



Instruction Manual optoNCDT 1302

ILD1302-20 ILD1302-50 ILD1302-100 ILD1302-200 Intelligent laser optical displacement measurement

MICRO-EPSILON MESSTECHNIK GmbH & Co. KG Königbacher Strasse 15

94496 Ortenburg / Germany

Tel. 08542/168-0 Fax 08542/168-90 e-mail info@micro-epsilon.de CE www.micro-epsilon.com

Certified acc. to DIN EN ISO 9001: 2008

# **Contents**

1.	Safety	7
1.1	Symbóls Used	
1.2	Warnings	
1.3	CE Compliance	8
1.4	Proper Use	8
1.5	Proper Environment	8
2.	Laser Class	9
3.	Functional Principle, Technical Data	11
3.1	Functional Principle	11
3.2	Functions	
3.2.1	Fitting the Measurement Range	
3.2.2	Peak Select	
3.2.3	Trigger, Time-based Measurement Value Output	12
3.2.4	Error Behavior	12
3.2.5	Averaging	
3.2.6	Video Signal	13
3.2.7	Programmable Search Threshold	13
3.3	Technical Data	
3.4	Control and Indicator Elements	15
4.	Delivery	16
<b>4.</b> 4.1	Scope of Delivery	
4.1	Scope of Delivery	
4.2	Sidage	10
5.	Installation and Mounting	17
5.1	Sensor Mounting	17
5.2	Pin Assignment	
5.2.1	Switching off the Laser	19
5.2.2	Input for Analog Scaling and Triggering	19
5.2.3	Error Output	20
5.3	Pin Assignment for RS422 Interface	20

6.         Operation         21           6.1         Getting Ready for Operation         21           6.2         Output Scaling         22           6.2.1         Output Scaling via the "Select" Key         24           6.2.2         Output Scaling via the Hardware Input         25           6.3         Average         26           6.3.1         Averaging Number N         26           6.3.2         Moving Average (Default Setting)         26           6.3.3         Median         27           6.4         Measurement Rate and Output Rate         28           6.5         Timing         29           6.6         Triggering         30           7.         Measurement Value Output         31           7.2         Digital Value Output         31           7.2         Digital Piror Codes         33           8.         Serial Interface RS422         34           8.1         Interface Parameter         35           8.2.1         Binary Format         35           8.2.2         ASCII Format         36           8.3.1         Setup of the Commands         36           8.3.2         Overview.         37
6.2       Output Scaling via the "Select" Key       24         6.2.1       Output Scaling via the "Select" Key       24         6.2.2       Output Scaling via the Hardware Input       25         6.3       Average       26         6.3.1       Averaging Number N       26         6.3.2       Moving Average (Default Setting)       26         6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       36         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview <td< td=""></td<>
6.2.1       Output Scaling via the "Select" Key       24         6.2.2       Output Scaling via the Hardware Input       25         6.3       Average       26         6.3.1       Averaging Number N       26         6.3.2       Moving Average (Default Setting)       26         6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.2       Digital Value Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.2.2       Output Scaling via the Hardware Input       25         6.3       Average       26         6.3.1       Averaging Number N       26         6.3.2       Moving Average (Default Setting)       26         6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.3       Average       26         6.3.1       Averaging Number N       26         6.3.2       Moving Average (Default Setting)       26         6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.2       Digital Value Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.3.1       Averaging Number N       26         6.3.2       Moving Average (Default Setting)       26         6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.3.3       Median       27         6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       35         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.4       Measurement Rate and Output Rate       28         6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       35         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
6.5       Timing       29         6.6       Triggering       30         7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
7.       Measurement Value Output       31         7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
7.1       Current Output       31         7.2       Digital Value Output       32         7.3       Digital Error Codes       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
7.2       Digital Value Output       32         7.3       Digital Error Codes.       33         8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
7.3       Digital Error Codes
8.       Serial Interface RS422       34         8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.1       Interface Parameter       35         8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.2       Data Format for Measurement Values and Error Codes       35         8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.2.1       Binary Format       35         8.2.2       ASCII Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.2.2       ASCIÍ Format       36         8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.3       Data Protocol       36         8.3.1       Setup of the Commands       36         8.3.2       Overview       37
8.3.1 Setup of the Commands
8.3.2 Overview
8.3.4 Reading the Sensor Settings, GET_SETTINGS
A T IA NET AV
8.3.6 Stopping the Measurement Value Output, DAT OUT OFF
8.3.7 Starting the Measurement Value Output, DAT OUT ON
8.3.8 Digital or Analog Data Output . SET OUTPUT CHANNEL
8.3.9 Characteristics for Digital or Analog Data Output, SET_OUTPUTMODE 47
8.3.10 Set Output Time. SET OUTPUTTIME MS
8.3.11 Error Output (Analog output), SET ANALOG ERROR HANDLER 49
8.3.5 Average Type and Average Number, SET AV
8.3.13 Input for Scaling and Trigger, SET_EXT_INPUT_MODE
8.3.14 Peak Detection with Video Signal, SET PEAKSEARCHING
8.3.15 Search Threshold, SET_THRESHOLD

8.3.16 8.3.17 8.3.18 8.3.19 8.3.20 8.3.21 8.3.22 8.3.23	Switching off the Laser (External), LASER_OFF Change Data Format, ASCII_OUTPUT Key Lock, SET_KEYLOCK Reset Sensor, RESET_BOOT Set Default Setting, SET_DEFAULT Save Settings in RAM or FLASH, SET_SAVE_SETTINGS_MODE. Scaling Values for the Analog Output, SET_TEACH_VALUE. Reset Scaling Values for the Analog Output, RESET_TEACH_VALUE.	55 56 57 58 59 60
9. 9.1 9.2 9.2.1 9.2.2 9.2.3 9.2.4 9.2.5 9.2.6 9.2.7 9.3	Instructions for Operating Reflection Factor of the Target Surface Error Influences. Light from other Sources Color Differences Temperature Influences Mechanical Vibrations Movement Blurs Surface Roughness. Angle Influences Optimizing the Measuring Accuracy. Cleaning the Protective Glasses	62 62 63 63 63 63 63 64
10.	Default Setting	66
11.	ILD1302 Tool	67
12.	Software Support with MEDAQLib	68
13.	Warranty	69
14.	Service, Repair	69
15.	Decommissioning, Disposal	69
16.	Free Space for Optics	70
17.	Available Cables	71
18.	Input /Output Circuit	72

Appen	dix	
A 1	Converter RS422-USB73	

## 1. Safety

Knowledge of the operating instructions is a prerequisite for sensor operation.

## 1.1 Symbols Used

The following symbols are used in this instruction manual:

**▲** CAUTION

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may lead to property damage.

 $\rightarrow$ 

Indicates an user action.

i

Indicates an user tip.

# 1.2 Warnings

Avoid unnecessary laser exposure to the human body

- Turn off the sensor for cleaning and maintenance.
- Turn off the sensor for system maintenance and repair if the sensor is integrated into a system.

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



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

> Danger of injury, damage to or destruction of the sensor

The power supply may not exceed the specified limits.

> Danger of injury, damage to or destruction of the sensor

**NOTICE** 

Avoid shock and vibration to the sensor. Damage to or destruction of the sensor

Avoid continuous exposure to fluids.

> Damage to or destruction of the sensor

Avoid contact with aggressive materials (washing agent, penetrating liquids or similar).

> Damage to or destruction of the sensor

# 1.3 CE Compliance

The following applies to the optoNCDT1302: 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

MICRO-EPSILON Messtechnik GmbH & Co. KG Königbacher Straße 15 D-94496 Ortenburg

The sensor is in compliance with the following standards

- EN 61326-1:2006-10
- DIN EN 55011: 2007-11 (Group 1, Class B)
- EN 61000-6-2: 2006-03

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

# 1.4 Proper Use

- The series optoNCDT1302 measuring system is designed for use in industrial areas.
- It is used
  - for measuring displacement, distance, position and thickness
  - for in-process quality control and dimensional testing
- The measuring system may only be operated within the limits specified in the technical data, see Chap. 3.3. The sensor 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 67
- Optical surfaces 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 +122 °F)
 Storage temperature: -20 to +70 °C (-4 to +158 °F)
 Humidity: 5 - 95 % (no condensation)

- Pressure: atmospheric pressure

- EMC: acc. to EN 61326-1:2006-10

DIN EN 55011: 2007-11 (Group 1, Class B)

EN 61000-6-2: 2006-03

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

#### 2. Laser Class

The sensors operate with a semiconductor laser with a wavelength of 670 nm (visible/red). The laser emits a permanent beam. The maximum optical power is  $\leq 1$  mW. The sensors are classified for Laser Class 2 (II).

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

Attach the following warning labels on the sensor housing front side:

LASER RADIATION
Do not stare into the beam
CLASS 2 LASER PRODUCT
IEC 60825-1: 2007
P≤1mW; λ=670 nm



THIS PRODUCT COMPLIES WITH FDA REGULATIONS 21CFR 1040.10 AND 1040.11

IEC label

Only for USA

If both warning labels are disguised in operation mode the user must add additional warning labels.

