turn away immediately if ever the laser beam should hit your eyes.

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).



IEC Standard
During operation of the sensor ILD 1800 the pertinent regulations acc. 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) as a Class II laser device.

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

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 optoNCDT1800/1801 may only be opened by the manufacturer. For repair and service purposes the sensors must always be sent to the manufacturer.

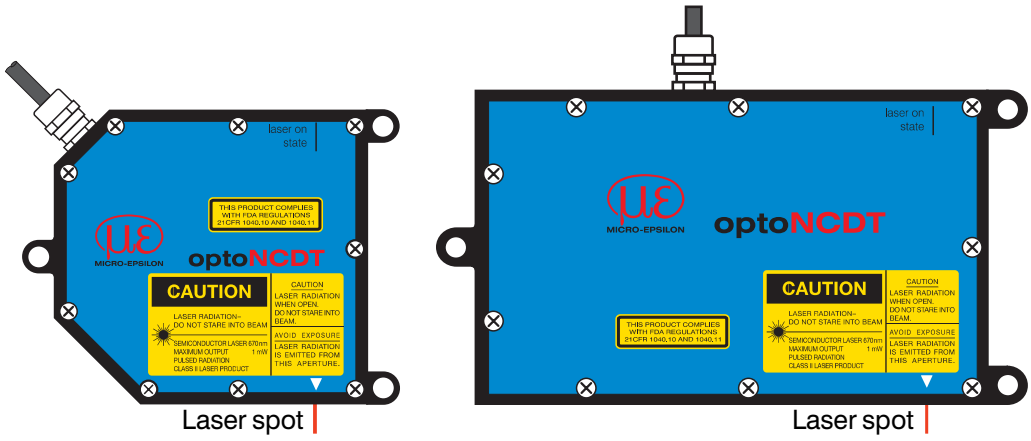


Fig. 2.1: True reproduction of the sensor with its actual location of the warning labels

3. Functional Principle, Technical Data

3.1 Short Description

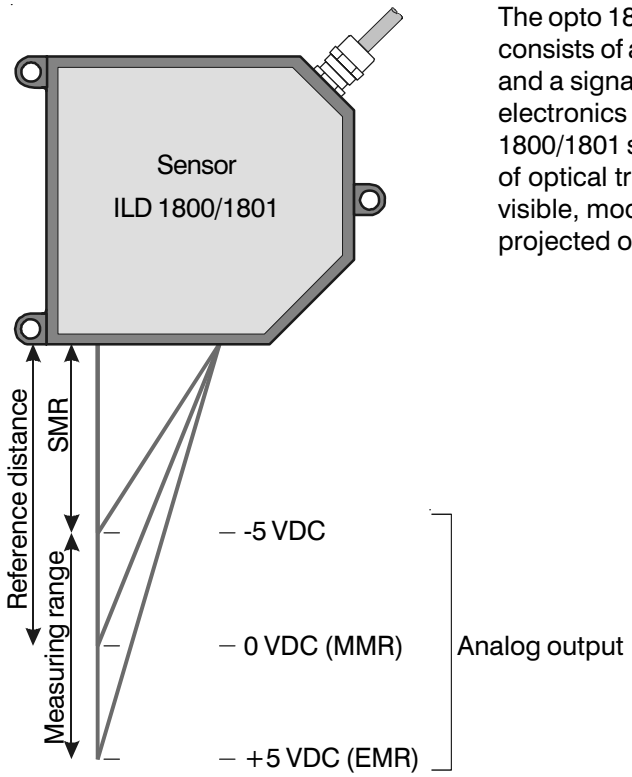


Fig. 3.1: Triangulation principle

The opto 1800/1801 system consists of an laser-optical sensor and a signal conditioning electronics (controller). The opto 1800/1801 sensor uses the principle of optical triangulation, i.e. a visible, modulated point of light is projected onto the target surface.

IMPORTANT!

Sensor and controller are one unit.

SMR
Start of measuring range

MMR
Midrange

EMR
End of measuring range

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).

LEDs on the controller (see chap. 3.4 and 6.2) signal:
- Out of range (upper and lower range values), poor Target (unfit or no object)
- In range
- Mid range
- Laser ON/OFF
- Power on

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 Technical Data

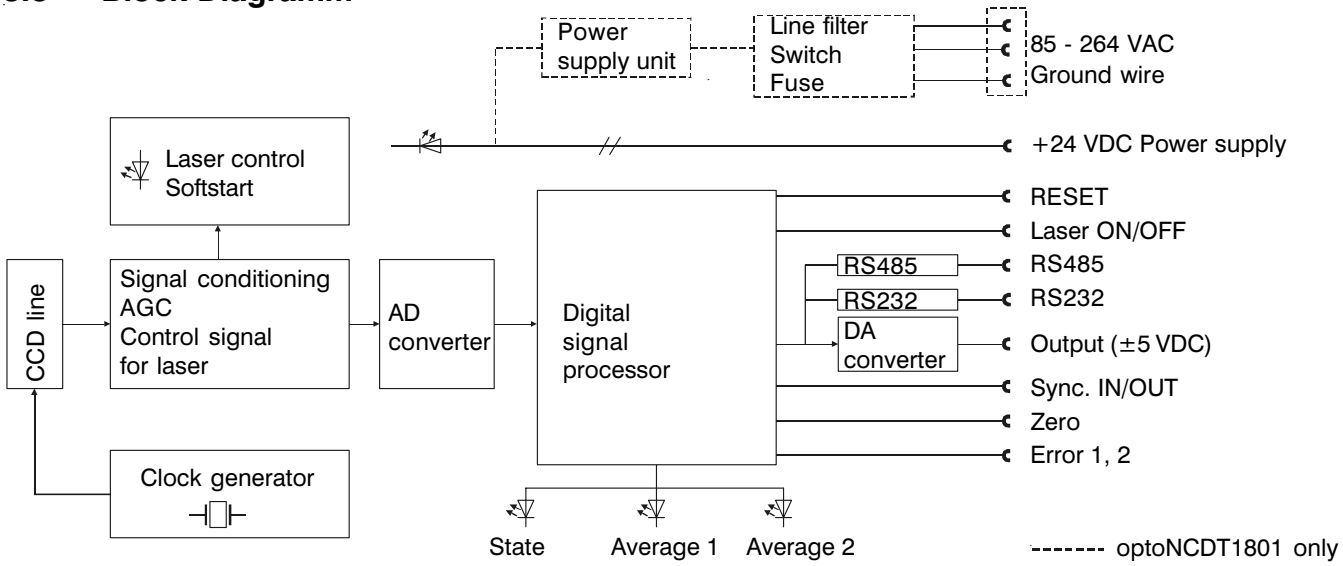
Type ILD 1800- /1801-		2	10	20	50	100	200	500	750	1810-50
Measuring principle		laser optical, triangulation								
Measuring range	mm (")	2 (.08)	10 (.39)	20 (.79)	50 (1.97)	100 (3.94)	200 (7.87)	500 (19.7)	750 (29.5)	50 (1.97)
Start of measuring range	mm (")	24 (.94)	30 (1.18)	40 (1.57)	45 (1.77)	70 (2.76)	70 (2.76)	200 (7.87)	200 (7.87)	550 (21.7)
Reference distance (=midrange)	mm (")	25 (.98)	35 (1.38)	50 (1.97)	70 (2.76)	120 (4.72)	170 (6.69)	450 (17.7)	575 (22.6)	575 (22.6)
End of measuring range	mm (")	26 (1.02)	40 (1.57)	60 (2.36)	95 (3.74)	170 (6.69)	270 (10.6)	700 (27.6)	950 (37.4)	600 (23.6)
Linearity	% FSO	±0.1		±0.08			±0.1	±0.08	±0.1	
Resolution	at 5 kHz: .01 % FSO	.2 µm	1 µm	2 µm	5 µm	10 µm	20 µm	50 µm at 2.5 kHz	75 µm at 2.5 kHz	5 µm at 2.5 kHz
Measuring rate		5 kHz							2.5 kHz	
Light source (Semiconductor laser)	Wave length	670 nm, red								
	Max. power	1 mW								
	Laser class	2 (DIN EN 60825-1 / IEC 825-111.93), II (FDA)								
Permissible ambient light		10,000 lx								
Spot diameter	SMR MR EMR	80 µm 35 µm 80 µm	110 µm 50 µm 110 µm	320 µm 45 µm 320 µm	570 µm 55 µm 570 µm	740 µm 60 µm 700 µm	1300 µm 1300 µm 1300 µm	1500 µm 1500 µm 1500 µm	1500 µm 1500 µm 1500 µm	appr. 400 x 500 µm
Operating temperature		0 to +50 °C (32 to 122 °F)								
Storage temperature		-20 to +70 °C (-4 to 158 °F)								
Long term stability		0.05 % FSO/month								
Temperature stability		0.01 % FSO/K								
Protection class	Sensor Controller	IP 65 IP 50								
Supply voltage	1800 1801	24 VDC (±15 %, max. 500 mA) 100 ... 240 VAC, 50 ... 60 Hz								
Mains fuse (two pole, controller 1801 only)		2 x T1 A, 250 V, slow								
Ouput	standard option	±5 V RS 232 or RS422/RS485								
Sensor cable	standard option	2 m (6 ft) - integrated up to 5/10 m (16/32 ft) - without calibration								
Electromagnetic compatibility (EMC)		EN 50081-1 and EN 61000-6-2								
Vibration [1]		2 g / 20 ... 500 Hz								
Shock [1]		15 g / 6 ms								
Weight	Sensor	0.5 kg								0.8 kg
	Controller 1800 1801	1 kg 1.5 kg								

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

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

1) The data for the sensor are based on
DIN EN 60028-2-6 (vibration) and
DIN EN 60028-2-29 (shock).

3.3 Block Diagramm



3.4 Operating State of the Controller

LED State	Color
OK	green
Mid range	yellow
Poor target; out of range	red
Laser off	-

LED Power	
Power on	

3.5 Electrical Diagramm 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 (e.g. open collector in an optocoupler) or a relay contact.

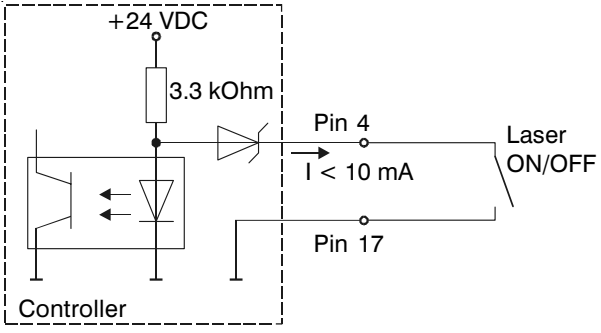


Fig. 3.2: Electrical wiring for laser on/off

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

The 25-pin D-SUB connector (contained in the delivery) contains a jumper between pin 4 and 17.

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

IMPORTANT!

If pin 4 and pin 17 (D-SUB receptacle) are not connected the laser is off.

IMPORTANT!

The pins 4 and 17 are connected in the PC1800/1801-3/RS232.

4. Delivery

4.1 Unpacking

Check for completeness and shipping damage immediately after unpacking. The delivery includes:

1 Controller
1 Sensor ILD 180x
1 25 pin D-SUB Receptacle with screened cable clamps
1 Set of installation angles with screws
1 Instruction manual
1 Rubber feet kit for controller

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: 5 - 95 % (no condensation)

5. Installation

The optoNCDT1800/1801 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 also Chap. 11.2.

