MICRO-EPSILON

Instruction Manual

optoNCDT 1607/1627

LD1607-0.5
LD1607-2
LD1607-4
LD1607-10
LD1607-20
LD1607-50
LD1607-100
LD1607-200
LD1627-2
LD1627-4
LD1627-10
LD1627-20
LD1627-50
LD1627-100
LD1627-200

Laser optical displacement measuring

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CE

Certified in compliance with DIN EN ISO 9001: 2008

Contents

1. Safety

1.1 Symbols Used

The handling of the sensor assumes knowledge of the instruction manual. The following symbols are used in this instruction manual:

WARNING! - potentially dangerous situation

IMPORTANT! - useful tips and information

1.2 Warnings

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

- Caution - use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure
- Avoid banging and knocking the sensor and the controller
  > Damage to or destruction of the sensor and/or controller
- The power supply may not exceed the specified limits
  > Damage to or destruction of the sensor and/or controller
- 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 sensor and/or controller
- Protect the sensor cable against damage
  > Damage to or destruction of the sensor
  > Failure of the measuring device

1.3 Notes on CE Identification

The following applies to the optoNCDT1607/1627: EMC regulation 2004/108/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 system is designed for use in industry and to satisfy the requirements of the standards

- EN 61000-6-4: 2001
- EN 61000-6-2 :2001

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

1.4 Proper Use

- It is used
  - for measuring displacement, distance, position and elongation
  - for in-process quality control and dimensional testing
- The sensor may only be operated within the limits specified in the technical data, see Chap. 3.2, 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 64 (Only with sensor cable connected)
  - Controller: IP 40
- 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 - 90 % (no condensation)
- Pressure: atmospheric pressure
- EMC: acc. to - EN 61000-6-4: 2001
  - EN 61000-6-2: 2001

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

2. Laser Class

When operating the sensors, the relevant regulations according to EN 60825-1 (IEC 60825, Part 1 of 11/2001) and the applicable accident prevention regulations must be followed.

2.1 Class 2 Lasers

The optoNCDT1607/1627 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 does not correspond to the measuring frequency. The duration of the pulse is regulated in dependency on the object to be measured and can form an almost permanent beam. The maximum optical power is ≤ 1 mW. The sensors fall within Laser Class 2 (II). Class 2 (II) lasers are not notifiable and a laser protection officer is not required either.

IMPORTANT!
Comply with all regulations on lasers.

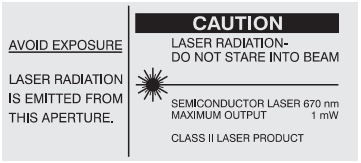
The housing of the optical sensors may only be opened by the manufacturer. For repair and service purposes the sensors must always be sent to the manufacturer.

The laser warning labels for Germany have already been applied, see Fig. 2. Those for other non German-speaking countries an IEC standard label and a FDA label are included in delivery and the versions applicable to the user's country must be applied before the equipment is used for the first time.

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

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

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



FDA label
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.

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.

IMPORTANT!
If both information labels are hidden in the installed state, the user must ensure that additional labels are fitted at the point of installation.

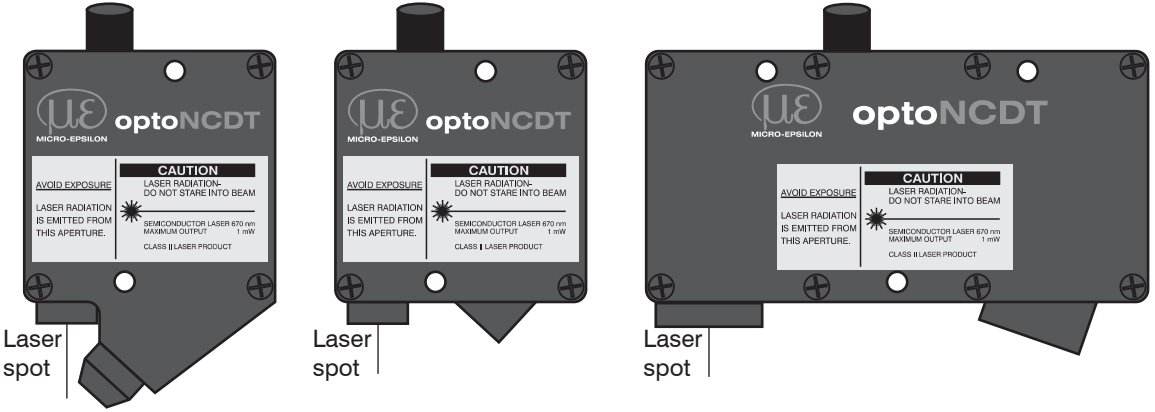


Fig. 1 True reproduction of the sensor with its actual location of the warning label

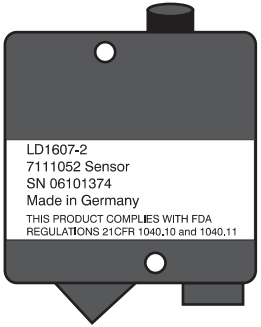


Fig. 2 True reproduction of the sensor with its actual location of the type label

2.2 Class 3R Lasers

The LD1627-100 and LD1627-200 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 does not correspond to the measuring frequency. The maximum optical power is ≤ 2.8 mW. The sensors fall within Laser Class 3R.

IMPORTANT!
Comply with all regulations on lasers.

The available laser radiation is hazardous for the eyes. Looking directely into the laser beam is hazardous for the eyes. Also reflections on shining or mirroring surfaces are hazardous for the eyes.

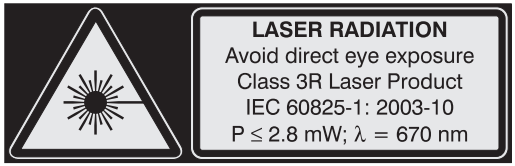
WARNING!
The available laser radiation is hazardous for the eye. Never deliberately look into the laser beam! Consciously close your eyes or turn away immediately if ever the laser beam should hit your eyes.

The 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 laser warning labels for Germany have already been applied, see Fig. 2. Those for other non German-speaking countries an IEC standard label is included in delivery and the version applicable to the user's country must be applied before the equipment is used for the first time.

Class 3R lasers are not notifiable and a laser protection officer is not required either.

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



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

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.

IMPORTANT!
If both information labels are hidden in the installed state, the user must ensure that additional labels are fitted at the point of installation.