**A** CAUTION

Do not look directly into the laser beam! Possible injury of the eyes. Close your eyes or turn away promptly if laser radiation strikes your eyes. During operation of the sensor the pertinent regulations acc. to EN 60825-1 on "radiation safety of laser equipment" must be fully observed at all times. The sensor complies with all applicable laws for the manufacturer of laser devices.

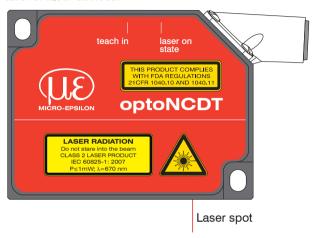


Fig. 1 True reproduction of the sensor with its actual location of the warning labels

Laser operation is indicated by LED.

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 optoNCDT1302 may only be opened by the manufacturer, see Chap. 14.. For repair and service purposes the sensors must always be sent to the manufacturer.

# 3. Functional Principle, Technical Data

## 3.1 Functional Principle

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

The diffuse element of the reflection of the light spot is imaged by a receiver optical element positioned at a certain angle to the optical axis of the laser beam onto a high-sensitivity resolution element (CCD), in dependency on distance.

The controller calculates the measured value from the CCD-array. An internal closed-loop control enables the sensor to measure against different surfaces.

A LED on the sensor indicates:

- In range
- Out of Range (upper and lower range values), poor target (unfit or no object)
- Mid range

The sensor outputs analog or digital values.

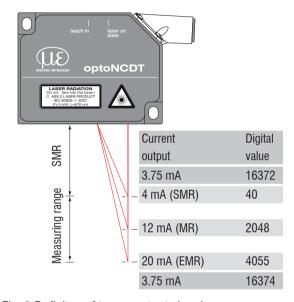


Fig. 2 Definiton of terms, output signal

SMR = Start of measuring range | MR = Midrange | EMR = End of measuring range

#### 3.2 Functions

## 3.2.1 Fitting the Measurement Range

The analog measuring range can be reduced with aid of the "Teach" function, see Chap. 6.2. This enables you to scale only a part of the measuring range to the full scale current output. Thus the resolution of analog evaluation systems like displays or PLCs will be used better.

#### 3.2.2 Peak Select

For measurements on mirroring or transparent surfaces like glass plates or plastic layers spurious reflections from the front or rear side can be suppressed by command, see Chap. 8.3.14.

## 3.2.3 Trigger, Time-based Measurement Value Output

Single measurements can be output via the trigger input. You can also output the measurements in a programmable timing period, see Chap. 8.3.10.

#### 3.2.4 Error Behavior

The sensor may replace or hold up to 99 consecutive errors by the last valid value. In addition, all error values at the analog output can be replaced by the last valid value.

Details about the behavior of the analog output, see Chap. 8.3.11.

#### 3.2.5 Averaging

The sensor enables an averaging of the measured values with the median or moving average, before they are output. This does not reduce the measurement rate.

#### 3.2.6 Video Signal

The sensor can use different peaks in the CCD array for displacement measuring. This function is auxiliary, if the sensor measures against glass or transparent targets, see Chap. 8.3.14.

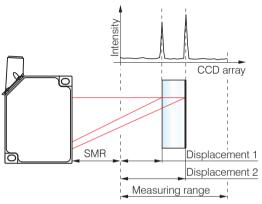
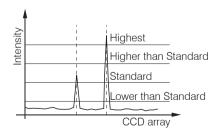


Fig. 3 Video signal

## 3.2.7 Programmable Search Threshold

The sensor can use different thresholds to detect a valid peak in the CCD array for displacement measuring.



Parameters, see Chap. 8.3.15 for parameter setting:

- lower than standard
- Standard
- higher than standard
- highest
  - Changing the threshold from factory default (standard) may influence linearity and resolution.

# 3.3 Technical Data

Туре	ILD1302-	20	50	100	200	
Measuring principle		Laseroptical triangulation				
Measuring range	mm (inches)	20 (0.79)	50 (2.0)	100 (3.9)	200 (7.9)	
Start of measuring range	mm (inches)	30 (1.2)	45 (1.8)	50 (2.0)	60 (2.4)	
Midrange	mm (inches)	40 (1.6)	70 (2.8)	100 (3.9)	160 (6.3)	
End of measuring range	mm (inches)	50 (2.0)	95 (3.7)	150 (5.9)	260 (10)	
Linearity	μm (mils)	40 (1.57)	100 (3 94)	200 (7 87)	400 (15.74)	
Linearity	% FSO		±	0.2		
	Averaged over 64 values	4 (.16)	10 (.39)	20 (0.79)	40 (1.6)	
Resolution	% FSO	0.02				
nesolution	dynamic at 750 Hz $\mu$ m (mils)	10 (.39)	25 (.98)	50 (2.0)	100 (.39)	
	% FSO	0.05				
Measuring rate		750 Hz				
Light source		Semiconductor laser < 1 mW, 670 nm (red)				
Laser class		2 (DIN EN 60825-1 2007)				
	SMR, µm (mils)	210 (8.27)	1100 (43.30)	1400 (55.12)	2300 (90.55)	
Spot diameter	MMR, μm (mils)	530 (20.87)	110 (4 33)	130 (5.12)	2200 (86.61)	
	EMR, µm (mils)	830 (32.68)	1100 (43.39)	1400 (55.12)	2100 (82.68)	
Protection class		IP 67				
Vibration		15 g/ 10 Hz1 kHz				
Shock		15 g / 6 ms (IEC 68-2-29)				
Weight		approximately 83 g, without cable				
Temperature stability	re stability % FSO/°C			0.03 0.08		

Туре	ILD1302-	20	50	100	200
Operating temperature		0 +50 °C (32 to 122 °F)			
Storage temperature	-20 +70 °C ( -4 to 158 °F)				
Output	analog	420 mA (15 V with cable PC 1302-3/U)			
Output	digital	al RS422			
Power supply	11 30 VDC, 24 VDC/ 50 mA				
Electronics	Integral signal processor				
Electromagnetic compatibility (EMC)	DIN EN 550	EN 61326-1 11: 2007-11 N 61000-6-2	Group 1, C	Class B)	

SMR = Start of measuring range

EMR = End of measuring range

MMR = Midrange FSO = Full Scale Output

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

#### 3.4 Control and Indicator Elements

LED State	Color	"Select" key LED "state"
Measuring object within measurement range	green	1017
Midrange	yellow	Lieberton Con Control
Error - e.g. poor target or out of range	red	OptoNCDT
Laser turned off	off	

The touch key "select" is used to scale the sensor. By factory default this key is only active for the first 5 minutes after the power up. After that it will be automatically locked. Via the software tool the auto lock feature can be disabled. With the select key you spread the analog output over a part of the nominal measuring range.

# 4. Delivery

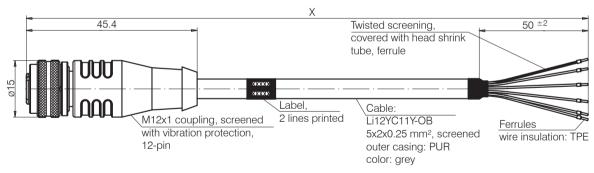
# 4.1 Scope of Delivery

- 1 Sensor optoNCDT1302
- 1 Assembly instructions
- 5 Sealing screws for connector
- 1 CD with driver and demo program

## Optional accessory, packed separately:

- 1 PC1402-x/I cable carriers suitable interface and supply cable for current output, one end of the cable has a molded M12 female connector, the other end has free leads with ferrules.
- 1 PC1402-x/U cable carriers suitable interface and supply cable for voltage output (250 Ohm load, U out = 1 ... 5 V), one end of the cable has a molded M12 female connector, the other end has free leads with ferrules.

A full list of all available cables, see Chap. 17...



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

## 4.2 Storage

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

# 5. Installation and Mounting

The sensor is an optical sensor for measurements with micrometer accuracy.

Make sure it is handled carefully when installing and operating.

# 5.1 Sensor Mounting

Mount the sensor via 2 screws M4.

Mount the sensor in such a way that the laser beam is 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. 9..

# Minimum bending radius PC1402-x

once: 39 mmcontinuous: 78 mm

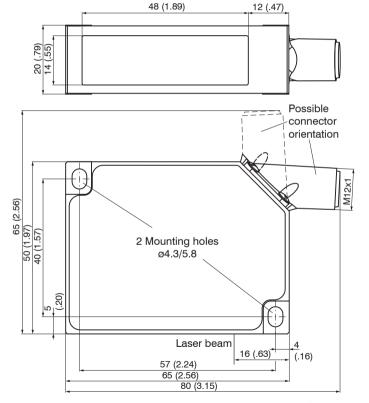
- cable-ø PC1402-x: 8 mm

#### Rotate the connector:

Loosen the 4 screws M2 and rotate the male connector.

Fasten the male connector. Use new sealing screws M2. Connector is sealed (IP 67) waiting 12 hours.