Fig. 5.1: System with sensor, sensor cable and controller

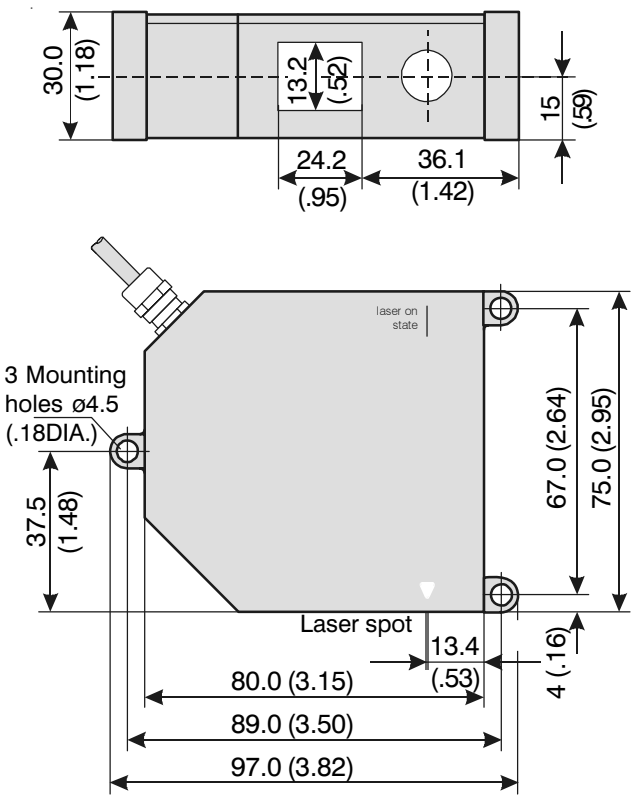
Cable	Continuous high flex cable	Bending radius (min, permanent)
CE1800-x	•	50 mm
PC1800-x	•	60 mm

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

x = Cable length in m

5.1 Mounting of the Sensor

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



Legend:
mm
(inches)

IMPORTANT!
Handle optical sensors with care.

Fig. 5.2: Sensor dimensions
ILD 1800/1801-2/10/20/50/100/200
(not to scale)

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

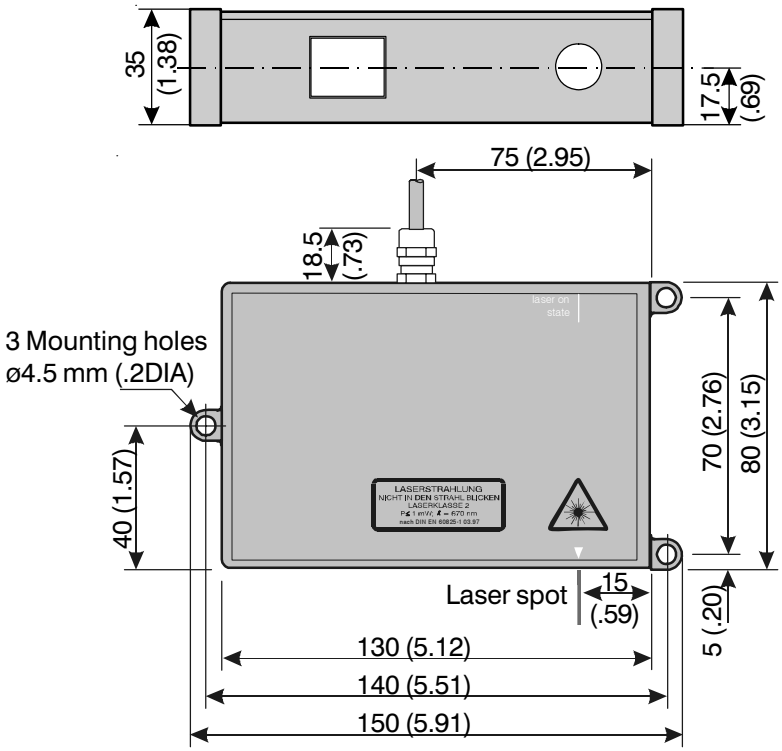
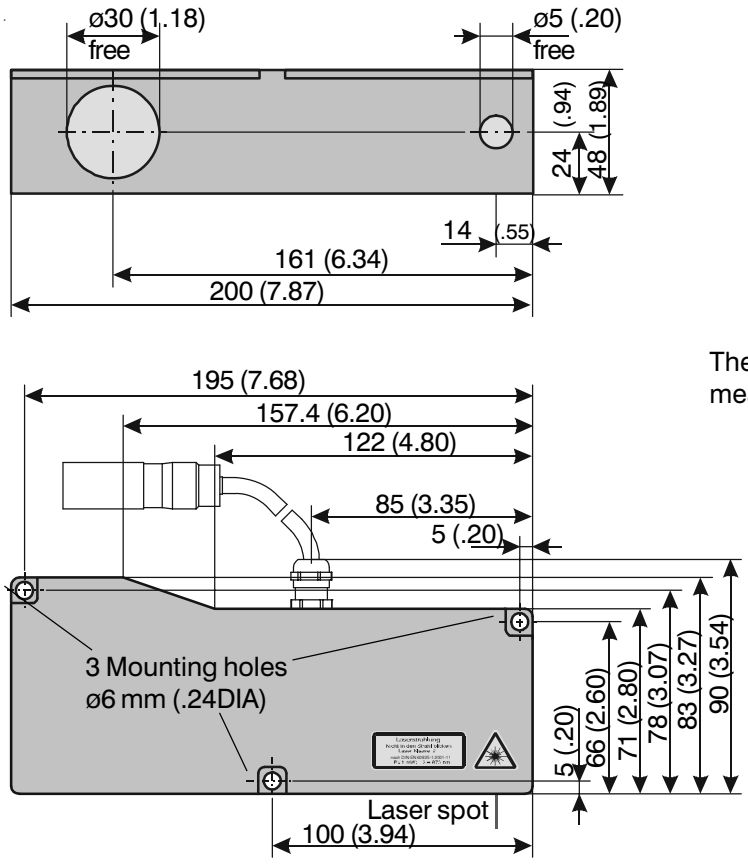


Fig. 5.3: Sensor dimensions ILD 1800/1801-500
(not to scale)



The sensor is mounted by means of 3 screws type M5.

Fig. 5.4: Sensor dimensions ILD 1810/1811-50
(not to scale)

5.2 Mounting of the Controller

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

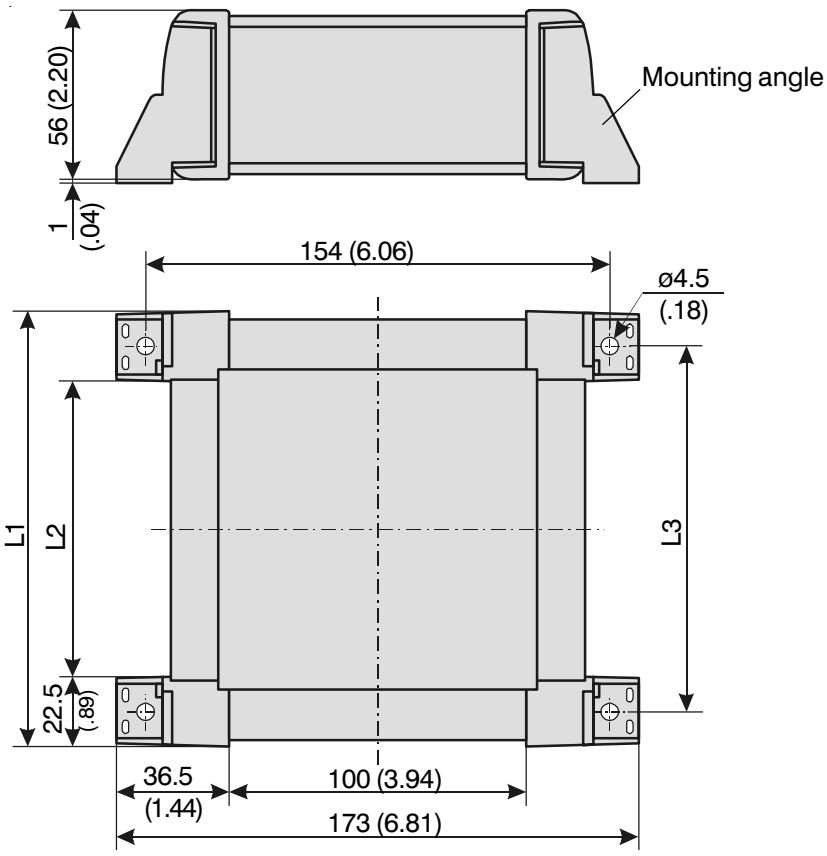


Fig. 5.5: Dimensions of the controller 1800/1801 with mounting angle (not to scale)

Controller	L1	L2	L3
1800	145 (5.71)	100 (3.94)	121.5 (4.78)
1801	295 (11.6)	250 (9.84)	272.5 (10.7)

5.3 Mains Fuse Controller 1801

The rear side of the controller contains the mains input, mains filter, line switch and the mains fuse (see Fig. 5.5).

Changing the mains fuse:
- Remove the AC power line
- Open the fuse box using a screw driver
- Reverse the fuse box about 90 °
- Change the mains fuse
- Close the fuse box
- Connect the AC power line

Use mains fuse ot the type **T 1A** (slow) for 250 V.

DANGER!
Do not open the controller 1801! Danger of injury through mains voltage.

Fig. 5.6: Rear view of the controller 1801

5.4 Cable Demands

Power supply:
Controller 1800:
- 24 VDC (±15 %, max. 500 mA)
- Screened cable, screen connected with the plug body
- Connect the screen of the supply cable with the safety earth conductor

Controller 1801 (integral power supply)**:**
- Mains voltage: 100 ... 240 V AC; 50 - 60 Hz
- Use AC power line with safety earth conductor only!

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

6. Measuring Setup and Commissioning

6.1 Getting Ready for Operation

Install sensor and controller according to the mounting options (chap. 5). Interconnect sensor and controller with the sensor cable. Interconnect the controller output with display or signal processing electronics. Connect the power cable to the controller.

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

Switch on the power supply voltage (24 VDC) or switch on the line switch on the rear side if you use the controller 1801. The LED “power” (see Fig. 6.1) signals the existance of the operating voltage.

Sensor and controller need a warm-up time for reliable measurements of 20 minutes.

IMPORTANT!

When commissioning please observe the notes on the laser class in chap. 2.

Operate sensor and controller only with the same serial number.

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. 6.1).

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 also Chap. 6.4.

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 also Chap. 6.3.