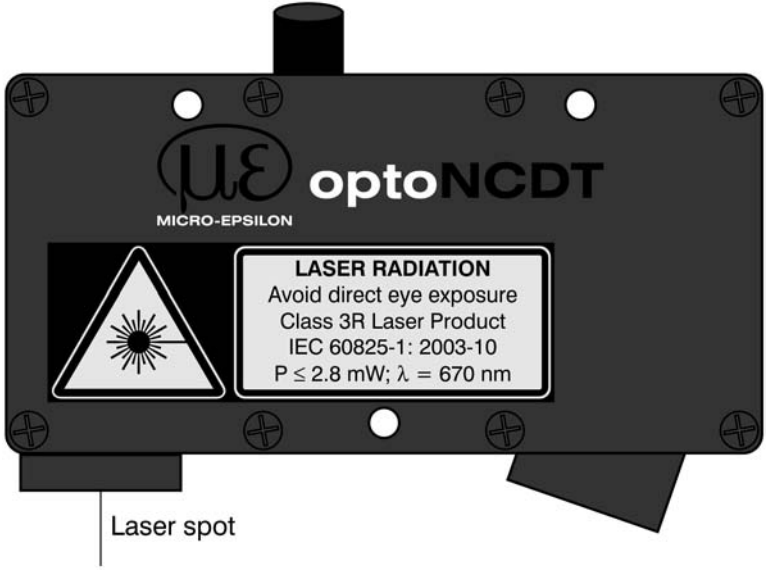


Fig. 3 True reproduction of the sensor with its actual location of the warning label

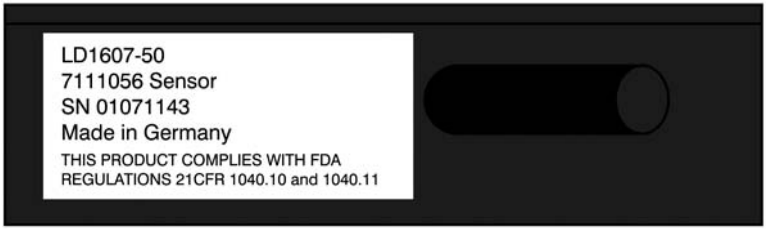


Fig. 4 True reproduction of the sensor with its actual location of the type label

3. Functional Principle, Technical Data

3.1 Short Description

The optoNCDT16x7 consists of an laser-optical sensor and a signal conditioning electronics. The sensor uses the principle of optical triangulation, i.e. a visible, modulated point of light is projected onto the target surface.

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

SMR = Start of measuring range

MR = Measuring range

EMR = End of measuring range

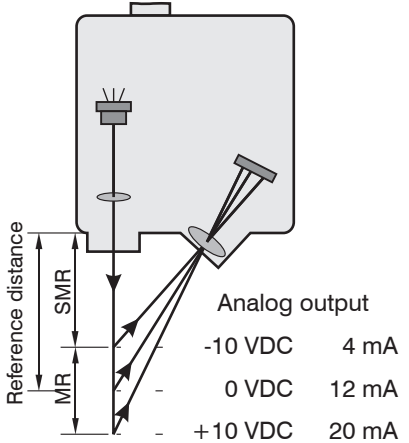


Fig. 5 Definition of terms, output signal

3.2 Technical Data LD1607

Sensor		LD 1607-							
Type		0.5	2	4	10	20	50	100	200
Measuring range	mm (“)	0.5 (.02)	2 (.08)	4 (.16)	10 (.39)	20 (.79)	50 (1.97)	100 (3.94)	200 (7.87)
Start of measuring range	mm	23.75 (.93)	23 (.91)	22 (.87)	40 (1.57)	55 (2.17)	95 (3.74)	170 (6.69)	240 (9.45)
Reference distance [1] (=midrange)	mm	24 (.94)	24 (.94)	24 (.94)	45 (1.77)	65 (2.56)	120 (4.72)	220 (8.66)	340 (13.4)
End of measuring range	mm	24.25 (.95)	25 (.98)	26 (1.02)	50 (1.97)	75 (2.95)	145 (5.71)	270 (10.6)	440 (17.3)
Linearity	µm	1	4	8	20	40	100	200	400
Resolution (noise) [2]	static, µm	0.1	0.5	1	3	6	20	30	60
Spot diameter	mm	0.1	0.2	0.3	0.6	0.9	1.5	1.5	2
Limit frequency		10 kHz, 7 kHz, 4 kHz, 1 kHz, 250 Hz, 100 Hz, 25 Hz or 15 Hz (-3 dB), selectable with DIP switches							
Light source		Laser, 1 mW, wavelength: 670 nm, red							
Laser class		2 (DIN EN 60825-1 :2001-11, II (FDA)							
Permissible ambient light		20.000 lx							
Life time (MTBF)		100.000 h for laser diode							
Isolation voltage		200 VDC, 0 V against housing							
Max. vibration		2 g up to 1 kHz (IEC 68-2-6)							

All specifications apply for a diffusely reflecting matt white ceramic target.
1) Referenzed on the horizontal housing edge of the sensors respectively on midrange.
2) Frequency response 15 Hz.

Sensor		**LD 1607-**							
Type		0.5	2	4	10	20	50	100	200
Shock		15 g (IEC 68-2-6)							
Operating temperature		0 bis +50 °C (32 to 122 °F)							
Storage temperature		-20 bis +70 °C (-4 to 158 °F)							
Air humidity		bis 90 % (no condensation)							
Temperature stability		0.02 % / °C							
Protection class	Sensor Controller	IP 64 IP 40							
Supply voltage		24 VDC (10 up to 30 VDC) / 200 mA							
Analog output	Displacement Intensity	±10 VDC / 4 ... 20 mA / RS232 0 ... 10 VDC							
Sensor cable		2 m (6 ft)							
Elektromagnetic compatibility (EMC)		EN 61000-6-4: 2001 EN 61000-6-2 :2001							
Sensor weight (with 2 m cable)		250 g	240 g				400 g		
Controller weight		274 g							

3.3 Technical Data LD1627

Sensor		LD 1627-						
Type		2	4	10	20	50	100	200
Measuring range	mm (“)	2 (.08)	4 (.16)	10 (.39)	20 (.79)	50 (1.97)	100 (3.94)	200 (7.87)
Start of measuring range	mm	23 (.91)	22 (.87)	40 (1.57)	55 (2.17)	95 (3.74)	170 (6.69)	240 (9.45)
Reference distance [1] (=midrange)	mm	24 (.94)	24 (.94)	45 (1.77)	65 (2.56)	120 (4.72)	220 (8.66)	340 (13.4)
End of measuring range	mm	25 (.98)	26 1.02)	50 (1.97)	75 (2.95)	145 (5.71)	270 (10.6)	440 (17.3)
Linearity	µm	6	12	30	60	150	300	600
Resolution (noise) [2]	static, µm	1	2	6	12	30	40	120
Spot diameter	mm	0.2	0.3	0.6	0.9	1.5	1.5	2
Frequency response	kHz	37 / 30 / 25 / 20 / 10 / 5 / 2.5 (-3 dB), selectable with DIP switches						
Light source		Laser, P ≤ 1 mW, Wavelenght: 670 nm, red					Laser, P ≤ 2.8 mW, λ = 670 nm, red	
Laser class		2 DIN EN 60825-1: 2001-11					3R IEC 60825-1: 2003-10	
Permissible ambient light		20.000 lx						
Life time (MTBF)		100.000 h for laser diode						

1) All specifications apply for a diffusely reflecting matt white ceramic target.
2) Frequency response 15 Hz.