Fig. 4 Dimensions ILD1302, mm (inches)



# 5.2 Pin Assignment

Pin	Description		Color code PC1402-x/l	Specification		
3	RS422 Rx+	0	green	Internally terminated with 100 Ohm		
4	RS422 Rx-	Serial input	yellow	Internally terminated with 120 Ohm		
5	RS422 Tx+	Carial autaut	grey	Tormingto outernally with 100 Ohm		
6	RS422 Tx-	Serial output	pink	Terminate externally with 120 Ohm		
7	+U <sub>B</sub>		red	11 30 VDC, typical 24 VDC / 50 mA		
8	Laser off	0	black	Laser is active, if pin 8 is connected with GND		
9	Teach in	Switch input	violet	Connected to GND for at least 30 ms		
10	Error	Switch output	brown	Open-Collector (NPN), $I_{max} = 100$ mA, $U_{max} = 30$ VDC, short circuit proof, turn off the power supply to reset the short circuit protection		
11	I <sub>OUT</sub> 4 20 mA		white	$R_{Load}$ = 250 Ω results $U_{OUT}$ 1 5 V with $U_{B}$ > 11 V $R_{Load}$ = 500 Ω results $U_{OUT}$ 2 10 V with $U_{B}$ > 17 V		
12	GND		blue	Supply and signal ground		
1/2	n.c.					

The shield of the cable is connected with the housing of the connector. The supply and output cable PC1402-x/I is cable carriers suitable.

One end of the cable has a molded M12 female connector, the other end has free leads with ferrules.

9 1 8 0 2 7 1 3 6 5 4

Fig. 5 Pin side male cable connector

## 5.2.1 Switching off the Laser

Connect pin 8 with pin 12 to switch on the laser.

If you open this connection

- the laser switches off.
- the error output switches on,
- the "State" LED switches off.

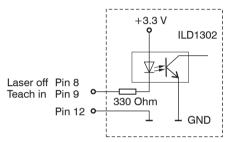


Fig. 6 Circuit for laser off, analog scaling and trigger input

## 5.2.2 Input for Analog Scaling and Triggering

If pin 9, see Fig. 6, is selected as input to scale the analog output in the sensor configuration, see Chap. 8.3.13 and if pin 9 is connected with pin 12 more than 2 sec, the scaling of the analog output starts, see Chap. 6.2. The minimum pulse duration is 30 ms, see Chap. Fig. 10.

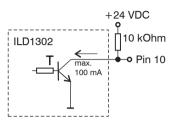
This external input can be configured as a trigger input to output the measurements also. If pin 9 is connected with pin 12 measurements are output at the serial or analog output. The maximum trigger frequency is 250 Hz. Trigger conditions:

Wiring connect with ground, for example a relay or open-collector (NPN)

## 5.2.3 Error Output

The error message is generated by:

- no measuring object or measuring object beyond measuring range
- poor target (reflectivity to small, transparent or mirroring object) or laser off



U<sub>CE max.</sub> = 30 VDC No error: T locked

Error: T conductive

The error output is low-active and short circuit proof.

Fig. 1 External wiring for the error output

With a user defined output scaling, see Chap. 6.2, you can use the hysteresis-free error output as a programmable limit switch.

## 5.3 Pin Assignment for RS422 Interface

The lines have to be crossed for the connection between sensor and PC.

Sensor	Terminal (USB converter)	Colors PC1402-x/I
Tx+ (Pin 5)	Rx+ (Pin 3)	grey
Tx - (Pin 6)	Rx - (Pin 4)	pink
Rx+ (Pin 3)	Tx+ (Pin 2)	green
Rx - (Pin 4)	Tx - (Pin 1)	yellow
GND (Pin 12)	GND (Pin 5)	blue

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

# 6. Operation

## 6.1 Getting Ready for Operation

Install and assemble the optoNCDT1302 in accordance with the instructions set out, see Chap. 5.1 and connect it with the indicator or monitoring unit and the power supply, having full regard to the connection instructions set out, see Chap. 5.2.

The laser diode in the sensor can only be activated if

- the input "Laser on/off" (Pin 9) or
- the black wire in the PC1402 sensor cable

is connected to GND.

Once the operating voltage has been switched on the sensor runs through an initialization sequence. This is indicated by the momentary activation of the "State" LED. If initialization has been finished, the sensor transmits the info string once in ASCII format via the serial interface independent of the selected interface. The initialization including the info string transmission takes up to 5 seconds. Within this period, the sensor neither executes nor replies commands.

To be able to produce reproducible measurements the sensor typically requires a start-up time of 15 minutes. Once this has elapsed the sensor will be in measurement mode and, in accordance with the factory settings, only the "State" LED is illuminated.

If the "State" LED is off, this means that

- either there is no operating voltage or
- the laser has been switched off.

#### **Operating Voltage**

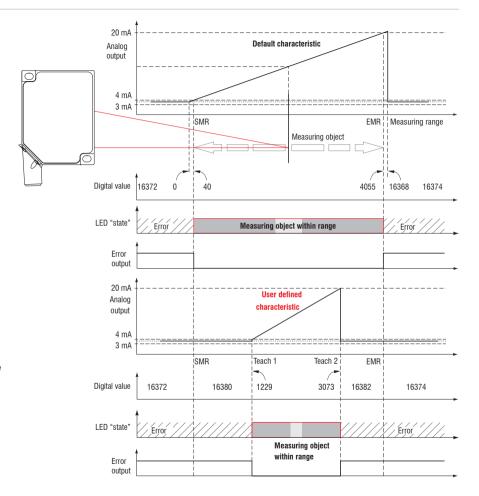
- Nominal value: 24 VDC (11 ... 30 V, max. 50 mA).
- Use the power supply unit for measurement instruments only, and not for drive units or similar sources of pulse interference at the same time.

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

# 6.2 Output Scaling

The "teaching" scales the analog output (4 to 20 mA) for a part of the measuring range. This allows you to optimize the resolution for the analog measurement range. Only the current and error output will be affected by the 2 point calibration. Therefore you define a new start and end for the measurement range. This "teaching" procedure can be performed live via the select key or via pin 9 of the connector.

You can use the error output with a user defined output scaling, see Chap. 5.2.3, as a programmable limit switch.



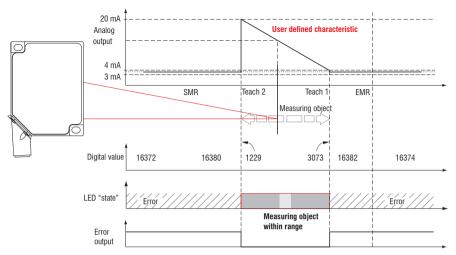


Fig. 7 Reverse user defined characteristic

The minimum distance of the teach values 1/2 to one other is 10 % of the measurement range. The teaching process requires a valid measuring signal. The teaching process is terminated at "no target", "target not evaluated", "to close to the sensor" - beyond SMR" or "to far from the sensor - beyond EMR".

#### 6.2.1 Output Scaling via the "Select" Key

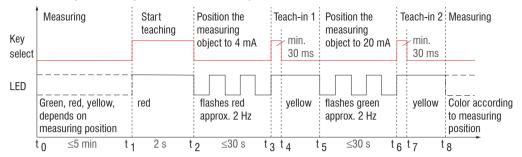


Fig. 8 Timing for the output scaling

The scaling is also available via the software tool.

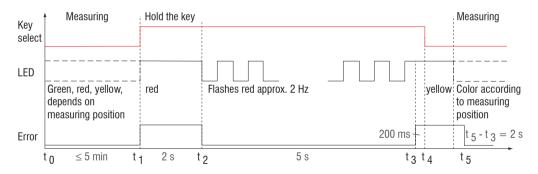


Fig. 9 Timing for the reset of the output scaling

## 6.2.2 Output Scaling via the Hardware Input

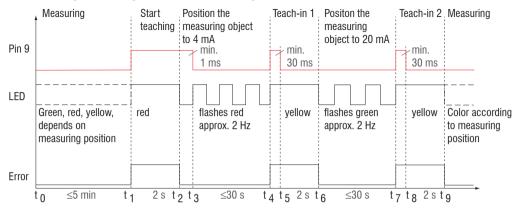


Fig. 10 Timing for the output scaling

The scaling is also available via the software tool.

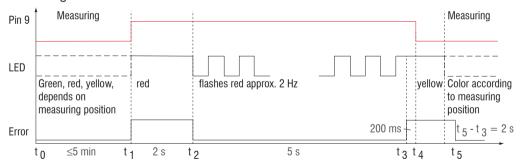


Fig. 11 Timing for the reset of the output scaling

## 6.3 Average

The optoNCDT1302 is supplied ex factory with the default setting "moving averaging, number of averaging N = 1" (no averaging activated).

Implemented averaging methods in the sensor:

- Moving average
- Median

The purpose of averaging is to:

- Improve the resolution
- Eliminate signal spikes
- "Smooth out" the signal.

Averaging has no effect on linearity. A combination of the two averaging methods is not possible. The averaging is recommended for static measurements or slowly changing measurement values.

#### 6.3.1 Averaging Number N

In every measurement cycle (at a measurement rate of 750 Hz every 1.3 ms) the internal average is calculated anew. The averaging number N indicates the number of consecutive measurement values to be averaged in the sensor.