If a well reflecting target, e. g. 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 mid range
red --> Target out of range, unfit or no object

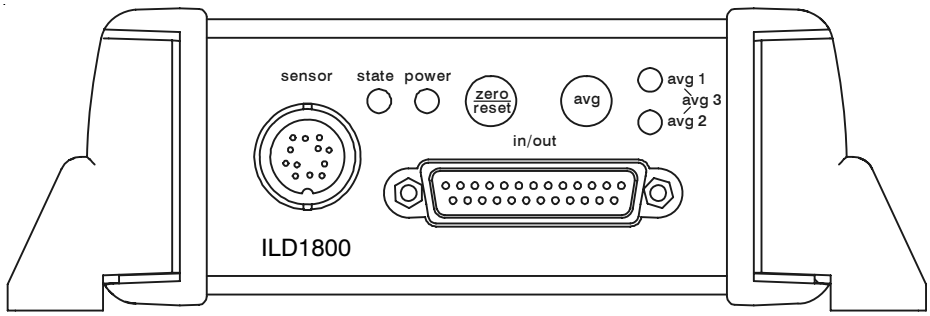


Fig. 6.1: Front view controller

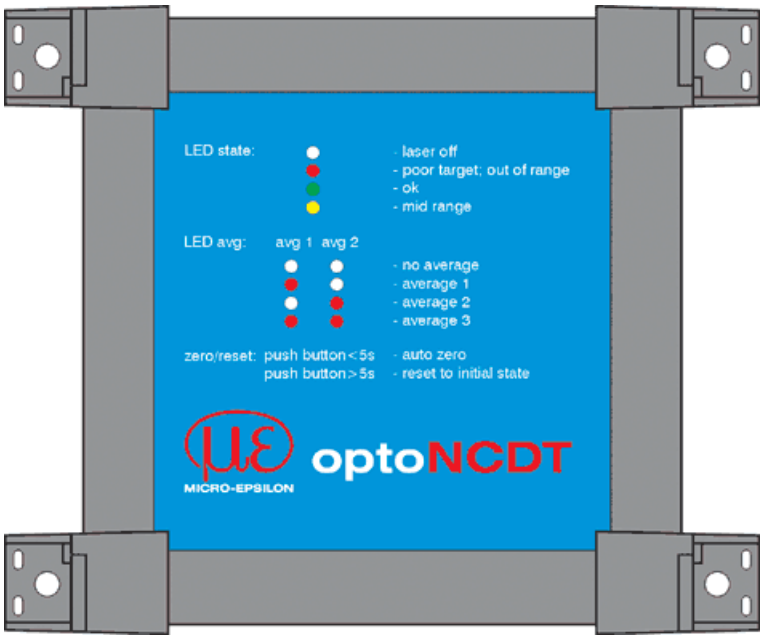


Fig. 6.2: Top view Controller

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
- „Smooth out“ the signal.

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

Controller	Change averaging mode	Change number of averaging [1]	
Booting	**AVG** Key (Chap. 6.2.5)	No	
Operation	Serial interface (Chap. 8)	**AVG** key (Chap. 6.2.1)	Press and hold **Zero**/**Reset** (> 5 s), to set the Number of averaging N = 1 (for the median N = 3).
		Serial interface	See Chap. 8.4.3, 8.4.4

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].

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

Tab. 6.1 Setting the averaging number

The selected number of averaging is indicated by the LEDs “AVG1” and “AVG2” (See Tab. 6.1). Once selected the averaging count remains saved after switching off. After completion of the measuring cycle (every 0.2 ms for a measuring frequency of 5 kHz and every 0.4 ms for a measuring frequency of 2.5 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, as described in Chapter 8.

Pressing and holding (> 5 secs) the **Zero**/**Reset** key will set the number of averaging to N = 1 (for the median N = 3).

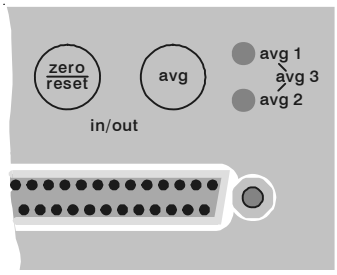
1) When the number of averaging is changed, an error will continue to be sent until the required number of measurement values for the selected averaging count have been reached (logged). For the optoNCDT1800/1801 and a number of averaging of 128, the maximum time required is 26 ms (128 x 0.2 ms = 25.6 ms)

6.3.2 Averaging Type

- Press the **AVG** key on the controller
- Switch on the controller.

The various averaging types are indicated by the LEDs “AVG1” and “AVG2” for a period of 1 sec after switching on the controller.

Averaging type	LED	State
Moving	AVG 1	On
	AVG 2	Off
Recursive	AVG 1	Off
	AVG 2	On
Median	AVG 1	On
	AVG 2	On



Front view controller

Tab. 6.2: Selecting the averaging type during the controller is booted

- Release the **AVG** key if the required averaging type is displayed.

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 type.

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” and “AVG2”:

Chronological order				Averaging type
AVG 1	AVG 2	than	AVG 1 / AVG 2	Moving
AVG 1	AVG 2	than	AVG 1 / AVG 2	Recursiv
AVG 1	AVG 2			Median

Tab. 6.3: LEDs display the averaging type during booting

6.3.2.1 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:

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

MW = Measurement 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] → $\frac{2+2+1+3}{4} = M_{gl}(n)$

… 1, 2, [2, 1, 3, 4] → $\frac{2+1+3+4}{4} = M_{gl}(n+1)$

Measurement values

Output value

The first average value is outputted when N measurement values have been reached. The output frequency stays constant at 5 kHz/2.5 kHz for the measuring range of 500 mm. Standard values for N: 1, 4, 32, 128 (window width).

6.3.2.2 Recursive Average

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

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

MW = 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 5 kHz / 2.5 kHz for the measuring range of 500 mm. Standard values for N: 1, 4, 32, 128 (window width).

6.3.2.3 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, i.e. 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 $\quad Median_n = 3$

… 1 2 4 5 1 3 5 ⟶ Sorted measurements: 1 3 **4** 5 5 $\quad Median_{n+1} = 4$

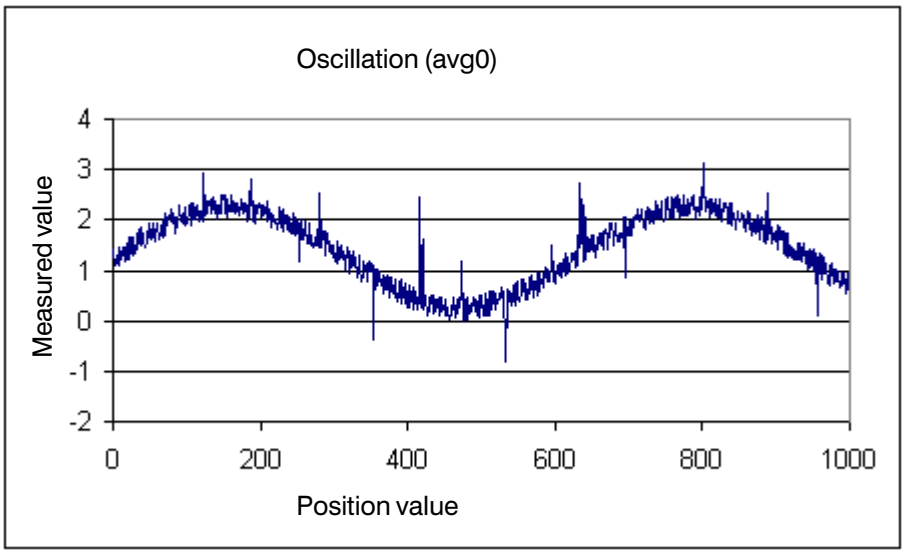
6.3.3 Comparison and Impact of Averaging

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, i.e. rolled 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:

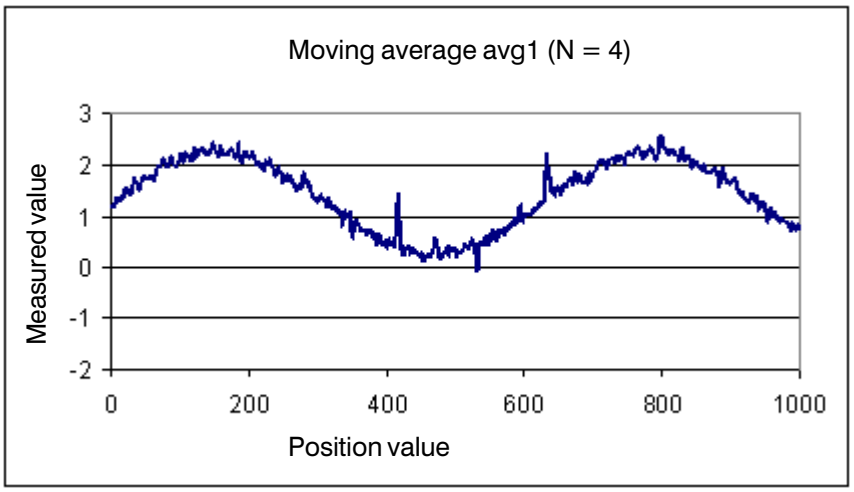
Example 1: Oscillation measurement on a rotating target (unbalaced) with raw surface and scratches

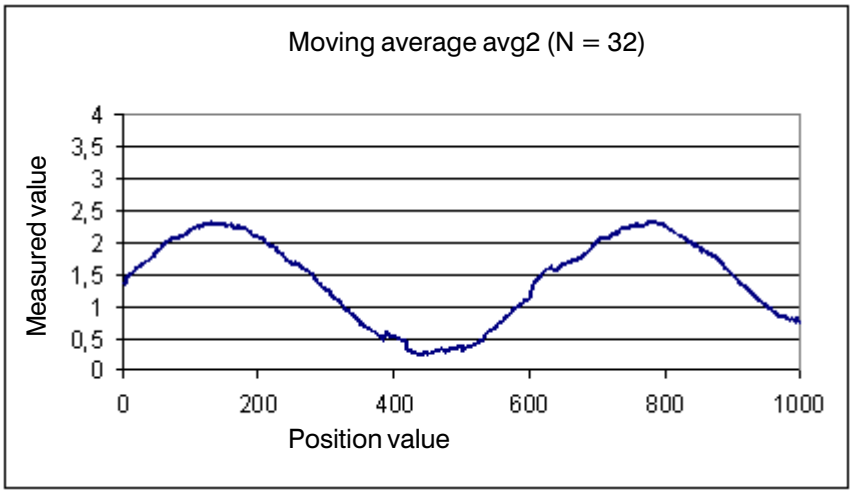


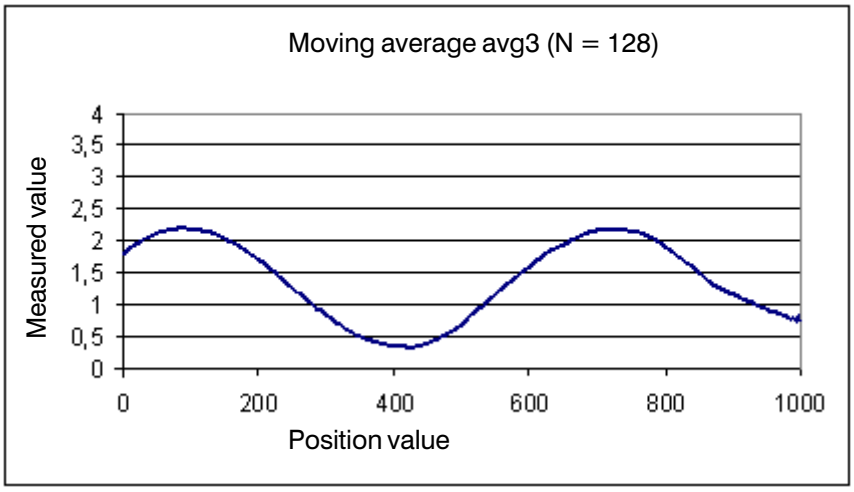
Moving averaging

Impact: Smoothing of surface noise, Lowering of surface defects, slight attenuation of the oscillation amplitude. Individual spikes will be smoothed with greater averaging numbers.