Sensor		**LD 1627-**						
Type		2	4	10	20	50	100	200
Isolation voltage		200 VDC, 0 V against housing						
Max. vibration		2 g bis 1 kHz (IEC 68-2-6)						
Shock		15 g (IEC 68-2-6)						
Operating temperature		0 bis +50 °C (32 to 122 °F)						
Storage temperature		-20 bis +70 °C (-4 to 158 °F)						
Air humidity		bis 90 % (no condensation)						
Temperature stability		0.02 % / °C						
Protection class	Sensor Controller	IP 64 IP 40						
Supply voltage		24 VDC (10 up to 30 VDC) / 200 mA						
Analog output	Displacement Intensity	±10 VDC / 4 ... 20 mA / RS232 0 ... 10 VDC						
Sensor cable		2 m (6 ft)						
Elektromagnetic compatibility (EMC)		EN 61000-6-4: 2001 EN 61000-6-2 :2001						
Sensor weight (mit 2 m cable)		240 g				400 g		
Controller weight		274 g						

3.4 LED Indicator Elements

Fig. 6 LEDs on the controller

LED		Color	Meaning
POWER	☼	green	Power on
MAX	o	red	MAX value is exceeded
OK	☼	green	LED level indicator OK shows the position of the target within the set limits.
MIN	o	yellow	Value drops below the set MIN.
ERROR	o	red	Too little light is reflected.

Fig. 7 Meanings of the LEDs in measurement mode

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

4. Delivery

4.1 Scope of Delivery

1 Controller
1 Sensor with 2 m connecting cable and cable jack
2 Laser warning labels in accordance with IEC standards
1 25 pin D-SUB receptacle
1 Instruction manual
1 Test report

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 bis +70 °C (-4 to +158 °F)
Humidity:	up to 90 % (no condensation)

5. Installation

The optoNCDT16x7 is an optical sensor for measurements with micrometer accuracy. Make sure it is handled carefully when installing and operating.

5.1 Sensor Mounting

- The laser beam must be directed perpendicularly onto the surface of the target. In case of misalignment it is possible that the measurement results will not always be accurate, see Chap. 7.2.9.
- The LED‘s MIN, OK and MAX help to adjust the sensor. Default settings of MIN, OK and MAX are the sensors range limits. OK lights up if the sensor is within the measuring range.

IMPORTANT!
Handle optical sensors with care.

- If the sensors are to be used in soiled environments or in higher ambient temperatures than normal, MICRO-EPSILON recommends the use of SGx1605 protective housings, see Chap. 9.2.

- Mount the sensor LD 16x7 - 0.5 by means of 2 screws type M4.

mm
(inches)

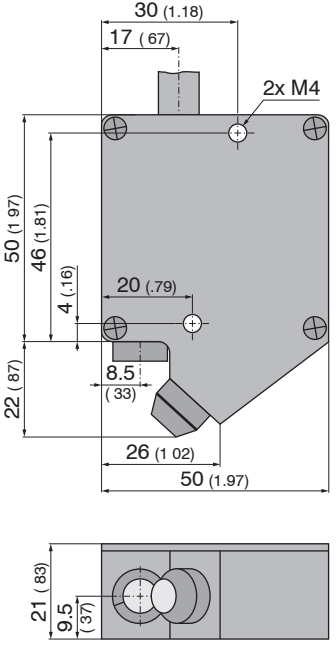


Fig. 8 Sensor dimensions LD 16x7 - 0.5 (not to scale)

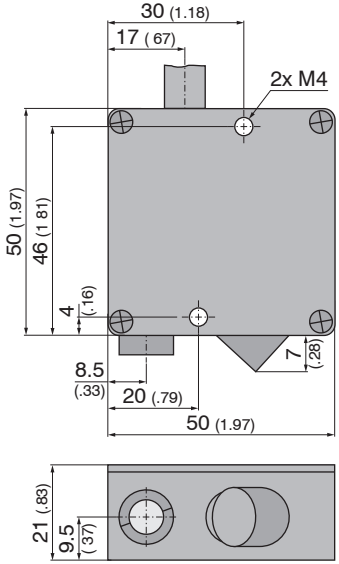


Abb. 9 Sensor dimensions
LD 16x7 - 2 / 4 / 10 / 20 (not to scale)

- Mount the sensor LD 16x7 - 2 / 4 / 10 / 20 by means of 2 screws type M4.

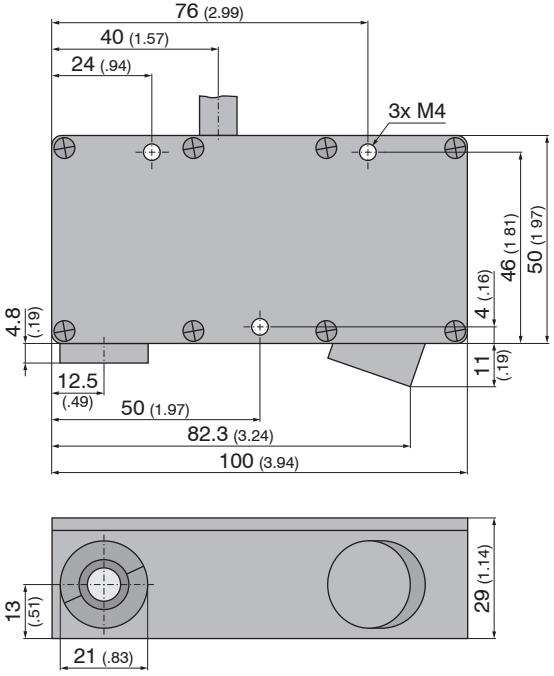
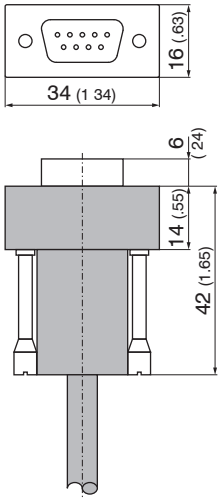


Abb. 10 Sensor dimensions
LD 16x7 - 50 / 100 / 200 (not to scale)

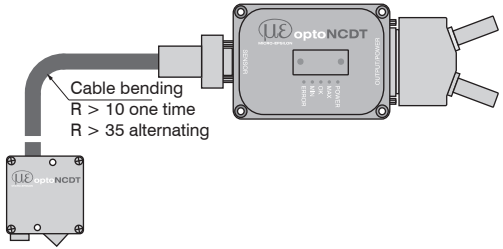
- Mount the sensor LD 16x7 - 50 / 100 / 200 by means of 3 screws type M4.