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

## 6.3.2 Moving Average (Default Setting)

The selected number N of successive measurement values (window width) is used to generate the moving average value M on the basis of the following formula:

$$M_{gl} = \frac{\displaystyle\sum_{k=1}^{N} MW \; (k)}{N} \hspace{1cm} MW = \text{Measuring value,} \\ M = \text{Averaging number,} \\ M = \text{Running index} \\ M_{gl} = \text{Averaging value respectively output value}$$

#### Mode:

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

Example: N = 4

... 0, 
$$1, \underbrace{2, 2, 1, 3}_{\downarrow}$$
 ... 1,  $2, \underbrace{2, 1, 3, 4}_{\downarrow}$  Measurement values 
$$\frac{2, 2, 1, 3}{4} = M_{gl} \text{ (n)} \qquad \qquad \frac{2, 1, 3, 4}{4} = M_{gl} \text{ (n+1)} \qquad \text{Output}$$

The moving average in the optoNCDT1302 can only be generated for up to a maximum of 128 values.

#### 6.3.3 Median

The median is generated from a pre-selected number of measurement values. To do so, the incoming measurement values (3, 5, 7 or 9 measurement values) are resorted again after every measurement. The average value is then given as the median. In generating the median in the controller, 3, 5, 7 or 9 measurement values are taken into account, i.e. there is never a median of 1. This permits individual interference pulses to be repressed, but the measurement value curve is not smoothed to any great extent.

Example: Average from five measurement values

... 0 1  $_{ \underbrace{ 2 \ 4 \ 5 \ 1 \ 3 }_{ }} \to Sorted$  measurement values: 1 2  $\underbrace{ 3 \ 4 \ 5 }_{ } \to Sorted$  Median  $_{ (n)} = 3$  ... 1 2  $_{ \underbrace{ 4 \ 5 \ 1 \ 3 \ 5 }_{ }} \to Sorted$  measurement values: 1 3  $\underbrace{ 4 \ 5 \ 5 }_{ } \to Sorted$  Median  $_{ \underbrace{ (n+1)} } = 4$ 

# 6.4 Measurement Rate and Output Rate

The measurement rate defines the number of measurements performed by the sensor per second. The measurement rate is 750 Hz.

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

Output	Maximum output rate
Current	Measurement rate
RS422	Output rate ≤ Measurement rate; Dependent on the transmission rate (baud rate) and data format (ASCII code).

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

Fig. 2 Output rates for the output types

Calculation of the output rate using the RS422 serial interface:

Abbreviations used:

n = Partial factor

int = Integral part of ()

b = Byte/measurement value (binary format b=2,

ASCII b=6)

MR = Measurement rate [Hz]

BR = Baud rate [Baud]

## Example:

Measurement rate = 750 Hz, ASCII-Format (b=6), Baud rate = 115200 Baud

$$-->$$
 n = int (0.43) + 1 = 1

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

--> Output rate =  $750 \, \text{Hz} / 1 = 750 \, \text{Hz}$ .

# 6.5 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.
- 4. Controlling.

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

Each cycle takes 1.3 ms at a measuring rate of 750 Hz. The measured value N is available after each cycle with a constant lag of four cycles in respect to the real time event. The delay between the input reaction and the signal output is therefore 2 up to 2.7 ms. The processing of the cycles occurs sequentially in time and parallel in space (pipelining, see Fig. 12). This guarantees a true constant real time data stream.

Cycle		1.		2.	3.	4.	5.	6.	
Time	max. 5 s	1.3 ms		2.6 ms	3.9 ms	5.2 ms	6.5 ms	7.8 ms	
		Exposur	e N	Reading N	Computation N	Controlling N	Output N		
				Exposure N+1	Reading N+1	Computation N+1	Controlling N+1	Output N+1	
	Initialisation including the				Exposure N+2	Reading N+2	Computation N+2	Controlling N+2	
	output of the info string	First exp	osure	after power up of	the sensor	Exposure N+3	Reading N+3	Computation N+3	
							Exposure N+4	Reading N+4	

Fig. 12 Sensor timing

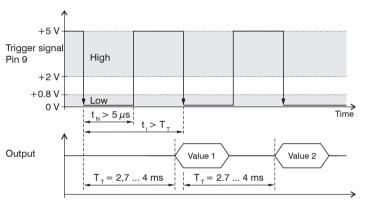
The sensor needs time until measuring values are available according to the set averaging number N.

# 6.6 Triggering

The ILD1302 measurement output is controllable through an external signal on the trigger input. Therefore the external input "Teach in" must be configured for triggering, see Chap. 8.3.13. This can be done with the "ILD1302 Tool" ("Configuration" > "General Settings" > "Digital Input: trigger acquisition") also.

#### Basics, procedure:

- The sensor measures and calculates also, if no trigger pulses are pending.
- The data output starts with a falling edge of the trigger signal.
- Sensor outputs the measurement value with a delay  $T_{\tau}$  of 1.4 up to 2 ms.
- A new trigger pulse can be sent.



t<sub>N</sub> Non-pulse period t<sub>1</sub> Pulse interval T<sub>+</sub> Delay time

 $T_{T} = 2,7 \dots 4$  ms true for a measurement rate of 750 Hz and a baud rate of 115.200 Baud

Maximum trigger rate: appr. 250 Hz

Fig. 13 Timing

You get a digital measurement value on the output for each trigger signal, see Chap. 8.3.8, see Chap. 8.3.9 (data output). The analog output is actualized with any trigger signal, if you use the analog output.

An averaging of the measuring values has no effect on the delay time  $T_{\tau}$  Consider certainly, that the controller needs time for the averaging, until measuring values are available according to the set averaging number N.

# 7. Measurement Value Output

The optoNCDT1302 can issue the measurement values either via the analog output or the RS422 serial interface. The two different types of output cannot be used concurrently.

# 7.1 Current Output

Max. range 4 mA ... 20 mA

Output amplification  $\triangle I_{OUT}$  16 mA = 100 % Measuring range

Error value: 3.75 mA ( $\pm 10 \mu$ A)

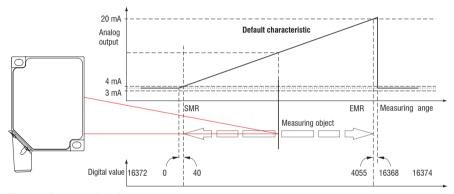


Fig. 14 Current signal output

Calculation of measurement value x in mm from analog current

Reference value SMR

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

Reference value MMR:

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

Proceed as follows

to set the sensor into

operation after a short

Switch off the

sensors power

Wait appr. 3 s. Switch on the sensors power

circuit on the analog

supply.

supply.

output:

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

#### 7.2 **Digital Value Output**

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

Digital value	Used for
0 39	SMR back-up
40 4055	Measurement range
4056 4095	EMR back-up
16370 16383	Error codes

Calculation of a measurement value in mm from digital output:

Reference value Start of Measuring Range:

$$x \text{ [mm]} = (\text{digital }_{\text{OUT}} * \frac{1.02}{4096} - 0.01) * \text{MR [mm]}$$
  $x \text{ [mm]} = (\text{digital }_{\text{OUT}} * \frac{1.02}{4096} - 0.51) * \text{MR [mm]}$ 

Reference value Midrange

$$x [mm] = (digital_{OUT} * \frac{1.02}{4096} - 0.51) * MR [mm]$$

Example: MR = 10 mm, digital value = 2048, measurement value = 5 mm or 0 mm

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

digital <sub>OUT</sub> = 
$$\left[ \frac{x \text{ [mm]}}{\text{MR [mm]}} + 0.01 \right] * \frac{4096}{1.02}$$

## 7.3 Digital Error Codes

Digital error codes are issued in the same way as measurement values.

Value range for error codes: 16370 ... 16384 (digital out)

- 16370 no object detected
- 16372 too close to the sensor
- 16374 too far from the sensor
- 16376 target can not be evaluated
- 16380 target moves towards the sensor
- 16382 target moves away from sensor

## 8. Serial Interface RS422

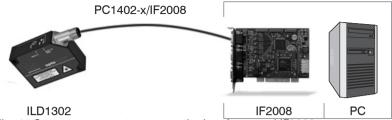


Fig. 15 System structure to operate the interface card IF2008

	Pin	Signal	Signal	Pin	
Sensor 1	3 Rx + (Input) 4 Rx - (Input)		Sensor 1/3 TxD+	2	
12-pol.			Sensor 1/3 TxD -	1	
connector	5	Tx + (Output)	Sensor 1/3 RxD+	4	
	6	Tx - (Output)	Sensor 1/3 RxD -	3	
			0 V supply	5	
When using	g 3 se	ensors apply	Sensor 1/3 TRG+	6	IF2008.
the optiona	al ava	ilable Y- adapter	7	X1 and X2,	
cable IF200	08-Y.		8	15-pol.	
			Sensor 2/4 TRG -	9	Sub-D
	7	24 V	+24 V supply 1	10	
	3	Rx +	Sensor 2/4 TxD+	12	
Sensor 2	4	Rx -	Sensor 2/4 TxD -	11	
12-pol. connector	5	Tx +	Sensor 2/4 RxD+	14	
	6	Tx -	Sensor 2/4 RxD -	13	
	12	GND	GND	15	

Fig. 16 Pin assignment PC1402-x/IF2008 and IF2008

Required cables and program routines

- IF2008
   RS422 interface card, for 1 to
   4 laser-optic sensors from the
   ILD1302 series and 2 encoders, including MEDAQlib
   programming interface.
- PC1402-x/IF2008
   Power supply and output cable, x = length with 3, 6 or 8 m.