Applications: Oscillation measurement, measurements on metal profiles



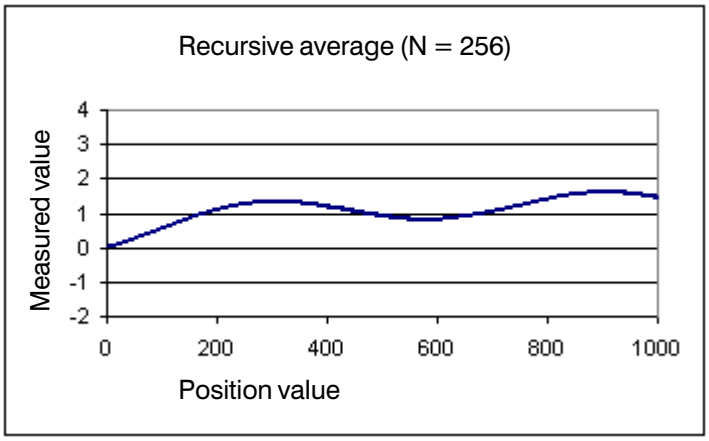




Recursive averaging

Impact: Smoothing the surface noise as far as possible, reduction of the oscillation amplitude, slow tuning on the average (during start or on jumps).

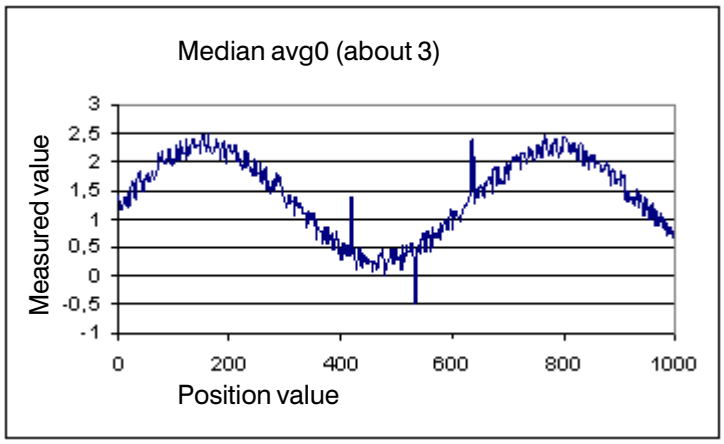
Applications: Measurements on non-profiled belt-type materials

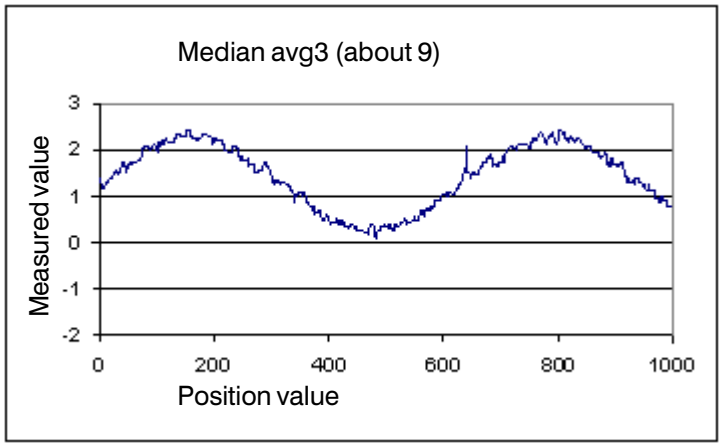


Median averaging

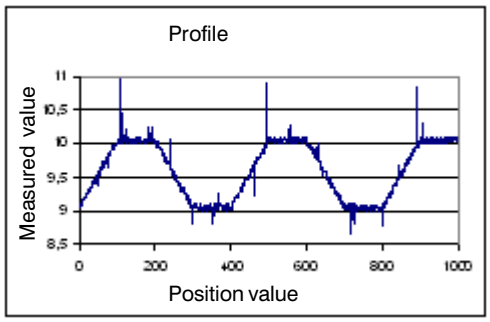
Impact: Removes individual spikes (e.g. scratches on the surface) without any reduction in the vibration amplitude, thereby low noise suppression.

Applications: Fast measurements on metal profiles.





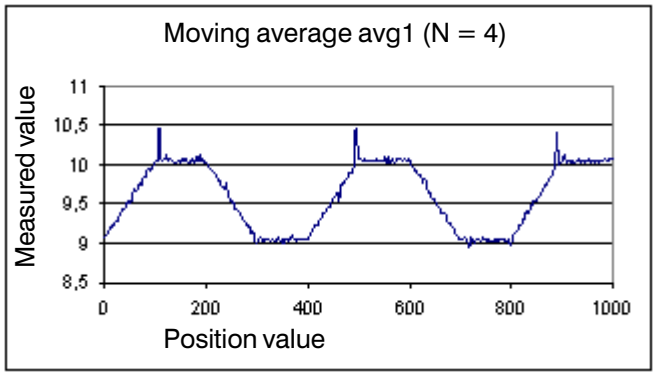
Example 2: Profile measurement
A trapezoid shape (e.g. a thread profile) will be scanned linear.

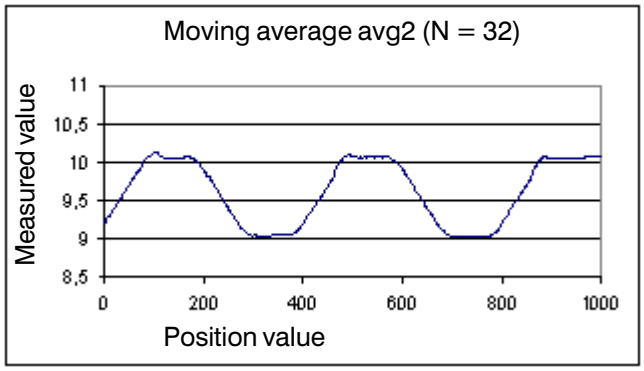


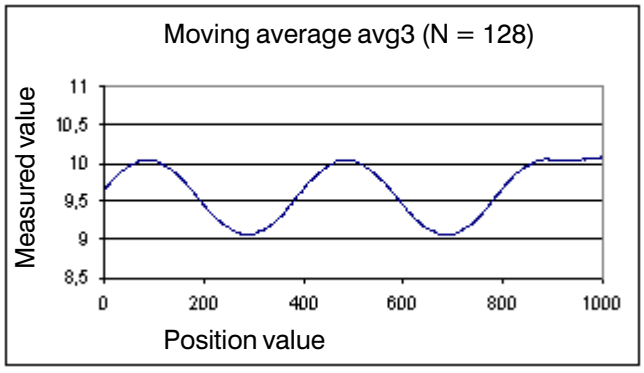
Output signal without averaging:
In the adjacent diagram both the background noise (speckles) and individual spikes (scratches) are identifiable in the measurement curve.

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

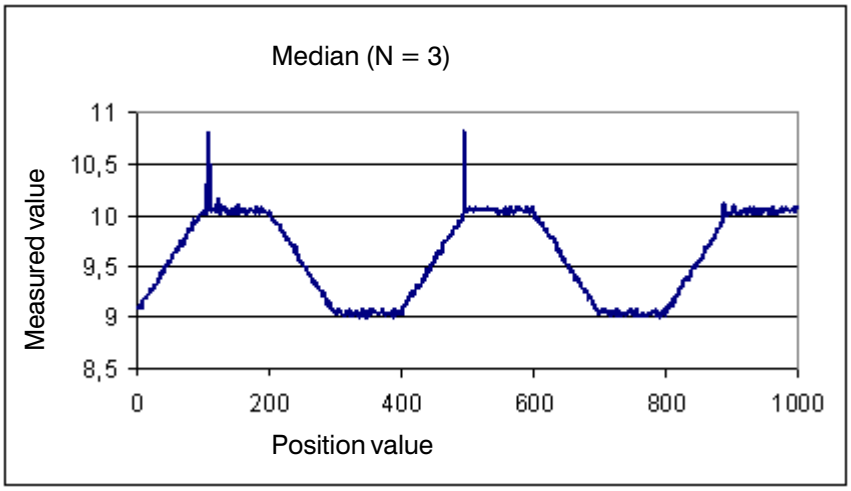
Applications: Measurements on metal profiles, vibration measurements, moderate smoothing of the wave form.
Applications: Measurements on metal surfaces, vibration and unbalance measurements

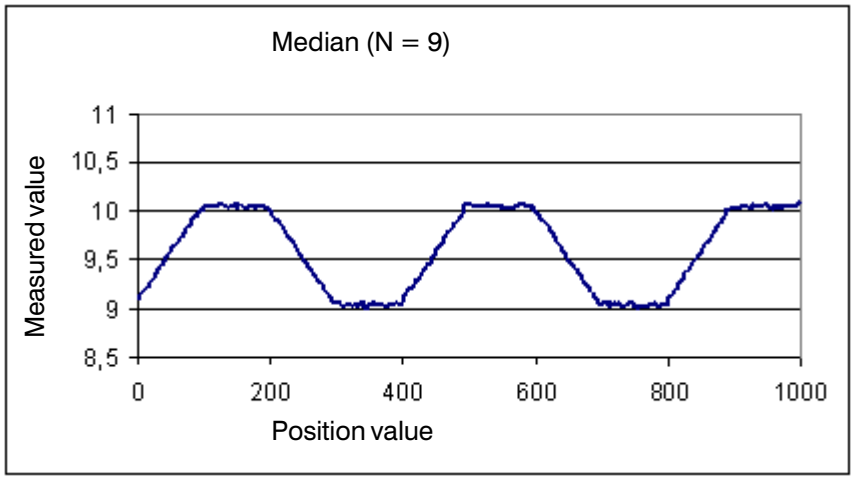






Median averaging
The measuring shape will be smoothed without reducing the vibration amplitude. Individual interferences caused through scratches will be suppressed.

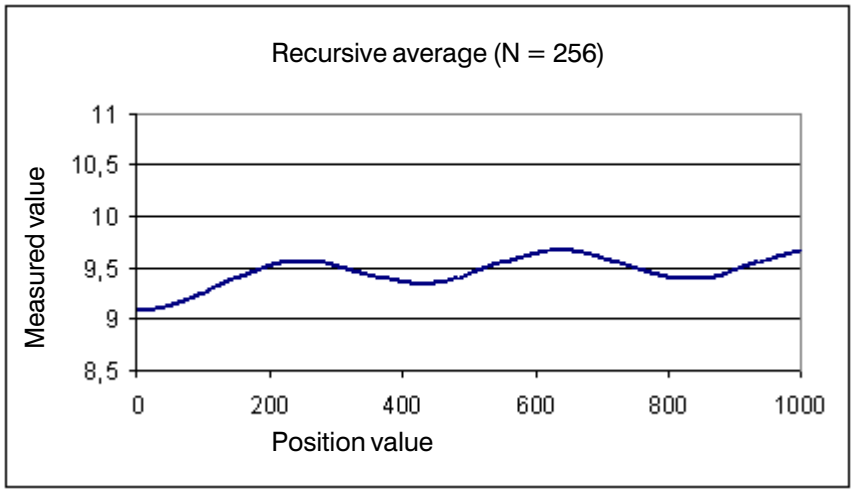




Recursive averaging

Impact: Reduces the surface noise and the vibration amplitude, strong smoothing of the wave form.