9-pin D-Sub

5.2 Sensor Cable

- Never bend the sensor cable by more than the bending radius.
- The sensor comes with a permanently mounted sensor cable of 2 m in length. Do not shorten the sensor cable or modify it. Failure of the measuring device and/or loss of specified technical data.
- Never lay signal leads next to or together with power cables or pulse-loaded cables (e.g. for drive units and solenoid valves) in a bundle or in cable ducts. Always use separate ducts.
- Connect the sensor cable to the controller.



5.3 Power Supply and Output

IMPORTANT!
Useful accessories:
- Power supply PS 2010
Input 230/115 VAC,
Output 24 VDC/2.5 A

- PC1605-3
Interconnecting cable, 3 m long
(supply / outputs)

Provide the power supply for the controller. To do this connect
- the connecting cable PC1605 (available as an accessory)
- or a cable made up by the user
1) to the 25-pole SUB-D connector (OUTPUT/POWER, see Fig. 11) on the controller,
2) to a power supply +24 VDC.
Connect the measurement signal displays and recording devices to the controller. To do this connect
- the connecting cable PC1605-3 or PC1605-3/RS232 (both available as accessory)
- or a cable made up by the user
1) to the 25-pole SUB-D connector (OUTPUT/POWER, see Fig. 11) on the controller
2) to measurement signal displays or recording devices.
- Recommended strand cross-section for self-made connection cables: ≥ 0.2 mm² (AWG 24).
- Check the plugged connections for firm seating.

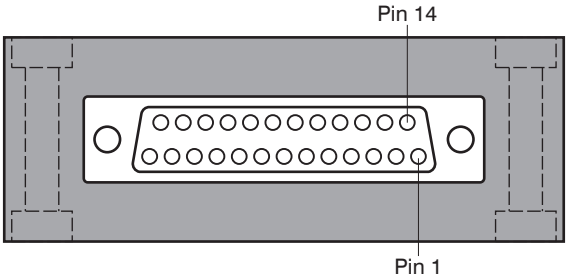


Fig. 11 25-pin power and output connector, view on solder pin side

25-pin SUB-D	Assignment	Color PC1605	
1	Sensor signal ±10 VDC	green	
14	Analog GND	blue screen	
20	Intensity 0 ... 10 VDC	red	
2	Error, +24 VDC/10 mA	grey	
3	Laser OFF	white	
8	Ground, power supply	brown	
21	+24 VDC supply	green	
6	Sensor signal 4 ... 20 mA	yellow	

Inner cable area

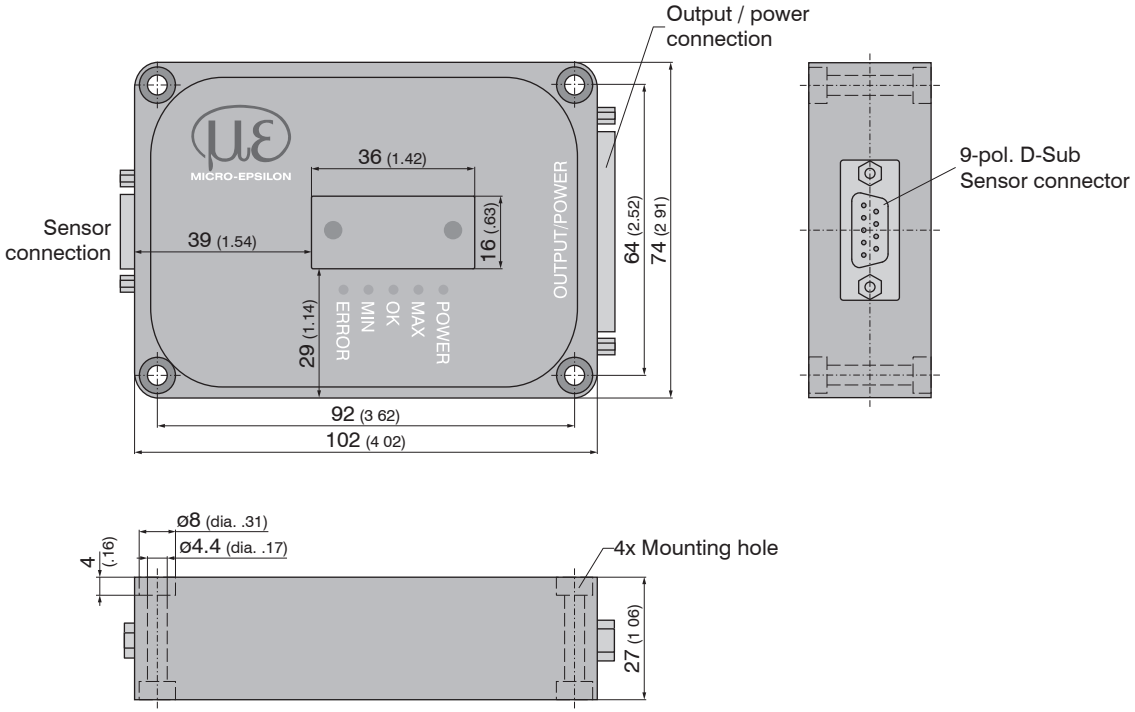
Outer cable area

25-pin SUB-D	Assignment	9-pol SUB-D
4	TxD	2
5	Range OK, +24 VDC/10 mA	
7	RxD	3
8	RS232 GND	5
16	MAX, +24 VDC/10 mA	
18	RTS	8
19	MIN, +24 VDC/10 mA	

Fig. 12 Pin assignment of the 25-pole SUB-D connector for power supply and output

5.4 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.



mm
(inches)

Fig. 13 Dimensions and mounting method for controller.

6. Operation

6.1 Getting Ready for Operation

Install and assemble the optoNCDT16x7 in accordance with the instructions set out, see Chap. 5..

Once the operating voltage has been switched on the controller runs through an initialization sequence. This is indicated by the momentary activation of all the LEDs.

To be able to produce reproducible measurements the sensor typically requires a start-up time of 10 minutes. Once this has elapsed the sensor will be in measurement mode and the “POWER“ and “OK“ LED on the controller will be illuminated.

6.2 Laser Diode Control Input

IMPORTANT!
The laser diode in the sensor will only be activated if the input „Laser on/off“ is NOT connected to GND.