Alternatively, data can be transferred with the demo software (ILD1302 Tool) and a RS422 converter to USB, see Chap. 11..

#### 8.1 Interface Parameter

The optoNCDT1302 comes with a RS422 serial interface to enable the sensor to be operated from a standard computer and measurement values and error codes to be transferred.

Default settings					
Baud rate	115200				
Parity	none				
Data bits	8				
Start/stop bit	1				

## 8.2 Data Format for Measurement Values and Error Codes

## 8.2.1 Binary Format

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

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

#### Conversion of the binary data format:

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

#### Reception:

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

#### Result of conversion

ı																
	0	0	0	0	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	_	-	_	-												

Replies with a length of 4 bytes must be swapped according to the following rule:

Reception: 0 1 2 3 4 5 6 7 Conversion: 3 2 1 0 7 6 5 4

This rule does not apply to values.

#### 8.2.2 ASCII Format

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

Example: Digital value 2099

Transfer: " 2099" (preceded by 1 blank character) "CR"

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

ASCII characters can be easily shown using a terminal program.

#### 8.3 Data Protocol

#### 8.3.1 Setup of the Commands

The commands for the sensors are comprised of command data which are transmitted in full duplex mode. Each command packet is comprised of a whole number multiple of 32 bit words, see Fig. 17.

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

Contents					
Start word					
Sensor identifier,	Command header (2 words)				
e.g. "ILD1"					
Command code	Data word quantity n+2				
1 st Dats worf (4 Bytes)					
n <sup>th</sup> Data word (4 Bytes)					

Fig. 17 Structure of a command packet

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

# 8.3.2 Overview

Information of	command		
0x20490002	Chap. 8.3.3	GET_INFO	Shows sensor data
0x204A0002	Chap. 8.3.4	GET_SETTINGS	Shows sensor settings
Average			
0x207F0004	Chap. 8.3.5	SET_AV	Sets average type and value
Measuremen	t value output		
0x20760002	Chap. 8.3.6	DAT_OUT_OFF	Stops measurement value output
0x20770002	Chap. 8.3.7	DAT_OUT_ON	Permanent measurement value output
0x20F40003	Chap. 8.3.9	SET_OUTPUTMODE	Output mode
0x20F50003	Chap. 8.3.10	SET_OUTPUTTIME_MS	Output time in ms
Switch output	t settings		
0x20900003	Chap. 8.3.8	SET_OUTPUT_CHANNEL	Output: current or RS422
Speed			
0x20800003	Chap. 8.3.12	SET_BAUDRATE	115.2 / 57.6 / 38.4 / 19.2 / 9.6 kBaud
Error output	(analog output)		
0x20810003	Chap. 8.3.11	SET_ANALOG_ERROR_HANDLER	Behavior of the analog output in the case of an error
External inpu	ıt		
0x20F80003	Chap. 8.3.13	SET_EXT_INPUT_MODE	Scaling, triggering
Switching of	the laser (exte	rnal)	
0x20870002	Chap. 8.3.16	LASER_ON	Switches the laser on
0x20860002	Chap. 8.3.16	LASER_OFF	Switches the laser off
Measuremen	t value data for	mat	
0x20880003	Chap. 8.3.17	ASCII_OUTPUT	Options: ASCII / Binary
Key lock			
0x20600003	Chap. 8.3.18	SET_KEYLOCK	Key enabled / locked / auto lock

Reset									
0x20F10002	Chap. 8.3.20	SET_DEFAULT	Reset to default factory settings						
0x20F00002	Chap. 8.3.19	RESET_BOOT	Reboot the sensor						
Memory mode									
0x20F70003	Chap. 8.3.21	SET_SAVE_SETTINGS_MODE	Volatile / nonvolatile						
Scaling value	es								
0x20F90004	Chap. 8.3.22	SET_TEACH_VALUE	Sets T1 + T2 0 16368						
0x20FA0002	Chap. 8.3.23	RESET_TEACH_VALUE	Sets T1 = 0 / T2 = 16368						
Search algor	ithm								
0x20FB0003	Chap. 8.3.14	SET_PEAKSEARCHING	First peak, last peak, global maximum						
Threshold									
0x20FC0003	Chap. 8.3.15	SET_THRESHOLD	Lower than standard, standard, higher than standard, highest						

# 8.3.3 Reading the Sensor Parameters, GET\_INFO

Name: GET\_INFO

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

Format:

31	24	23	16	15	8	7	0	hex
"+"		"+"		"+"		"CR"		0x2B2B2B0D
"l"		"L"		"D"		"1"		0x494c4431
0x	20	0x	49	0x	00	0x	02	0x20490002

Reply:

31	24	23	16	15	8	7	0	hex
"I	"	,,,	L"	"!	D"	,,	1"	0x494c4431
0x.	A0	0x	49	0x	00	0x	81	0xA049006F

ILD 1302: Standard

A/N: 4120166 O/N: 000 S/N: 0902003

MR: 50

SoftVer: 1.003.7 BootVer: 1.002.1 Date: 09/07/31 Out Channel: digital Analog Error: error value Filter Type: moving average

Filter Number: 1 Scanrate: 750 Hz

type of digital output: binary

mode of analog/digital output: continuous

key status: auto lock

mode of save setting: save at each time mode of extern input: as teach in peak searching: global maximum

threshold: standard Teach value 1: 0.00 Teach value 2: 16368.00

Factory setting: Median off

## 8.3.4 Reading the Sensor Settings, GET\_SETTINGS

Name: GET SETTINGS

Description: Supplies the current sensor settings. Swap the received bytes according, see Chap. 8.2.1.

These are as follows:

### Output channel

- 0 = Current
- 1 = Digital

#### Teach value 1

0.0 ... 16368.0

e. g. float: 3027.426 = hexadecimal: 0x453d36d1

#### Teach value 2

0.0 ... 16368.0

e. g. float: 11068.851 = hexadecimal: 0x462cf367

## Analog error handler

- 0 = hold last value
- 1 = error output
- 2...99 hold last value for 2...99 images respectively cycles

#### Average type

- 0 = moving average
- 1 = Median

# Average value

- 1...128 moving average, if average type = 0
- -2 = 750 Hz
- 3, 5, 7, 9 Median, if average type = 1

#### **Baud rate**

- -0 = 115200 Baud
- 1 = 57600 Baud
- 2 = 38400 Baud
- 3 = 19200 Baud
- -4 = 9600 Baud

## Digital output type

- 0 = Binary
- 1 = ASCII

## Analog, digital output mode

- 0 = continuously each measurement, depending on baud rate and the measuring frequency;
   delay = (Bit quantity / Baud rate) \* measuring frequency [Hz] (if delay < 0, delay = delay +1)</li>
   delay = number of cycles with no serial output
- 1 = time-based, see output time [ms]
- 2 = trigger controlled, see external input mode

## Output time [ms]

1...65535

#### **Key lock**

- 0 = key enabled
- 1 = key locked
- 2 = automatic key lock after 5 min power is on

#### Save settings mode

- 0 = transmitted settings are stored in the RAM and are valid until power off
- 1 = transmitted settings are stored in the FLASH and are valid, even after power off/on

### **External input type**

- 0 = external input is used for scaling
- 1 = external input is used as trigger input (trigger controlled output)

### Peak searching

- 0 = peak with global maximum
- 1 = first peak, direction pixel 0 up to pixel 127, left to right
- 2 = last peak, direction pixel 0 up to pixel 127, left to right

#### **Threshold**

- 0 = lower than standard
- 1 = standard
- 2 = higher than standard
- 3 = highest

# Measuring range [mm]

- XXX X = 1 ...65535

Reserved 1

Reserved 2

Reserved 3

Reserved 4

Format:

31	24	23	16	15	8	7	0	hex
"+	⊦"	"-	<b>-"</b>	"-	⊢"	0x0d	("CR")	0x2B2B2B0D
,,,	"	,,,	"	",	<b>D</b> "	,,	1"	0x494C4431
0x	20	0x	4A	0x	00	0>	(02	0x204A0002

Reply:

31	24	23	16	15	8	7	0	hex			
,,	I"	,,,	"	",,	<b>)</b> "	"1"		0x494C4431			
0x	:A0	0x	4A	0x	00	0x	17	0xA04A0016			
	Output channel										
0x	(00	0x	00	0x00		0x0X		0x0000000X			
	Teach value 1										
0xXX		0x	XX	0x	XX	0x	XX	0xXXXXXXX			