Applications: Measurements on non-profiled belt-type materials



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.

IMPORTANT!

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 DSUB Connector

Pin	Assignment	Coment	Color PC1800-3/RS232/422
1 14	+24 VDC Supply ground	Supply voltage is dc-insulated from the system	red blue
2	GND	Ground	-
15	GND	Ground	-
3 16	Analog signal Signal ground	R_i appr. 100 Ohm, R_L >1 MOhm $C_L \leq 47$ nF	green Inner screen
4 17	Laser Off (+) Laser Off (-)	Optocoupler input both pins are connected: laser On pins open: laser Off	violet black
5 18	Zero (+) Zero (-)	Optocoupler input both pins are connected (< 5 sec): Zero both pins are connected (> 5 sec): Reset open the pins after the function is used.	pink grey
6	GND	Ground	-
19	Sync Out	3.3 VDC CMOS output	-
20 7	Sync In (+)	Optocoupler input	- -
21 8	Error 1 (+) Error 1 (-)	Optocoupler output 30 V / 100 mA	white brown
22 9	Error 2 (+) Error 2 (-)	Optocoupler output 30 V / 100 mA	grey/pink blue/red

	Serial interface				Pin in the connector	
Pin	**Signal name**		**RS232**	**RS422**	**DSUB (DB9F)**	**HDSUB (15)**
10	connected internal	RS422 S	do not use	Output +	do not use	3
23	RS232 TXD	RS422 /S	Output	Output -	2	4
11 24		RS422 /R RS422 R		Input - Input +		2 1
12	RS232 RXD		Input		3	
13	connected internal		do not use		do not use	
25	GND		System ground		5	

Pin 4 and pin 17 are connected in the connector of the PC1800-3/RS232.

6.6 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

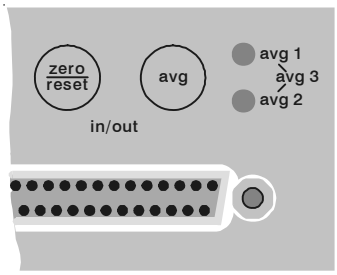
You can change the responses of the analog output to errors as follows:

- 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:

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

Tab. 6.4: Selection of output response



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, i.e. the output option will be selected again.

Functions of the **Zero**/**Reset** key in measuring mode:
- Pressing the **Zero**/**Reset** key momentarily will set the analog output to 0 V (see Chapter 6.3. Zero-Point)
- Pressing and holding the **Zero**/**Reset** key for longer (> 5 secs) will cancel the zero shift (offset) and set the number of averaging to N = 1 (for the median N = 3).

6.7 Error Output Circuit

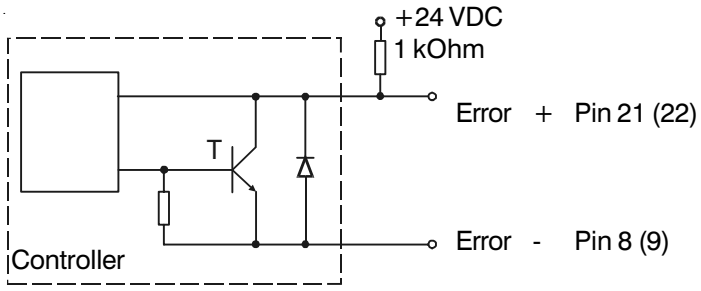


Fig. 6.3: Error output, wiring with external pull-up resistor

Status:

No error	T closed (locked)
Error	T open

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.

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

6.8 Synchronization

If two or more optoNCDT1800/1801 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.

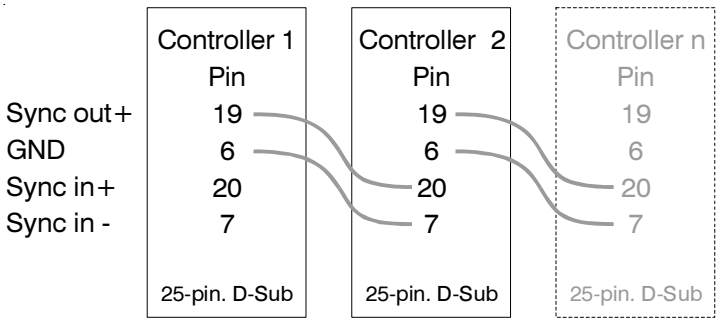


Fig. 6.4: Synchronization of optoNCDT1800/1801

All synchronization inputs are dc decoupled with optocouplers. Use screened cables for synchronization.

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 200 µs (= 1 / measuring rate). 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 therfore 600 µs. The processing of the cycles occurs sequentially in time and parallel in space (see Tab. 6.5, pipelining). This guarantees a true constant real time data stream.

Cycle Time	1. 200 µs	2. 400 µs	3. 600 µs	4. 800 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

Tab. 6.5: Controller Timing

7. Measurement Value Output

7.1 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:

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

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

Value = 4.6 mm

IMPORTANT!
Reference value for all measurements is the reference distance (mid range).

7.2 Digital Value Output

Value range				
	0	... 16367	14 Bit -16	
	0	... 160	SMR reserves	
	161	... 16207	Measuring range	
	16208	... 16367	EMR reserves	

SMR
Start of measuring range

MMR
Midrange

EMR
End of measuring range

Calculation of a value:

$$x\,[mm] = \left(digital_{OUT} * \frac{1.02}{16368} - 0.51\right) * \text{Measuring range [mm]}$$

Example:

8184	(8184	* 6.23167e-5 - 0.51) * 10 mm	= 0 mm	(midrange)
10261	(10261	* 6.23167e-5 - 0.51) * 10 mm	= 1.294 mm	
161	(161	* 6.23167e-5 - 0.51) * 10 mm	= -4.99967 mm	(SMR)

7.3 Digital Error Codes

Value range 16368 ... 16383 (digital $_{OUT}$)

F1 bad objekt	16370
F2 out of range +	16372
F3 out of range -	16374
F4 poor target	16376
F5 Laser off	16378

8. Serial Interface (Option)

The optoNCDT1800/1801 controller can be operated with a PC if the ssystem has a digital interface (RS232 or RS485). This manual describes the communication protocol between a PC and the sensor optoNCDT1800/1801.

8.1 RS232

The RS232 module uses the RS232 standard (EIA/TIA-232-E resp. EIA/TIA-694) for serial communication.

Parameters

Data rate: 5.000 measurement data/s
Bit rate: 115.2 kBaud
Data format: 8 Data bits, no parity, one start/stop bit
Line length: 3 m

A data word consists of two bytes (H-Byte/L-Byte).

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

Conversion of the binary data:

H-Byte	1	D13	D12	D11	D10	D9	D8	D7

L-Byte	0	D6	D5	D4	D3	D2	D1	D0

Result of the conversion:

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

IMPORTANT!

optoRS232 is a driver for the RS232 serial interface. At the software end an interface is provided which is based on DLL. A Header file and a Library file are available for integration in in-house applications.

Drivers and documentation can be found on www.micro-epsilon.com/software_e “Standard applications > optoRS232 SDK“.

8.2 RS422/485

The optoNCDT1800/1801 controller can be operated with a RS422/485 module optional. This interface is not bus compatible.

Parameters

Data rate: 5.000 measurement data/s
Bit rate: 691.2 kBaud
Data format: 8 Data bits, no parity, one stop bit
Line length: 10 m

The data word consists of two consecutive bytes which are transmitted in series without a identity bit. Use the **IF2004** interface card (available from MICRO-EPSILON) for communication with a PC. Interface card and controller are connected with the **PC1800-3**/**10**/**RS485** interface cable (available from MICRO-EPSILON). The interface card combines the both bytes from the data word and storages it as a 16 bit value in the FIFO. Therefrom 14 bits are used for measurements and error values.

The interface card can operate two or up to four controller 1800/1801 or three controller plus a incremental encoder.

Further informations will be published with the IF2004 manual as well as in the documentation to the programs libOPTO and ICONNECT (both available from MICRO-EPSILON).

IMPORTANT!

Communication with the RS422/485 interface is possible with the IF2004 PCI card from Micro-Epsilon only.

8.3 Set-up 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)			

Fig. 8.1: Set-up 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 wreby bit 31 and bit 30 have a logical "0".

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

8.4 Available Commands

The following commands are available for the optoNCDT180x and 2200.

Information command		
0x20490002	INFO	shows sensor data
Zero command		
0x20660002	ZERO	sets offset like the "Zero/Reset"-key
Avg command		
0x20700002 0x20710002 0x20720002 0x20730002 0x20750003	AVG 0 AVG 1 AVG 2 AVG 3 AVG n	sets average 0 = 0 sets average 1 = 0 sets average 2 = 32 sets average 3 = 128 average n = $\log_2$ (MW)
AVG method		
0x207D0003	AVGTYP	Changes averaging method
Reset and boot command		
0x20F00002	RESET	reset and boots again
Start command		
0x20770002	Start	Output of data is on
Stop command		
0xA0760002	Stop	Output of data is stopped

Tab. 8.1: Instruction set of the 1800/1801 controllers

The following commands are optional for the controller 1800/1801

0x20780002	Displacement	Change to displacement measurement
0x20790002	Thickness	Change to thickness measurement
0x207C0002	Refraction	Transfers the refractive index (float) to calculate the thickness
0x207A0002	Multilayer	Transfers the amount of layers as an integer

Tab. 8.2: Optional commands of the 1800/1801 controllers for glass measurements

8.4.1 Information Command

Name: INFO
Description: Sensor data are sent in ASCII format when the command is returned. 7.4 Zero Command
Format:

31 24	23 16	15 8	7 0	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	0x25	0xA0490025

Controller 1800/1801 STD +/-5V 5.0 or
STD +/-5V 2.5 with 500 mm measuring range

Range: 10
Option: 003
SerialN: 01299123
Average: 0001
Modul RS232: detect
Modul voltage: detect

8.4.2 Zero Command

Name: ZERO
Description: Sets the analog output on 0.0 V. Function like the "Zero/Reset"-key

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	0x02	0xA0660002

IMPORTANT!
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.

8.4.3 Average Command 0 ... 3

Name: AVG 0 ... 3
Description: Number of averaging (0, 1, 2 or 3) and the LEDs are set.

Value	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

IMPORTANT!
The averaging method will be saved if you power-down your system.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	z [1]	0x00	0x02	0x207y0002[2]

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	z [1]	0x00	0x02	0xA07y0002 [2]

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

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

8.4.4 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

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

IMPORTANT!
The averaging number (N) will be lost if you power-down your system.

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 ... 32767	1 ... 128	Command without action

8.4.5 Change Average Method

Name: AVGTYP
Description: Selects a averaging type
- Recursive Average
- Moving Average (Standard)
- 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

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

Value for X (0, 1, 2)

Response:

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

8.4.6 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

8.4.7 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

Note: When switching the sensor on 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.