The laser beam can be switched off during NON use if pin 3 of the output connector of the controller is connected to GND (0 V). Alternatively to it you may switch off the laser, if the DIP-switches SW7 and SW8, are in position ON, see Fig. 22.

6.3 Linearization

The receiver element (PSD) in the sensor supplies a nonlinear output voltage for the distance, causing a linearization to take place in the evaluation electronics. This takes into account various surface reflection factors and supplies a proportional voltage for the measuring distance.

IMPORTANT!
Selectable reaction times LD 1607:
0.1/ ... /67 msec, see Chap. 6.6

IMPORTANT!
Longer reaction/integration time reduces the noise.

6.4 Rise Time and Frequency Response

The rise time of the analog output is very fast. This time amounts to approx. 100 µsec for a rise to 90 % of the final value. The use of DIP switches in the controller can increase the rise/integration time, whereby noise is reduced and measuring accuracy is improved.

6.5 Noise

The system generates various levels of noise, depending on the degree of reflection from the object. With good scattered light reflection (matt white), noise is reduced. Noise limits the sensor resolution. Extending the integration time, see Chap. 6.6, considerably reduces the noise.

6.6 Integration Time

The switches (DIP switch S4/S5/S6, see Fig. 15) must be flipped to **ON** in order to select the integration time. All switches flipped to **OFF** corresponds to an integration time of 67 msec for the LD1607.

LD1627	Integration time	µsec	27	33	40	50	67	100	200	400
	Frequency	kHz	37	30	25	20	15	10	5	2.5
	SW4		On	Off	On	Off	On	Off	On	Off
	SW5		On	On	Off	Off	On	On	Off	Off
	SW6		On	On	On	On	Off	Off	Off	Off
LD1607	Integration time	msec	0.1	0.14	0.25	1	4	10	40	67
	Frequency	kHz	10	7	4	1	0.25	0.1	0.025	0.015

Fig. 14 Selecting the integration time for the sensor

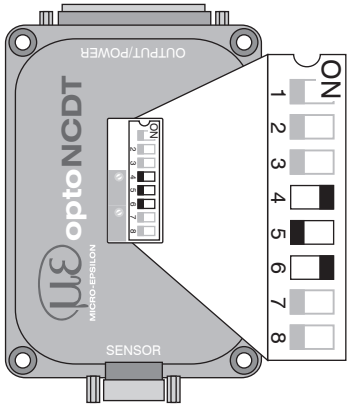


Fig. 15 Localization of the DIP switches on the controller

6.7 Measuring Accuracy, Repeatability

IMPORTANT!
Surface structures created by lathing, milling, etc. can distort readings.

Unlike mechanical measuring systems, the optical displacement sensor does not exhibit any hysteresis or inconsistent repeat accuracies. Accuracy is limited by noise, linearity and surface condition. Observe the accuracy and temperature frequency of the mechanical conditions when using for measurements in the µm range. With mechanically processed parts (lathing, milling, grinding), the formation of mini prisms and mirroring on the grooved surface structure can distort results. The sensor always should be used with its lens axis pointing in the direction of the grind marks.

6.8 Analog Outputs

IMPORTANT!
Output
voltage: ±10 VDC
current: 0 ... 20 mA

Signal increases in strength up to +10 V, the farther away the measurement object is from the sensor.

The displacement signal is shown as the voltage [expressed in V] or current [expressed in mA] proportional to the distance [expressed in mm]. The zero point or reference distance is in the middle of the measuring range; objects farther away yield a positive voltage (up to +10 V), while closer objects yield a negative voltage.

The „Light intensity“ analog output supplies additional information on the intensity of the reflected light. Voltage ranges from 0 to 10 V. Surfaces with good reflection properties yield approx. 7 V. The control mechanism reduces the transmitted light intensity at +4 V. The voltage is proportional to the light intensity of the reflected light. Below 1 V the sensor is at the limit of detection; very distorted readings and increased noise are the result.

IMPORTANT!
Caution:
The signal voltage will again fall back to ±10 V if the measuring range is over or undershot.