	Teach	value 2		
0xXX	0xXX	0xXX	0xXX	0xXXXXXXXX
	Analog err	or handler		
0x00	0x00	0x00	0xXX	0x000000XX
	Averaç	ge type		
0x00	0x00	0x00	0x0X	0x000000X
	Averag	e value		
0x00	0x00	0x00	0xXX	0x000000XX
	Measur	ing rate		
0x00	0x00	0x00	0x0X	0x0000000X
	Baud	l rate		
0x00	0x00	0x00	0x0X	0x0000000X
	Digital οι	tput type		
0x00	0x00	0x00	0x0X	0x0000000X
	Analog digita	l output mode		
0x00	0x00	0x00	0x0X	0x0000000X
	Outpu	ıt time		
0x00	0x00	0xXX	0xXX	0x0000XXXX
	Key	lock		
0x00	0x00	0x00	0x0X	0x0000000X
	Save setti	ngs mode		
0x00	0x00	0x00	0x0X	0x0000000X
	External i	nput type		
0x00	0x00	0xXX	0xXX	0x0000XXXX
	Peak se	earching		
0x00	0x00	0x00	0x0X	0x0000000X
	Thres	shold		
0x00	0x00	0x00	0x0X	0x0000000X
	Measuri	ng range		
0x00	0x00	0xXX	0xXX	0x0000XXXX

	Reser	ved 1		
0x00	0x00	0x00	0x0X	0x00000000
	Reser	ved 2		
0x00	0x00	0xXX	0xXX	0x00000000
	Reser			
0x00	0x00	0x00	0x0X	0x00000000
	Reser	ved 4		
0x00	0x00	0x00	0x0X	0x00000000
	Last da			
0x20	0x20	0x0D	0x0A	0x20200D0A

# 8.3.5 Average Type and Average Number, SET\_AV

Name: SET AV

Description: Sets the average type and the average number N.

Parameter:

- Average type

■ X = 0 --> Moving average

■ X = 1 --> Median

- Average number

■ XX = 1 ... 128 --> Moving average, if average type = moving average

■ XX = 3, 5, 7, 9 --> Median, if average type = Median

Format:

31	24	23	16	15	8	7	0	hex
"-	+"	"+"		"+"		0x0d ("CR")		0x2B2B2B0D
,,	l"	",,	"	"D"		"1"		0x494C4431
0x	20	0x7F		0x00		0x04		0x207F0004
0x	:00	0x00 0x00 0x0X		0X	0x0000000X			
0x	:00	0x	00	0x	00	0xXX		0x000000XX

Default setting: moving average 1, thus no averaging

Reply:

31	24	23	16	15	8	7	0	hex
	"I" "L"		",,	D"	"	1"	0x494C4431	
0x	0xA0		0x7F		0x00		02	0xA07F0002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.6 Stopping the Measurement Value Output, DAT\_OUT\_OFF

Name: DAT OUT OFF

Description: Switches off the digital output for the measurement values. This has no effect on communication with the sensor via the digital interface. This command has a higher priority in trigger mode. The command is volatile. Therefore data out is on after power on.

Format:

31	24	23	16	15	8	7	0	hex
"⊣	⊦"	"⊣	- "	"⊣	- "	0x0d (	("CR")	0x2B2B2B0D
"["		"L"		"D"		"1"		0x494C4431
0x	20	0x	76	0x	00	0x	02	0x20760002

Reply:

31	24	23	16	15	8	7	0	hex
"!	<b>"</b>	,,,	L"	",,	D"	"	1"	0x494C4431
0xA0 0x76		76	0x	00	0x	02	0xA0760002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.7 Starting the Measurement Value Output, DAT\_OUT\_ON

Name: DAT OUT ON

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

Format:

31	24	23	16	15	8	7	0	hex
"⊣	<b>⊢"</b>	"-	<b>⊢"</b>	"-	<b>⊢"</b>	0x0d	("CR")	0x2B2B2B0D
"["		"L"			"D"		1"	0x494C4431
0x	20	0x	77	0x	00	0x	02	0x20770002

Reply:

31	24	23	16	15	8	7	0	hex
"["		"!	-"	",	<b>D</b> "	"	1"	0x494C4431
0xA0		0x77		0x00		0x02		0xA0770002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.8 Digital or Analog Data Output , SET\_OUTPUT\_CHANNEL

Name: SET OUTPUT CHANNEL

Description: Sets the output type for the measurement values.

Parameter:

- X = 0 --> Analog output (4 ... 20 mA)

- X = 1 --> Digital output (RS422)

Format:

31	24	23	16	15	8	7	0	hex
"-	⊦"	"-	<b>- "</b>	"-	<b>- "</b>	0x0c	("CR")	0x2B2B2B0D
"["		"L"		"D"		"1"		0x494C4431
0x	20	0x	90	0x	00	C	x03	0x20900003
0x	00	0x	00	0x	00	C	x0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
",	<b>"</b>	,,,	L"	"[	<b>)</b> "	"	1"	0x494C4431
0xA0		0x90		0x00		0x02		0xA0900002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

Default setting: analog output

Default setting:

continuously

## 8.3.9 Characteristics for Digital or Analog Data Output, SET\_OUTPUTMODE

Name: SET OUTPUTMODE

Description: Sets the output characteristics.

X = 0 --> continuously each measurement, depending on baud rate;
 delay = (Bit quantity / Baud rate) \* measuring frequency [Hz], if delay < 0, delay = delay +1)</li>
 delay = number of cycles with no serial output

- X = 1 --> time-based, see Chap. 8.3.10.
- X = 2 --> trigger controlled, see Chap. 8.3.13.

Format:

:	31	24	23	16	15	8	7	0	hex
	"+	_"	"-	F"	"-	F"	0x0d	("CR")	0x2B2B2B0D
	"["		"L"		"D"		"1"		0x494C4431
	0x20		0xF4		0x00		0>	:03	0x20F40003
	0x(	00	0x	00	0x	00	0x	:0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
"["		"L"		"D"		"1"		0x494C4431
0xA0		0xF4		0x00		0x02		0xA0F40002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.10 Set Output Time, SET\_OUTPUTTIME\_MS

Name: SET\_OUTPUTTIME\_MS

Description: Sets the output time for the analog or digital output value to be updated.

Will be applicable at time-based measurement value output, see Chap. 8.3.9.

Default setting: 500 ms

## Parameter:

- XXXX = 1 ... 65535 [ms].

Format:

:	31	24	23	16	15	8	7	0	hex
	"+	- "	"-	_"	"-	F"	"C	R"	0x2B2B2B0D
	"["		"L"		"D"		"1"		0x494c4431
	0x	20	0x	F5	0x	00	0x	:03	0x20F50003
	0x	00	0x	00	0x	XX	0x	XX	0x0000XXXX

Reply:

31	24	23	16	15	8	7	0	hex
"["		"L"		"D"		"1"		0x494c4431
0xA0		0xF5		0x00		0x02		0xA0F50002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

Default setting:

error value

# 8.3.11 Error Output (Analog output), SET\_ANALOG\_ERROR\_HANDLER

Name: SET ANALOG ERROR HANDLER

Description: Hold or not hold last measurement value.

#### Parameter:

i didilicici.

- X = 0 --> hold last measurement value
- X = 1 --> error value (3.75 mA)
- X = 2 ... 99 --> hold last measurement value for 2 ... 99 images respectively cycles

This command only affects the analog output. If set to X=0, the last valid measurement value will continue to be issued if an error occurs (no object, invalid object, object outside the measurement range or laser turned off). If set to X=1, an error signal will be generated for the current output that has an error value of 3.75 mA. If set to X=2...99, the last valid measurement value will continue to be issued for X=10 measuring cycles before an error signal is generated on the analog output.

Format:

		5	5						
:	31	24	23	16	15	8	7	0	hex
	"-	+"	"-	+"	,,-	F"	0x0d	("CR")	0x2B2B2B0D
	"I"		"L"		"!	"D"		1"	0x494C4431
	0x	20	0x	81	0x	00	0x	:03	0x20810003
	0x	00	0x	00	0x	00	0x	0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,	<b>l</b> "	,,,	L"	,,,	D"	,,	1"	0x494C4431
0xA0		0x81		0x00		0x	02	0xA0810002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

Default setting:

115200 Baud

# 8.3.12 Set Baud Rate, SET\_BAUDRATE

Name: SET\_BAUDRATE

Description: Sets the transmission rate.

Parameter:

-X = 0 --> 115200

- X = 1 --> 57600

- X = 2 --> 38400

- X = 3 --> 19200

-X = 4 --> 9600

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

Do not forget to change your programs baud rate.

Format:

31	24	23	16	15	8	7	0	hex
"+"		"+"		"-	- "	0x0d	("CR")	0x2B2B2B0D
" "		,,,	"	"[	<b>)</b> "	,,	1"	0x494C4431
0x20		0x80		0x	0x00		03	0x20800003
0x	00	0x	00	0x	00	0x	0X	0x000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,,	<b>"</b>	,,,	L"	",	D"	33	1"	0x494C4431
0x.	0xA0 0x80		0x00		0x02		0xA0800002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

#### 8.3.13 Input for Scaling and Trigger, SET\_EXT\_INPUT\_MODE

Name: SET EXT INPUT MODE

Defines the function of the switching input "Teach in" (Pin 9 on the sensor connector). Description:

Parameter:

- X = 0 --> external input operates as scaling input
- X = 1 --> external input operates as trigger controlled input for the data output

Format:

31	24	23	16	15	8	7		0	hex
"+" "		- "	"-	+" 0x0d ("CR")			("CR")	0x2B2B2B0D	
	"I"		"L"		"D"			1"	0x494C4431
0x	0x20 0xF8		0x00			0x	03	0x20F80003	
0x	00	0x	00	0x	00		0x	0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,	l"	,,	L"	,,,	D"	"	1"	0x494C4431
0x	0xA0 0xF8		0x00		0x02		0xA0F80002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

Default setting: Scaling

### 8.3.14 Peak Detection with Video Signal, SET PEAKSEARCHING

Name: SET PEAKSEARCHING

Description: Specifies the search algorithm.