8.4.8 Stop Command

Name STOP
Description Output of data via serial output is stopped

Format:

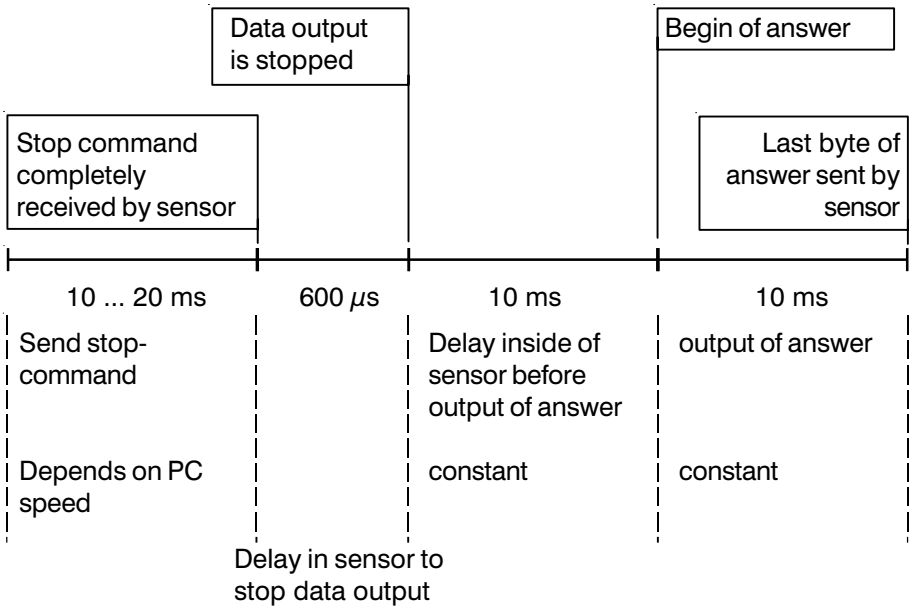
31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x76	0x00	0x02	0x20760002

IMPORTANT!
The stop command will be lost if you power-down your system or send the reset command.

Response:

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

Reaction Time



8.4.9 Displacement Command

Name DISPLACEMENT
Description Changes to displacement measurement.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x78	0x00	0x02	0x20780002

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x78	0x00	0x02	0xA0780002

8.4.10 Thickness Command

Name: THICKNESS
Description: Changes to thickness measurement.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x79	0x00	0x02	0x20790002

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x79	0x00	0x02	0xA0790002

8.4.11 Refraction Command

Name: REFRACTION
Description: Transfers the refractive index (float) to calculate the thickness.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x7C	0x00	0x02	0x207C0002
Refraction parameter in IEEE format as floating point number				0xXXXXXXXX

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x7C	0x00	0x02	0xA07C0002

8.4.12 Multilayer Command

Name: MULTILAYER
Description: Transfers the number of layers as an integer to determine the back reflection and ignore refelections from rear sided mirrored-glass.

Format:

31 24	23 16	15 8	7 0	hex
"+"	"+"	"+"	0x0d	0x2B2B2B0D
"I"	"L"	"D"	"1"	0x494C4431
0x20	0x7A	0x00	0x02	0x207C0002
Layer parameter as an integer, example for two layers:				0x0000000X
0x00	0x00	0x00	0x02	0x00000002

Response:

31 24	23 16	15 8	7 0	hex
"I"	"L"	"D"	"1"	0x494C4431
0xA0	0x7A	0x00	0x02	0xA07A0002

IMPORTANT!

Up to three layers can be measured.

9. Instructions for Operating

9.1 Reflection Factor of the Target Surface

In principle the sensor evaluates the diffuse part of the reflected laser light (fig.9.1). 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 pre-testing is necessary.

9.2 Error Influences

9.2.1 Colour Differences

Because of intensity compensation, colour difference of targets affect the measuring result only slightly. However, such colour 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 colour 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 optimised for the black material, a clearly improved linearity behaviour is achieved again.

9.2.2 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.

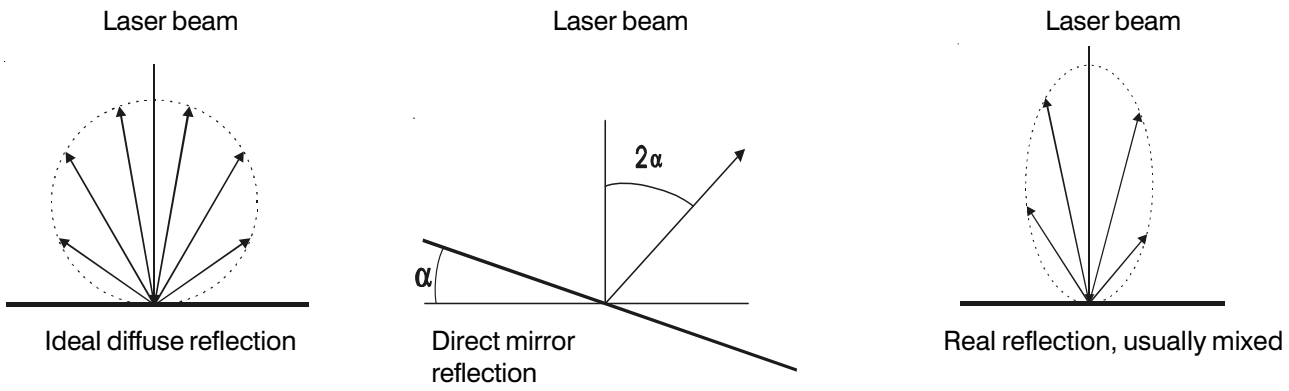


Fig. 9.1: Reflection factor of the target surface

9.2.3 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.

9.2.4 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 (chapter 6.3).

9.2.5 Angle Influence

Tilt angles of the target 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 approx. 0.12 ... 0.2 % of the measuring range (fig. 9.2).

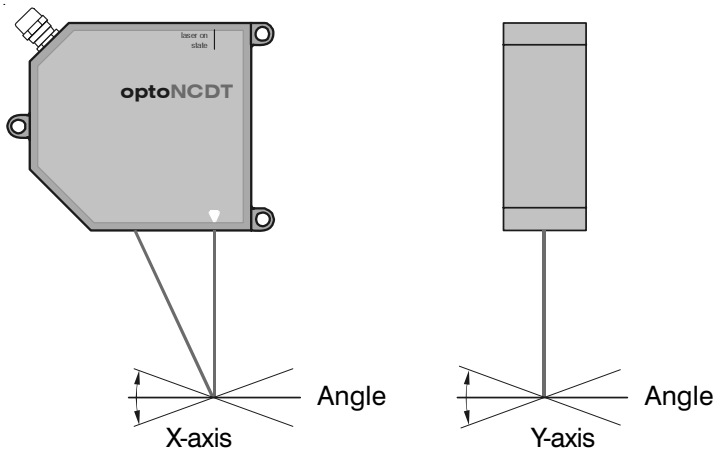


Fig. 9.2: Angle influence

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

Tilt angles between 15 ° and 30 ° lead to an apparent distance change of approx. 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.

9.3 Optimising 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 grinding marks. The same arrangement must be used for colour strips (fig. 9.3).

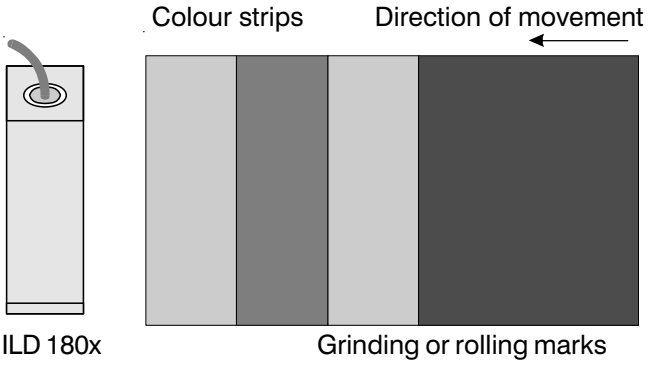


Fig. 9.3: Sensor arrangement in case of ground or striped surfaces

- 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 (fig. 9.4).

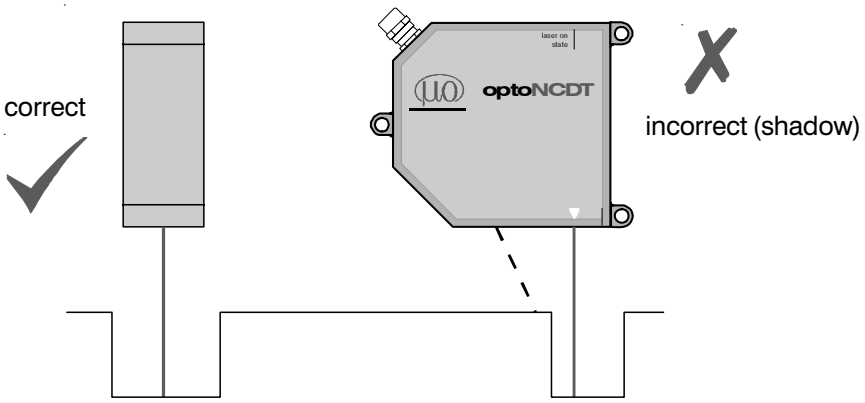


Fig. 9.4: Sensor arrangement for holes and ridges

10. 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.

No other claims, except as warranteed, are accepted. The terms of the purchasing contract apply in full.

MICRO-EPSILON will specifically not be responsible for eventual consequential damages.

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.

11. Decommissioning, Disposal

- Disconnect the power supply and output cable on the controller.
- Disconnect the sensor cable between sensor and controller.

The optoNCDT180x is produced according to the directive 2002/95/EC („RoHS“). The disposal is done according to the legal regulations (see directive 2002/96/EC).

12. Appendix

12.1 Pin Assignment DSUB Connector

Pin	Assignment		Comment		Color PC1800-3/ RS232/422	Color PC1800-3/10/ RS485(07)
1 14	+24 VDC Supply ground		Supply voltage is dc-insulated		red blue	red blue
2	GND		Ground		-	-
15	GND		Ground		-	-
3 16	Analog signal Signal ground		R_i appr. 100 Ohm, R_L >1 MOhm $C_L \leq 47$ nF		green Inner screen	green Inner screen
4 17	Laser Off (+) Laser Off (-)		Optocoupler input both pins are connected: laser On pins open: laser Off		violet black	violet black
5 18	Zero (+) Zero (-)		Optocoupler input both pins are connected (< 5 sec): Zero both pins are connected (> 5 sec): Reset open the pins after the function is used.		pink grey	pink grey
6	GND		Ground		-	blue/red
19	Sync Out		3.3 VDC CMOS output		-	grey/pink
20 7	Sync In (+) Sync In (-)		Optocoupler input Optocoupler input		- -	white brown
21 8	Error 1 (+) Error 1 (-)		Optocoupler output 30 V / 100 mA		white brown	- -
22 9	Error 2 (+) Error 2 (-)		Optocoupler output 30 V / 100 mA		grey/pink blue/red	- -
	Serial interface				**Pin in the connector**	
Pin	**Signal name**		**RS232**	**RS422**	**DSUB (DB9F)**	**HDSUB (15-pin)**
10	connected internal	RS422 S	do not use	Output +	do not use	3
23	RS232 TXD	RS422 /S	Output	Output -	2	4
11 24		RS422 /R RS422 R		Input - Input +		2 1
12	RS232 RXD		Input		3	
13	connected internal		do not use		do not use	
25	GND		System ground		5	

Controller 1801:
Pin 1 (+24 VDC) of the DSUB connector is not allocated.
Do not connect Pin 1 and pin 14!

IMPORTANT!
Pin 4 and pin 17 are connected in the connector of the PC1800-3/RS232.

12.2 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.

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.

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.