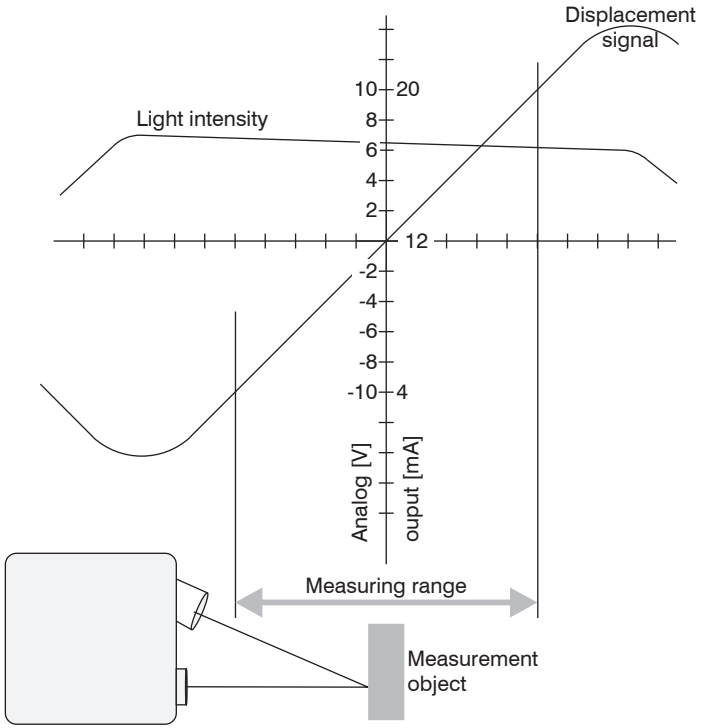


Fig. 16 Output characteristic of displacement signal

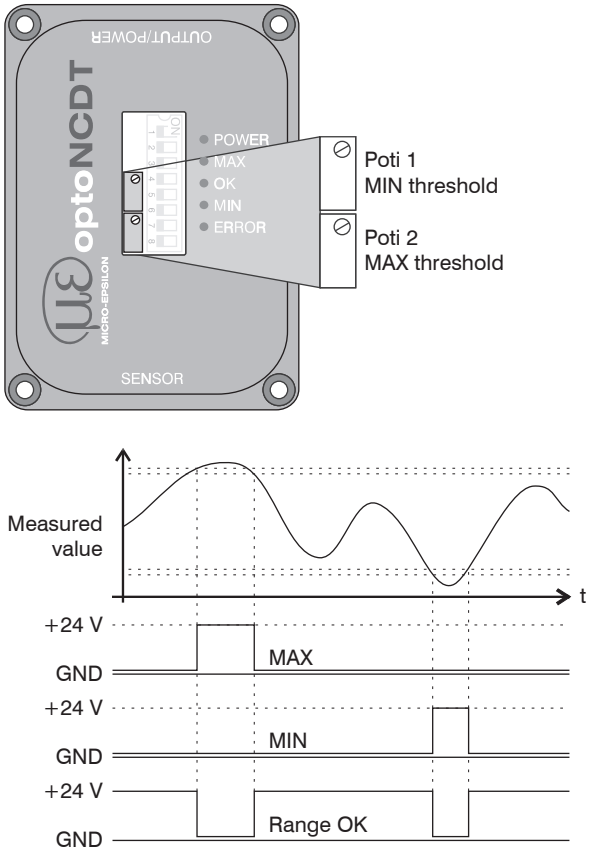


Fig. 17 Signal sequence for the thresholds and range OK

6.9 Thresholds Min and Max, Range OK

The optoNCDT series 16x7 has two switching levels in the controller that can be adjusted with a screwdriver for minimum and maximum threshold values. The thresholds can be adjusted over the entire measuring range.

Each threshold operates with a small hysteresis, approx. 0.4 % from the measuring range, in order to prevent fluttering during slow transitions. When the minimum is undershot, the MIN output activates; the OK output is switched on in the interim.

It should be noted that the switching levels are only unique within the measuring range. If the object is much closer or farther away than the permitted measuring range, ambiguities can occur. In order to simplify initial application, the limit values are set at the factory to the correct limits of the application range:
MAX, Pot 2: +10 V
MIN, Pot 1: -10 V

If the upper limit is exceeded the assigned output (pin 16 of the 25-pole SUB-D connector) will be activated and deactivated again with the follow-on shortfall on the upper hysteresis value. The same applies in principle to a shortfall on the lower limit (pin 19 of the 25-pole SUB-D connector), see Chap. 5.3 for more details. The range OK output is assigned to pin 5 of the 25-pole SUB-D connector.

Electrical charateristics
Output active: +24 VDC / 10 mA max.
Output passive: near 0 V

6.10 Error Output, Light Intensity

The intensity of the diffuse reflected light creates a signal in the sensor proportional to the intensity or brightness of the spot. This signal is an indicator of „how good is this measurement“. If the light intensity is too low or too high the error output (pin 2 of the 25-pole SUB-D connector, see Chap. 5.3 will be activated.

Electrical characteristics
Error output active: +24 VDC / 10 mA max.
Error output passive: near 0 V

6.11 Test Report

Each sensor comes with a test report that graphically depicts the individual measurement error of the sensor in enlarged format. The measurement error is shown relative and absolute for matt white measurement surfaces.

7. Instructions for Operating

7.1 Self-test

Permanent monitoring of the reflected light checks to see if an object is in the measuring range or if the intensity of the reflected light is sufficient.

7.2 Surface-dependent Measurement Errors

7.2.1 Impairment due to Material and Color

Measurement objects are made from all possible materials, including metal, plastic, ceramic, rubber, paper, etc. Only in the case of highly reflective surfaces or liquids must the application (use of the instrument) be individually checked (tested). Measurement cannot be done on transparent objects such as glass or highly reflective surfaces.

ⓘ IMPORTANT!
Diffuse reflection of at least 10 %.

7.2.2 Surface Reflection

The sensor requires a minimal surface reflection of 10 % for fault-free operation. Only diffuse reflection can be used for measurements.

Scratches can simulate changed distances.

7.2.3 Scratch within the Measurement Spot

A scratch on the measurement object whose direction is transverse to the lens axis (transmission lens, receiving lens) can cause very strong light emissions, whereby the intensity of the emissions is highest next to the center of the light spot. This simulates a change in distance.

Substantially higher degrees of measuring accuracy can be achieved with this effect than with pure distance measurement when testing surfaces for scratches.

If it is a moving object that is in question, the mean (integral) reading remains constant while scanning the scratch area, i.e. the positive and negative flanks (caused by the scratch) cancel each other out.

7.2.4 Lateral Scattered Light

When the light spot is projected, there is a certain (minimal) amount of lateral scattered light reflected from the side of the measurement point that reaches the receiver. If there are highly reflective parts close to the measurement point in the area of the scattered light that reflect this light directly back to the receiver, measurement errors can result.

Objects that scatter homogenous light with an equal degree of reflection do not cause this error. If the reflective area is outside of the measurement point, the error rate will be no higher than 2 %.

7.2.5 Penetration of the Beam into the Measurement Object

With semi-transparent plastics or cloudy liquids, the measuring beam penetrates a certain amount into the medium before the diffusely reflected light is sent back. Here, the true measurement plane is expanded to include the penetration depth. In isolated cases, this can only be determined by experimentation.

7.2.6 Lined Objects

If the measurement objects have light/dark lines on them (e.g. wood), the sensor must be mounted with its longitudinal axis parallel to the line direction. Here, laser sensors yield a better result, due to their smaller measurement point.

7.2.7 Light/Dark Change within the Measurement Point

If a displacement measurement is taken at an area that transitions from a diffusely reflecting material to a reflecting material (which translates into a severely changing reflection factor), measurement errors can result in this transition area. The maximum light intensity is here (due to the surface), not in the center of the measurement point. If the transition border line is in the direction of lens axis A (sensor longitudinal axis), error is minimal; error is greatest in axis B, see Fig. 21.

7.2.8 Change in Surface Reflection during Measurement

The optical sensor has an automatic light intensity regulation mechanism in order to adapt to highly reflective and semi-reflective media. If the surface emission changes during the measuring process, the sensor automatically adapts.

7.2.9 Sensor Orientation with Moving or Lined Measurement Objects

If moving or lined objects are to be measured, the sensor should be mounted with its long side transverse to the direction of motion and parallel to the lines. This allows better measurement results in edge areas.

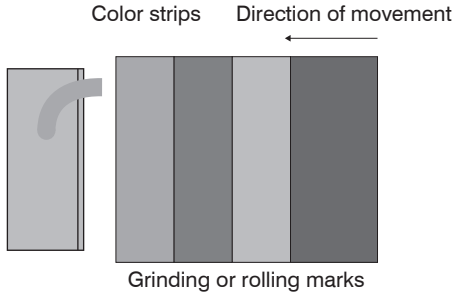


Fig. 18 Sensor arrangement in case of ground or striped surfaces

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. 19.