#### Parameter:

- X = 0 --> peak with global maximum

X = 1 --> first peak, direction pixel 0 up to pixel 127, left to right
 X = 2 --> last peak, direction pixel 0 up to pixel 127, left to right

Format:

31	24	23	16	15	8	7		0	hex
"-	+"	"-	<b>-"</b>	"-	"+" 0x0d ("CR")		0x2B2B2B0D		
,,	l"	,,	L"	"I	D"		"1"		0x494C4431
0x	20	0x	FB	0x00			0x03		0x20FB0003
0x	:00	0x	00	0x	00		0x	0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,,	<b>l</b> "	,,	L"	"[	D"	,,	1"	0x494C4431
0x	0xA0 0xFB		0x00		0x02		0xA0FB0002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

A peak inside the video signal is limited by overrun and subsequent shortfall the threshold limit. Several valid peaks are evaluated when measuring glass. Measurements on metal surfaces can also produce multiple peaks. Determine the valid peaks in the software tool (video signal).

# 8.3.15 Search Threshold, SET\_THRESHOLD

Name: SET\_THRESHOLD

Description: Defines the characteristics of the search threshold.

#### Parameter:

- X = 0 --> lower than standard

- X = 1 --> Standard

- X = 2 --> higher than standard

- X = 3 --> highest

Changing the threshold from factory default (standard) may influence linearity and resolution.

Modify the sensor only with specific materials as with semitransparent plastics and so educate the sensor recently.

Format:

31	24	23	16	15	8	7		0	hex
",-	F"	"-	- "	"+"		0x0d ("CR")			0x2B2B2B0D
,,,	<b>"</b>	,,	"	"I	D"	"1"		1"	0x494C4431
0x	20	0x	FC	0x	00		0x	03	0x20FC0003
0x	00	0x	00	0x	00		0x	0X	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,,	<b>"</b>	,,,	L"	",,	D"	,,	1"	0x494C4431
0x	0xA0 0xFC		0x00		0x02		0xA0FC0002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.16 Switching off the Laser (External), LASER\_OFF

Name: LASER\_OFF

Description: Switches off the laser. This command is volatile e.g. the laser is on after power on.

Format:

t:	31	24	23	16	15	8	7	0	hex
	"-	F"	"-	_"	"-	۰"	0x0d	("CR")	0x2B2B2B0D
	"	"	"	-"	],,	<b>)</b> "	,,	1"	0x494C4431
	0x	20	0x	86	0x	00	0x	02	0x20860002

Reply:

31	24	23	16	15	8	7	0	hex
,,	l"	,,,	_"	],,	<b>)</b> "	"	1"	0x494C4431
0x	0xA0 0x86 0x00		00	0x	02	0xA0860002		
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

The command LASER\_OFF is volatile. This means that the laser is switched on again if the power supply was switched off or the sensor was rebooted by means of the RESET\_BOOT command and pin 8 is connected with GND.

Name: LASER ON

Description: Switches on the laser

Format:

31	24	23	16	15	8	7	0	hex
"-	<b>+</b> "	,,-	⊢"	,, -	+"	0x0d	("CR")	0x2B2B2B0D
,,	l"	,,	L"	,,	D"	,,	1"	0x494C4431
0x	20	0x	87	0x	00	0x	02	0x20870002

Reply:

31	24	23	16	15	8	7	0	hex
,,	<b>l</b> "	,,	L"	,,	D"	"	1"	0x494C4431
0x	A0	0x	87	0x	00	0x	02	0xA0870002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

The command LASER\_ON is effective only if pin 8 is connected with GND.

# 8.3.17 Change Data Format, ASCII\_OUTPUT

Name: ASCII OUTPUT

Description: Switches the data format for the measurement value output via the digital interface. The command replies will remain unaffected.

#### Parameter:

Default setting: Binary format

X = 0 --> Binary output (2 Byte)X = 1 --> ASCII output (6 Byte)

Format:

:	31	24	23	16	15	8	7	0	hex	
	"+"		"-	"+"		"+"		("CR")	0x2B2B2B0D	
	"["		"L"		"D"		,	,1"	0x494C4431	
	0x20 0x88		0x00		0x03		0x20880003			
	0x(	00	0x	00	0x	00	0)	κ0X	0x0000000X	

Reply:

31	24	23	16	15	8	7	0	hex
,,	<b>"</b>	,,,	_"	,,[	D"	33	1"	0x494C4431
0x	0xA0 0x88		0x00		0x02		0xA0880002	
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.18 Key Lock, SET\_KEYLOCK

Name: SET KEYLOCK

Description: Locks or enables the key "select". The set status is not volatile.

Parameter:

Default setting: key locked automatically after 5 min power

- X = 0 --> enable keyX = 1 --> lock key
- X = 2 --> key locked automatically after 5 min power on

Format:

:	31	24	23	16	15	8	7	0	hex
	"⊣	_"	"-	F"	"-	F"	0x0d	("CR")	0x2B2B2B0D
	"I"		,,,	L"	",	D"	31	1"	0x494C4431
	0x	20	0x	60	0x	00	0>	(03	0x20600003
	0x	00	0x	00	0x	00	0>	(OX	0x0000000X

Reply:

31	24	23	16	15	8	7	0	hex
,,	l"	,,,	L"	",	D"	33	1"	0x494C4431
0x	A0	0x	60	0x	00	0x	02	0xA0600002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.19 Reset Sensor, RESET\_BOOT

Name: RESET\_BOOT

Description: Starts the sensor's initialization phase. Duration about 900 ms.

Procedure: The sensor replies and then re-boots. The string of the boot message contains "Cl140x", "CR" "LF" and the answer of "GET INFO".

Format:

:	31	24	23	16	15	8	7	0	hex
	"+	<b>- "</b>	"-	<b>⊢"</b>	"-	۲"	0x0d	("CR")	0x2B2B2B0D
	"I	"	,,	L"	"[	O"	,,	1"	0x494C4431
	0x	20	0x	F0	0x	00	0x	02	0x20F00002

Reply:

31	24	23	16	15	8	7	0	hex
"I	66	,,	_"	",	D"	,,	1"	0x494C4431
0x.	A0	0x	F0	0x	00	0x	02	0xA0F00002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 8.3.20 Set Default Setting, SET\_DEFAULT

Name: SET\_DEFAULT

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

This concerns:

• Output channel: 0 --> analog output,

■ Teach value 1 --> 0.0

■ Teach value 2 --> 16368.0

• Analog error handler: 1 --> in the case of an error: 3.75 mA on the analog output,

Average type: 0 --> moving average,

Average value: 1 --> no averaging,

■ Baud rate: 0 --> 115200 Baud,

Digital output type: 0 --> binary,

Analog digital output mode: 0 --> continuous,

Output time --> 500 ms,

Key lock: 2 --> key locked automatically after 5 min power on,

Save settings mode: 1 --> transmitted new settings are stored in the FLASH,

External input type: 0 --> external input for scaling

Procedure: The sensor replies and then re-boots. The string of the boot message contains "Cl140x", "CR" "LF" and the answer of "GET\_INFO".

Format:

31	24	23	16	15	8	7		0	hex
"+	+"	"-	<b>- "</b>	"-	F"		0x0d	("CR")	0x2B2B2B0D
"	l"	,,,	"	,,,	D"		"	1"	0x494C4431
0x	20	0x	F1	0x	00		0x	02	0x20F10002

Reply:

31	24	23	16	15	8	7	0	hex
,,	<b>I</b> "	,,,	"	"[	<b>)</b> "	,,	1"	0x494C4431
0x	A0	0x	F1	0x	00	0x	02	0xA0F10002
0x	20	0x	20	0x	OD.	0x	0A	0x20200D0A

Default setting:

Save in FLASH

# 8.3.21 Save Settings in RAM or FLASH, SET\_SAVE\_SETTINGS\_MODE

Name: SET SAVE SETTINGS MODE

Description: Saves the transmitted settings into the RAM or the FLASH.

Parameter:

- X = 0 --> transmitted new settings are stored in the RAM and valid until power off.

- X = 1 --> transmitted new settings are stored in the FLASH and are thus are generally valid.