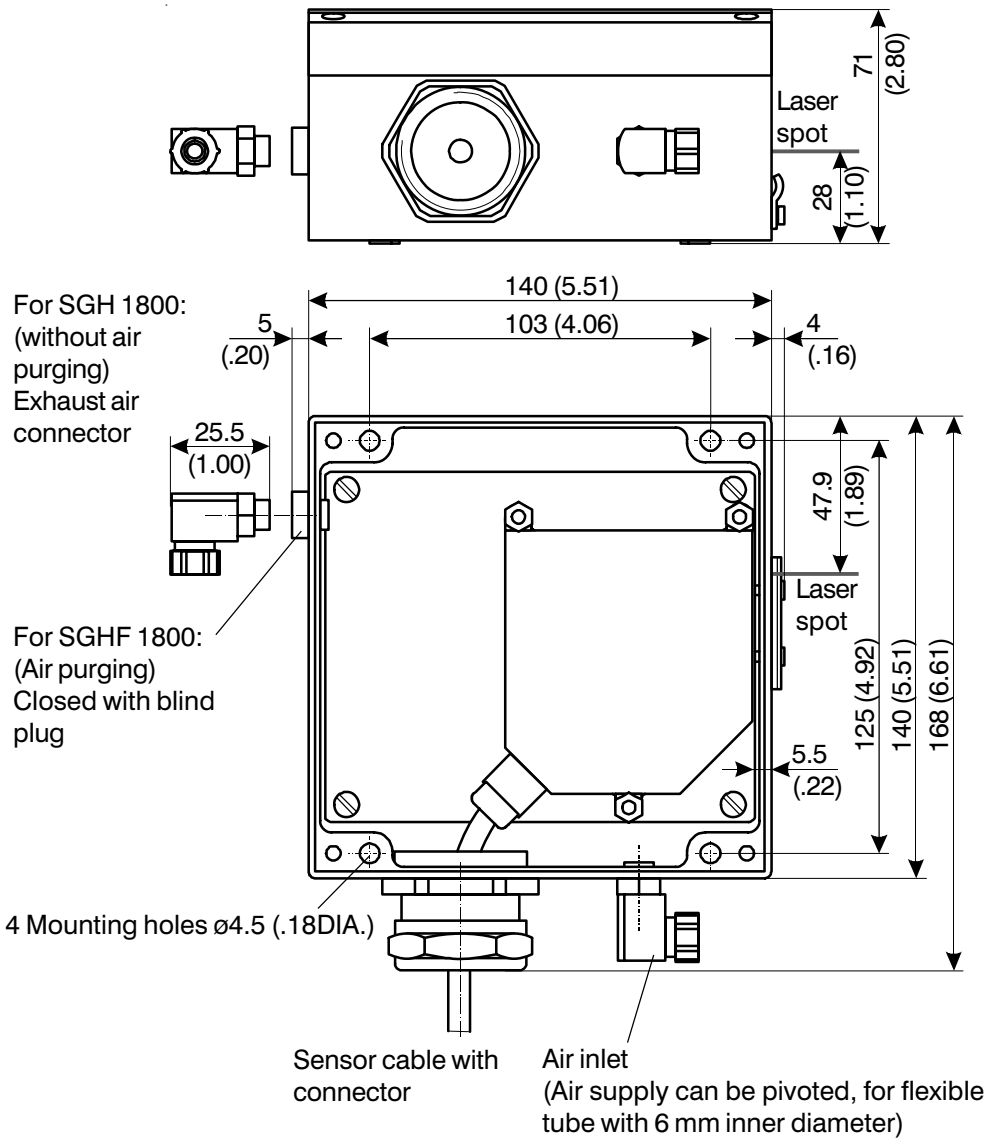
6. It is recommended that the protective window is cleaned from time to time with a soft alcohol-soaked cloth or cotton pad.

Legend:
mm
(inches)

The delivery includes:

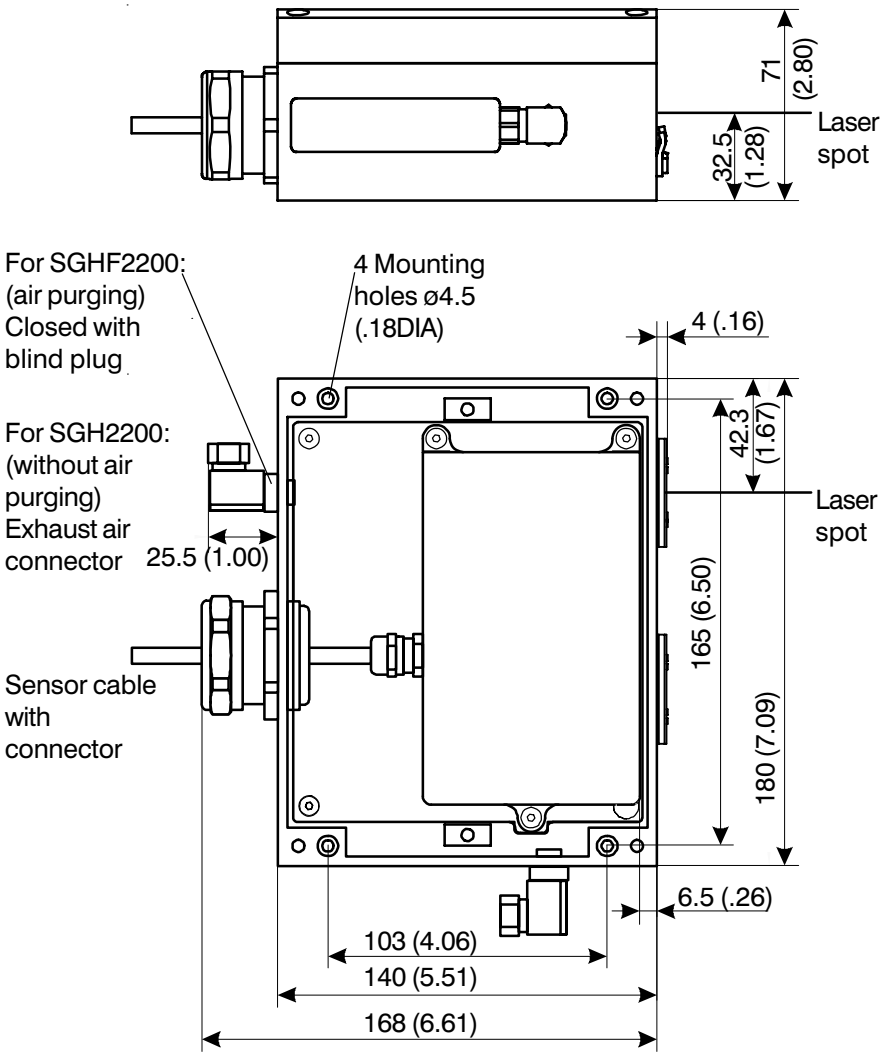
The rotatable plug-nipple glands type LCKN-1/8-PK-6 (FESTO) for the compressed-air tubes with a inner diameter of 6 mm, the air plate (SGHF) and the sensor fastening accessories are included in the delivery of the protective housing.

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



Protective Housing SGH1800/1801
(Not to scale)

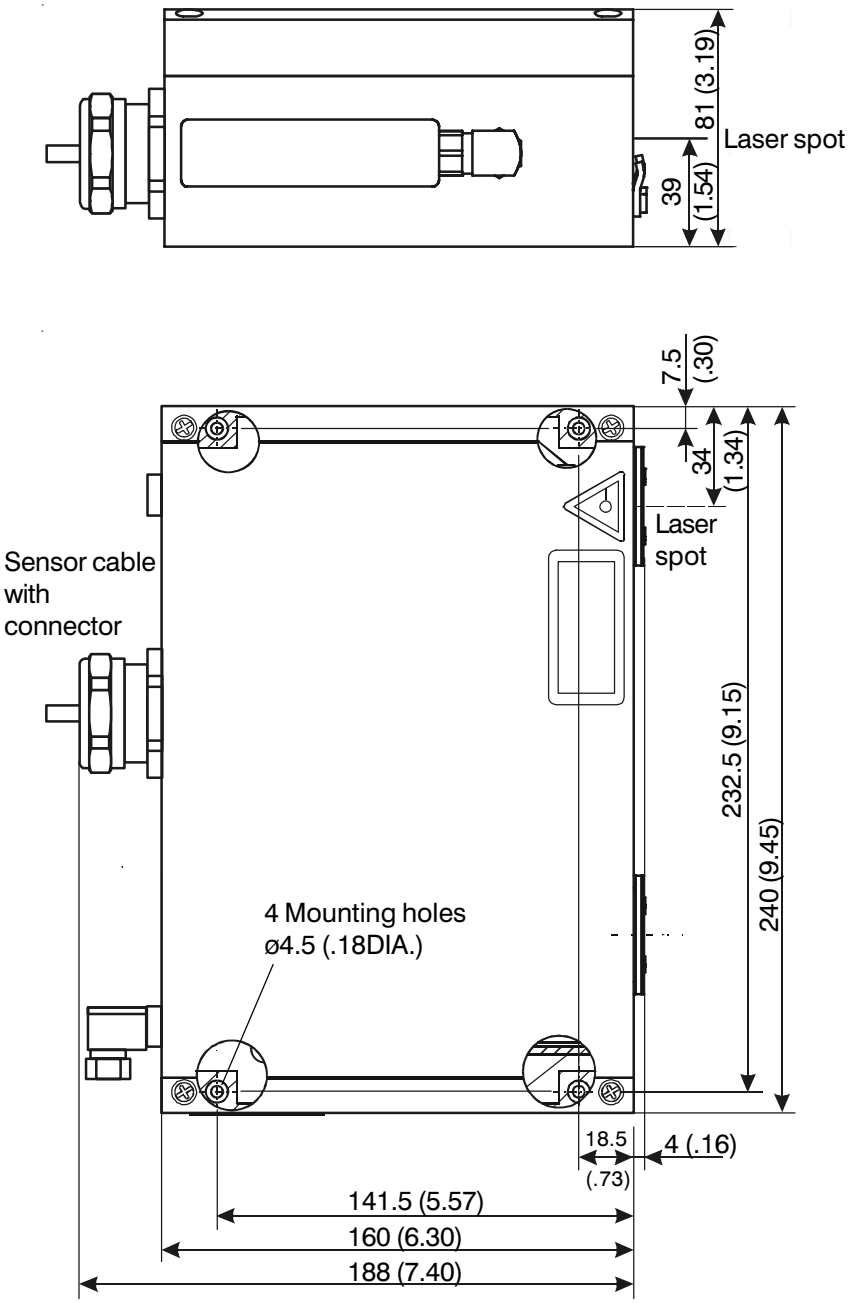
Fig. 12.1: Protective housing for measuring ranges 2/10/20/50/ 100/200 mm



Protective Housing
SGH2200
(Not to scale)

Legend:
mm
(inches)

Fig. 12.2: Protective housing for measuring range 500/750 mm



SGHF1810-50
(Not to scale)

Legend:
mm
(inches)

Fig. 12.3: Protective housing for the sensor optoNCDT1810-50

12.3 Free Space for Optics

Not to scale.