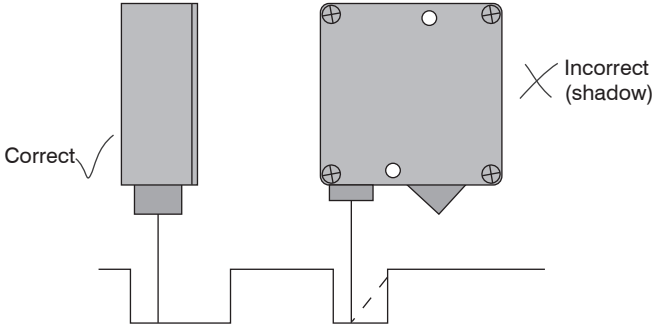


Fig. 19 Sensor arrangement for holes and ridges

7.3 Thickness Measurement

The thickness of a measurement object can be calculated by using two sensors, mounted on opposite sides. The thickness is attained by adding the measuring signals. Output voltage ranges from 0 to +10 V. The scanning range corresponds to the measuring range of a sensor. Within this range, thickness measurement is nearly independent of the position. The scanning range should be a little larger than the change in depth to be measured, plus the range of motion.

Each sensor is equipped with separate evaluation electronics. The light measurement pulses are synchronized, with both systems operating isolated from each other so that thin, transparent materials also can be measured without one of the sensors influencing the other with its transmitted light pulses.

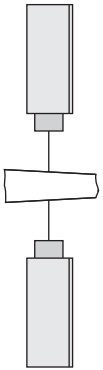


Fig. 20 Thickness measurement

7.4 Angle Dependency of Measurements

IMPORTANT!
Measurement error is lower for matt surfaces with severely diffuse reflection than for more reflective surfaces.

Measurement is slightly angle-dependent if the sensor is not perpendicular to the object surface. The angle dependency for matt surfaces with a high degree of diffuse reflection is minimal. Angle dependency is less when tilted around the A axis of rotation than when tilted around axis B.

The angle of rotation of the object around axis A can reach 30 ° without causing any significant measurement error, whereas only 15 ° is possible around axis B. Measurement error is present when the relationship between output voltage and distance changes. If the angle is constant, the influence can be eliminated by recalibrating.

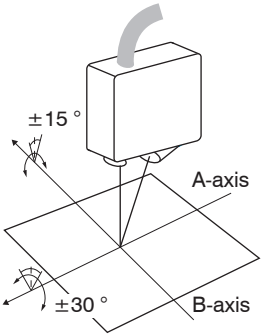


Fig. 21 Max. tilt of the object, definition of axis/orientation

7.5 Assynchronous Measurement

If two sensors are located in a short distance to each other, a mutual interference by the adjoining laser light is possible.
Relief: Both sensors measure alternately.
Procedure:

- Connect both controllers with the cable PC1607-3(01).
- Define the status of
  - controller 1 as master
  - controller 2 as slave.

Status	Master	Slave
SW7	On	Off
SW8	Off	Off

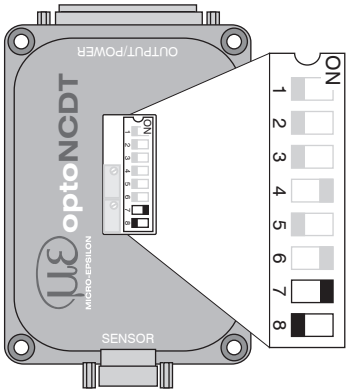


Fig. 22 View with SW7 / SW8

In the mode asynchronous measurement the limit frequency decreases from 10 kHz to 7 kHz (LD1607) and from 37 kHz to 24 kHz at the LD1627.

7.6 Possible Interferences

7.6.1 Optical Interferences

- Do not let welding flashes cross the sensor when arc welding.
- Sunlight cast on the measurement object impairs measurement, resulting in minimal deviation error.
- Sunlight cast directly on the sensor can considerably reduce its accuracy.
- Light from tubular fluorescent lamps or incandescent lamps does not have a negative effect.

7.6.2 Electrical Interferences

- Power cables with high interference voltage running parallel to the sensor feed.
- Heavy interference on the 24 V supply line, e.g. half-wave rectification without charging capacitor.

The sensor housing is isolated to keep the sensor away from interference, however the analog ground is routed to the housing ground via a 0.1 µF/200 V capacitor. The housing of the controller also is isolated. The electronic ground is routed to the housing with a 0.1 µF/200 V capacitor.

8. Serial Interface RS232

8.1 Interface Parameters

The optoNCDT16x7 comes with a RS232 serial interface to enable the sensor to be operated from a standard computer and measurement values and error codes to be transferred.

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

The factory-set baud rate is 115.2 kBaud but it can be programmed to 9.6 kBaud by dip switch on the controller.

8.2 Data Format for Measurement Values and Error Codes

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

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

Conversion of the binary data format:
For conversion purposes the high and low bytes must be identified on the basis of the first bit (flag bit), the flag bits and status bits deleted and the remaining bits compiled into 12 bit data word.
Reception:

H-Byte	1	D11	D10	D9	D8	D7	SB2	SB1

H-Byte	0	D6	D5	D4	D3	D2	D1	D0

SB2	SB1	Status bits
0	0	Range OK
0	1	MIN
1	0	MAX
1	1	ERROR

Result of conversion

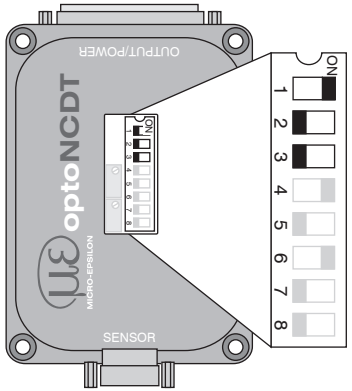
D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Conversion must be done in the application program.

8.3 Transmission Mode and Baud Rate

The controller supports the RTS mode for communication with the AD-converter.

The RTS mode requires to receive the „ready to send“ (RTS) signal from the computer. RTS remains high as long as the computer is ready to receive data. After a read request to the COM port data are transmitted until the COM port is open. At high baud rates the COM buffer could get full. This may happen either at a quick read or when closing the COM port.



Factory setting

Transmission mode	---	RTS
SW1	Off	On

Transmission mode	9.6 kBaud	19.2 kBaud	38.4 kBaud	115.2 kBaud
SW2	On	Off	On	Off
SW3	On	On	Off	Off

8.4 Digital Output

The data word contains the two bytes (H-byte/L-byte) and start and stop bits. So 20 bits are transmitted per measurement. The measurement frequency can be calculated from the baud rate diveded through 20 bits.

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

AD converter output code:

Output voltage	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
+10.235	0	1	1	1	1	1	1	1	1	1	1	1
+0.005	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0
-0.005	1	1	1	1	1	1	1	1	1	1	1	1
-10.24	1	0	0	0	0	0	0	0	0	0	0	0

8.5 Pin Assignment Connection Cable

Hardware handshake connections :
- Connect pin 1 + 4 + 6 and
- Connect pin 7 + 8 of the 9 pin SUB-D connector

The above connections are necessary when no software handshake and no hardware handshake signals are available.

9-pin SUB-D		Function	25-pin SUB-D
1	connect pins	DCD	
4		DTR	
6		DSR	
2		RXD	4
3		TXD	7
5		GND	8
7	connect pins	RTS	18
8		CTS	

9. Protective Housing

The protective housing are designed to be used especially if the sensor operates in a dirty environment or higher ambient temperature. It is available as an accessory. 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.

9.1 LD16x7 with Integrated Protective Window

Recommended for soiled environments, for quick cleaning of the smooth plastic pane. The sensor has a smooth underside (without protruding conduits for transmitter and receiver optics).

Available for LD 16x7 - 2 / 4 / 10 / 20

- Mount the sensor LD 16x7 - 2 / 4 / 10 / 20 by means of 2 screws type M4.

Legend:
mm
(inches)

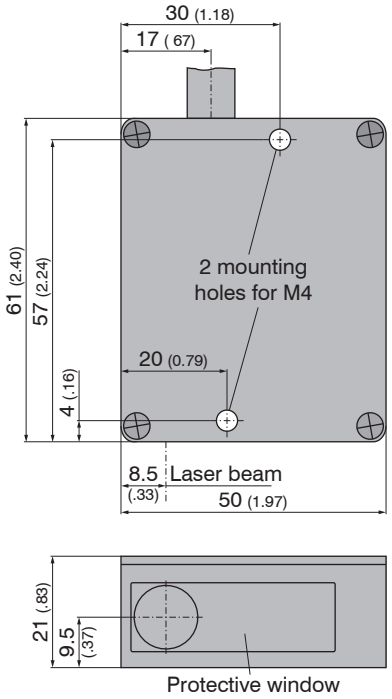
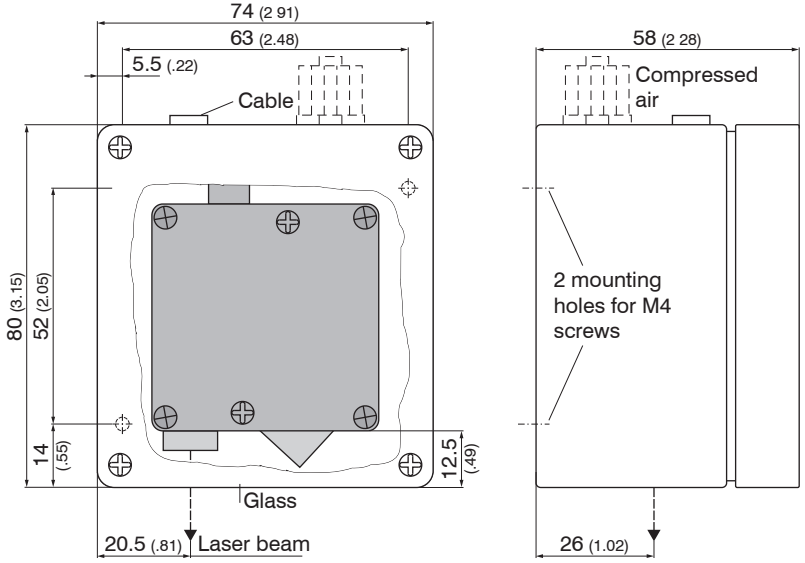


Fig. 23 LD16x7 with integrated protective window

9.2 Protective Housing for Sensors

SGL 1605 - with compressed air connection
SGF 1605 - with window



Legend:
mm
(inches)

Fig. 24 Protective housing for LD16x7 - 2/4/10/20

SGL 1605 - with compressed air connection
SGF 1605 - with window

Legend:
mm
(inches)

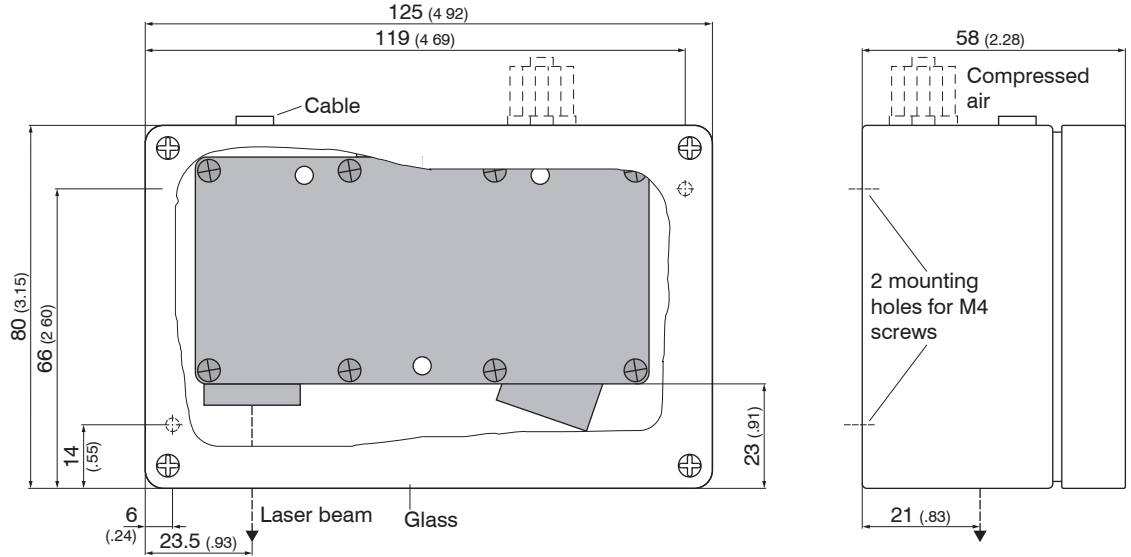


Fig. 25 Protective housing for LD16x7 - 50/100/200

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 MESSTECHNIK.

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 MESSTECHNIK.

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 warranted, are accepted. The terms of the purchasing contract apply in full.

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

MICRO-EPSILON MESSTECHNIK 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 optoNCDT16x7 is produced according to the directive 2011/65/EU („RoHS“). The disposal is done according to the legal regulations (see directive 2002/96/EC).

12. Appendix

Accessories:
PC1605 - 3
Supply- and ouput-cable, 3 m long

PC1607-3/RS232
Supply- and ouput-cable,
3 m long with 9-pin. Sub-D connector for RS232

PC1607-3(01)
Power supply and output cable, 3 m long, for asynchron measurement

CSP 301
Digital signal processing unit with display, programmable for 2 analog signals

PS2020
Power supply 24 V for mounting on DIN-rail, input 230 VAC, output 24 VDC/2.5 A

SGF 1605
Aluminium protection housing
with glass window and air connection with blowing the air along the glass window

Sensor-cable in lengths up to 5 m

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