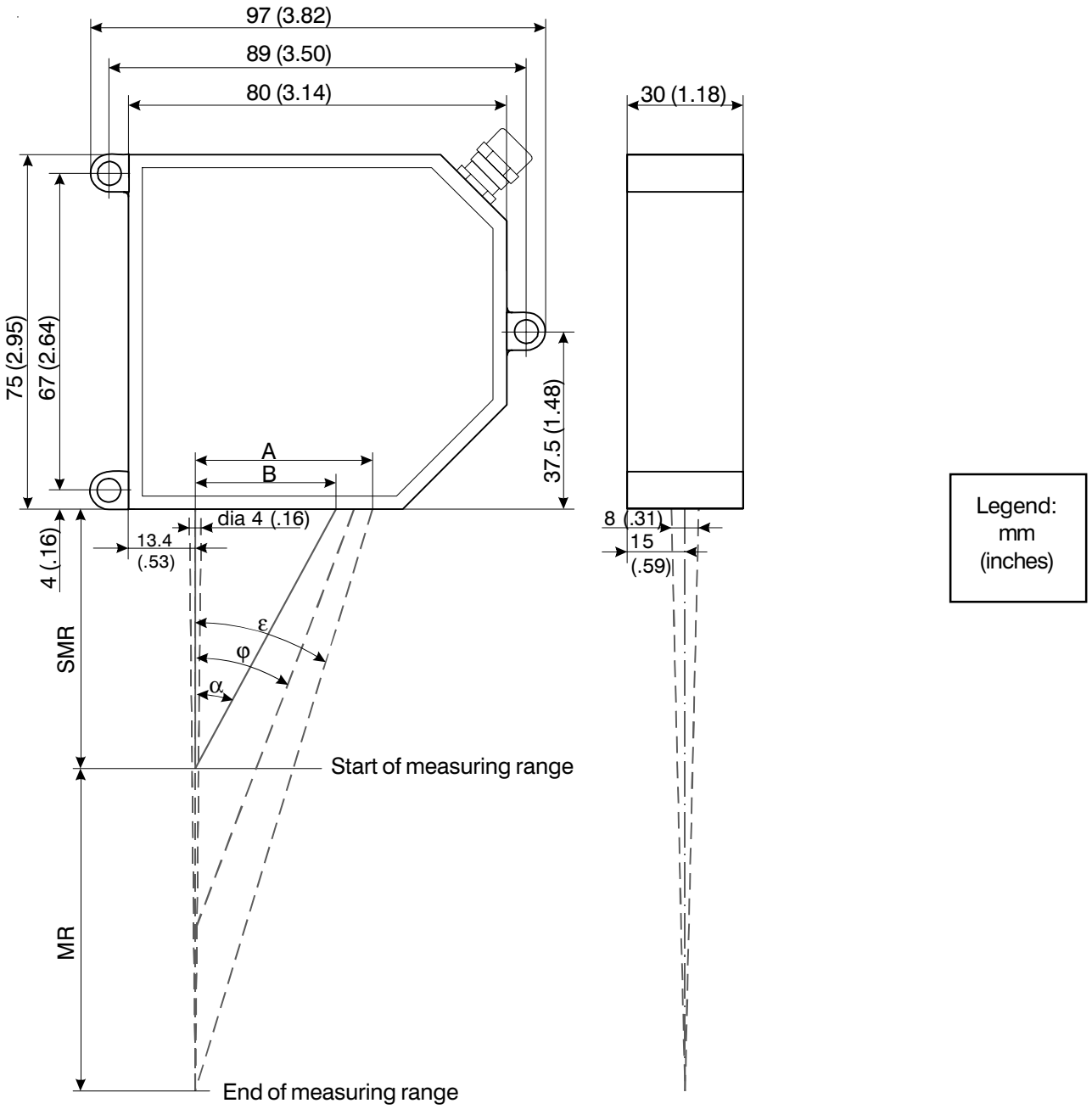


Fig. 11.4: Free space for measuring ranges 2/10/20/50/100/200 mm

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)
200 (7.87)	70 (2.76)	19.0 °	9.78 °	6.97 °	33.1 (1.30)	24.1 (.95)

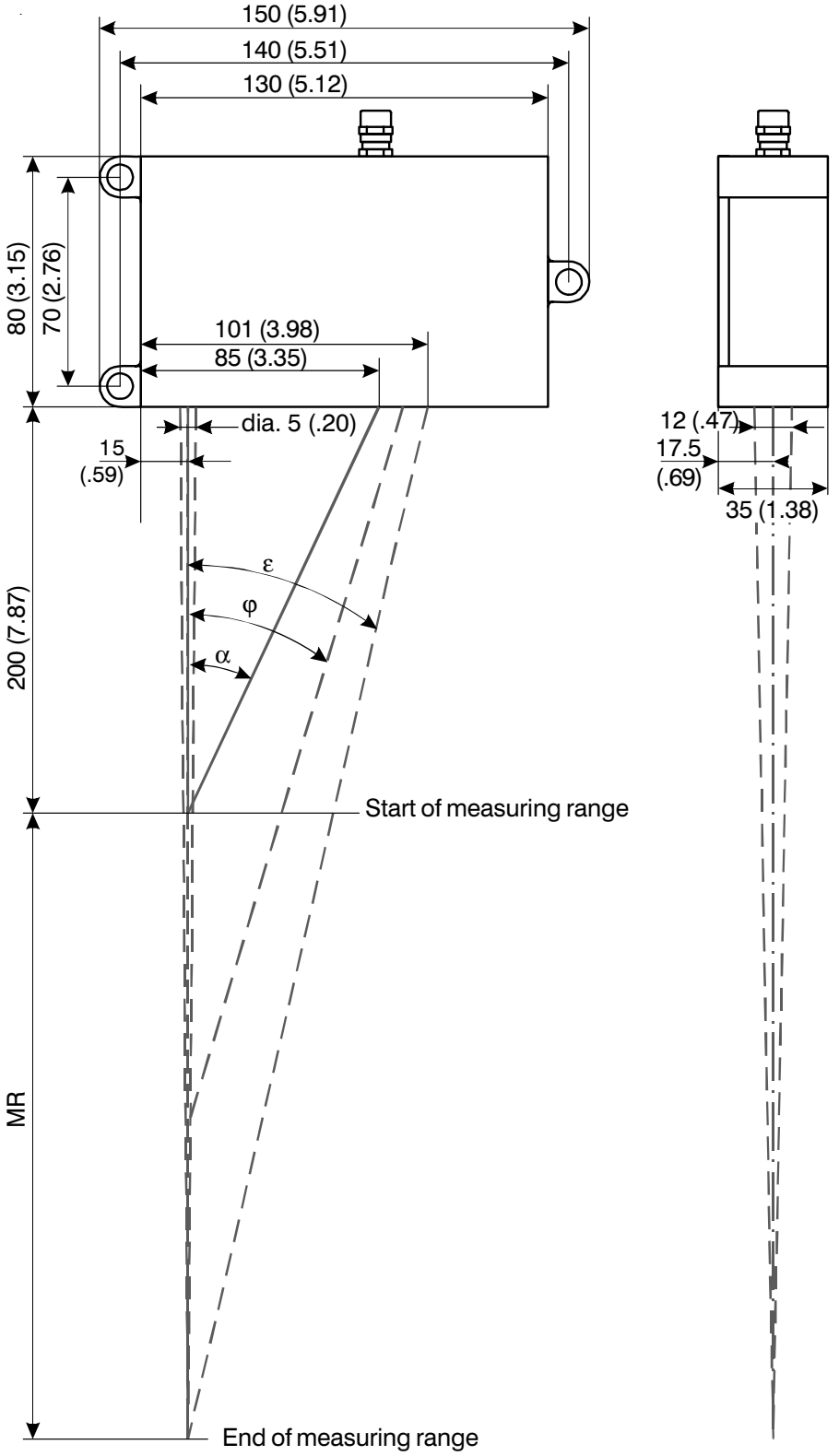


Fig. 12.5: Free space for measuring ranges 500/750 mm

MR	α	φ	ε
500	19.3 °	9.8 °	7.0 °
750	19.3 °	7.7 °	5.0 °

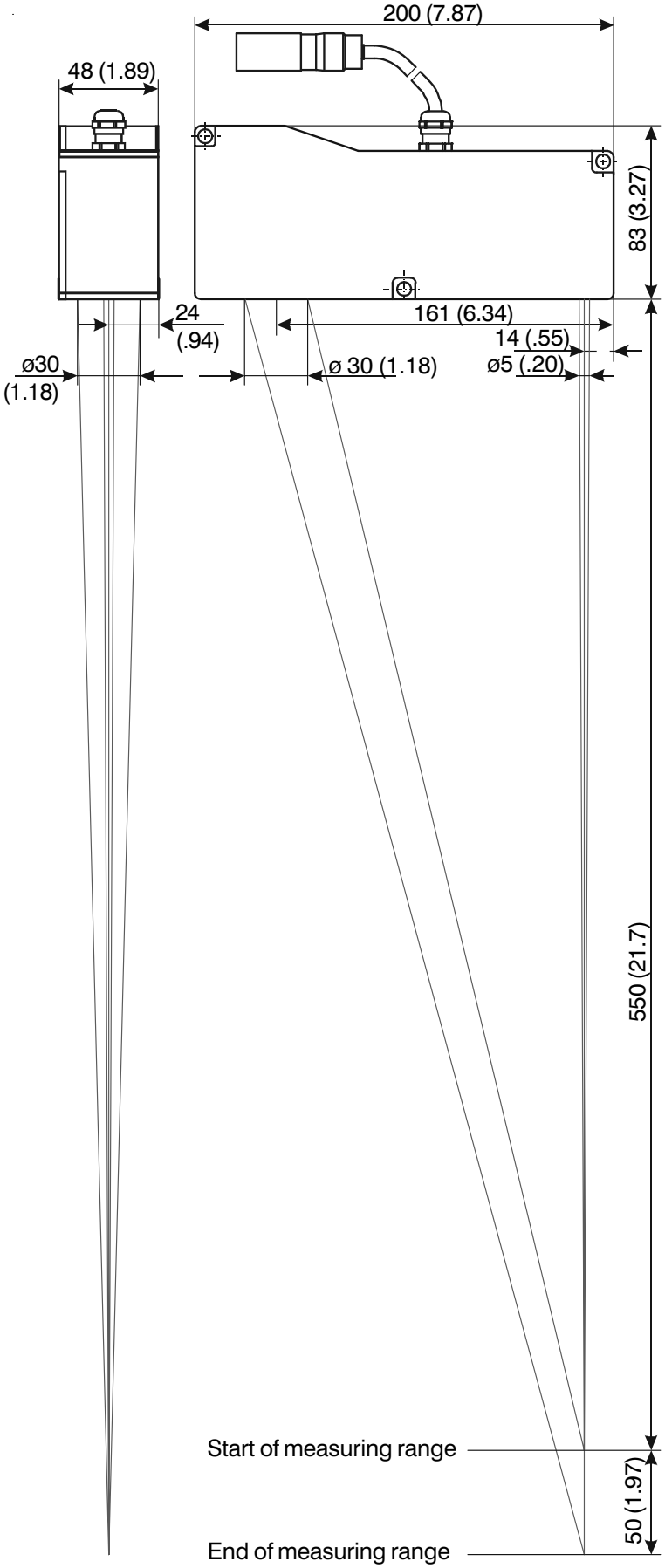


Fig. 12.6: Free space for the sensor optoNCDT1810-50

12.4 Service, Repair

In the event of a defect in the sensor, sensor cable or controller the whole measuring system must be sent back for repair or replacement. In the case of faults the cause of which is not clearly identifiable, the whole measuring system must be sent back to

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