Format:

t:	31	24	23	16	15	8	7		(	)	hex	7
	"+	<b>- "</b>	"-	F"	"-	F"		0x0d	("CR")		0x2B2B2B0D	٦
	"I"		"L"		"D"		"1"				0x494C4431	٦
	0x	20	0x	F7	0x	00		0x	03		0x20F70002	٦
	0x	00	0x	00	0x	00		0x	0X		0x0000000X	٦

Reply:

31	24	23	16	15	8	7	0	hex
,,	"	,,,	"	",,	D"	"	1"	0x494C4431
0x	A0	0x	F7	0x	00	0x	02	0xA0F70002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

Default setting:

Teach value 1: 0.0

Teach value 2: 16368.0

# 8.3.22 Scaling Values for the Analog Output, SET\_TEACH\_VALUE

Name: SET\_TEACH\_VALUE

Description: Sets the scaling values.

Parameter:

- Teach value 1, XXXXXXXX --> 0.0 up to 16368.0

- Teach value 2, XXXXXXXX --> 0.0 up to 16368.0

Format:

31	24	23	16	15	8	7		0	hex	X
"+	<b>+</b> "	"⊣	- "	"-	<b>-"</b>	(	0x0d (	("CR")	0x2B2B	2B0D
"I" "L"			,,[	<b>D</b> "	"1"			0x494C	4431	
0x20		0xF9		0x	00		0x	04	0x20F9	0004
0xXX 0xXX		0xXX			0x	XX	0xXXXX	XXXX		
0x	XX	0x2	XX	0x	XX		0x	XX	0xXXXX	XXXX

Reply:

31	24	23	16	15	8	7	0	hex
,,	"	,,	L"	",,	O"	,,	1"	0x494C4431
0x	A0	0x	F9	0x	00	0x	02	0xA0F90002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

The teaching process requires a valid measuring signal. The teaching process is terminated at "no target", "target not evaluated", "to close to the sensor" - beyond SMR" or "to far from the sensor - beyond EMR".

# 8.3.23 Reset Scaling Values for the Analog Output, RESET\_TEACH\_VALUE

Name: RESET\_TEACH\_VALUE

Description: Resets the scaling values.

Format:

:	31	24	23	16	15	8	7	0	hex
	"+	<b>- "</b>	"-	۲"	"-	- "	0x0d	("CR")	0x2B2B2B0D
	"I	"	,,	L"	"[	<b>)</b> "	,,	1"	0x494C4431
	0x	20	0x	FA	0x	00	0x	02	0x20FA0002

Reply:

31	24	23	16	15	8	7	0	hex
,,,	<b>"</b>	,,,	_"	",	<b>D</b> "	,,	1"	0x494C4431
0x.	A0	0x	FA	0x	00	0x	02	0xA0FA0002
0x	20	0x	20	0x	0D	0x	0A	0x20200D0A

# 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, see Fig. 18.

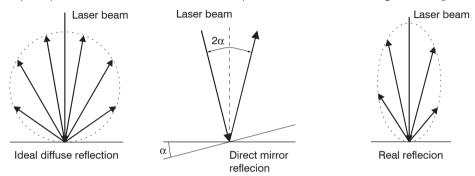


Fig. 18 Reflection factor of the target surface

A statement concerning a minimum reflectance is difficult to make, because even a small diffuse fraction can be evaluated from highly reflecting surfaces. This is done by determining the intensity of the diffuse reflection from the CCD array signal in real time and subsequent compensation for intensity fluctuation, see Chap. 3.2. Dark or shiny objects being measured, e.g. black rubber, may require longer exposure times. The exposure time is dependent on the measurement rate and can only be increased by reducing the sensor's measurement rate.

### 9.2 Error Influences

# 9.2.1 Light from other Sources

Thanks to their integrated optical interference filters the optoNCDT1302 sensors offer outstanding performance in suppressing light from other sources. However, this does not preclude the possibility of interference from other light sources if the objects being measured are shiny and if lower measurement frequencies are selected. Should this be the case it is recommended that suitable shields be used to screen the other light sources. This applies in particular to measurement work performed in close proximity to welding equipment.

#### 9.2.2 Color Differences

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

#### 9.2.3 Temperature Influences

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

#### 9.2.4 Mechanical Vibrations

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

#### 9.2.5 Movement Blurs

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

#### 9.2.6 Surface Roughness

In case of traversing measurements a surface roughness of 5  $\mu$ m and more leads to an apparent distance change (also-called surface noise). However, they can be dampened by averaging, see Chap. 6.3.

### 9.2.7 Angle Influences

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, see Fig. 19. 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 behavior in triangulation also depends on the reflectivity of the target.

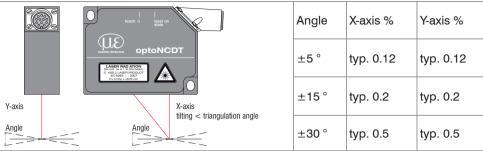
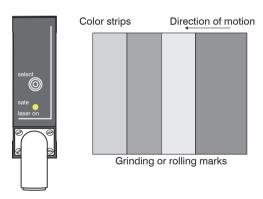


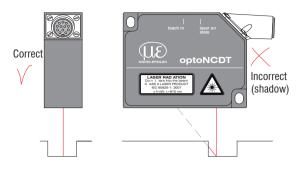
Fig. 19 Measurement errors through tilting with diffuse reflection

# 9.3 Optimizing the Measuring Accuracy



In case of rolled or polished metals that are moved past the sensor the sensor plane must be arranged in the direction of the rolling or grinding marks. The same arrangement must be used for color strips, see Fig. 20.

Fig. 20 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. 21.

Fig. 21 Sensor arrangement for holes and ridges

# 9.4 Cleaning the Protective Glasses

A periodically cleaning of the protective housings is recommended.

## Dry cleaning

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

# Wet cleaning

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

Do not use commercial glass cleaner or other cleansing agents.

# 10. Default Setting

- Current output with error value (3.75 mA)
- Interface: 115.2 kBaud, binary format (no ASCII)
- Moving average avg =1 (no averaging)
- Teach value 1: 0.0
- Teach value 2: 16368.0
- External input for scaling
- Continuous measurement output
- Output first measured value after switching on: 500 ms.
- Key lock after 5 min power on
- Settings saved into FLASH
- Measuring range:
  - 100 % FSO: I = 20 mA, digital 4055
  - 0 % FSO: I = 4 mA, digital 40
- Maximum output (101 % FSO):
   20.16 mA / digital 4095
- Minimum output (-1 % FSO): 3.84 mA / digital 0

Set sensor on default settings:

- Switch off the sensors power supply.
- Keep the "Select" key pressed.
- Switch on the sensors power supply.
- LED on sensor flashes green.
- Press again the "Select" key.
- LED flashes green three times, approx. 1 Hz.

During this time the factory parameters are set.

Then the sensor re-boots.

## 11. ILD1302 Tool

The ILD1302 Tool is an application to configure the ILD1302 sensor. In addition it supports a 1 channel data acquisition. It is for demonstration purposes only.

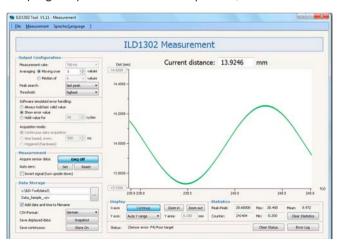
System requirements:

- Windows 2000 with SP 4 / Windows XP / Windows Vista / Windows 7
- Pentium III. 256 MB RAM
- Install the PC based program. Use the corresponding setup.exe supplied from the attached CD.
- Follow the advices during the installation.

You will find the actual drivers respectively program routines under:

www.micro-epsilon.com/link/opto/1302

This program part is evidence of acquisition, calculation and data storage of ILD1302.



If the sensor's analog output is to be used after termination of the ILD1302 tool, it previously has to be definded as output version. Do not forget to save the settings made.

 $oldsymbol{1}$  Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from power supply only.

# 12. Software Support with MEDAQLib

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

- RS422/USB converter (optional accessory) and a suitable PC1402-3/D-SUB/9pol cable or
- PC1402-3/USB/IND cable or
- IF2008 PCI interface card and PC1402-3/IF2008 cable

into an existing or a customized PC software.

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

#### **MEDAQLib**

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

You will find the latest MEDAQLib version at:

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

# 13. 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 warranted, 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.

# 14. Service, Repair

In the event of a defect on the sensor or sensor cable, the parts concerned must be sent back for repair or replacement. The opening of the sensor is only subjected to the manufacturer. In the case of faults the cause of which is not clearly identifiable, the whole measuring system must be sent back to

MICRO-EPSILON MESSTECHNIK GmbH & Co. KG Königbacher Straße 15 94496 Ortenburg / Germany

Tel. 08542/168-0 Fax 08542/168-90 e-mail info@micro-epsilon.de www.micro-epsilon.com

# 15. Decommissioning, Disposal

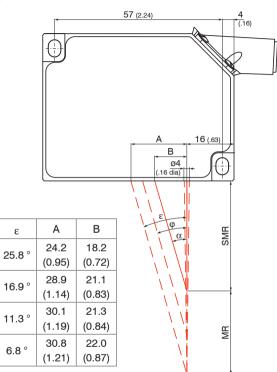
Disconnect the power supply and output cable on the sensor.

The disposal is done according to the legal regulations.

The optoNCDT1302 is produced according to the directive 2011/65/EU ("RoHS"). The disposal is done according to the legal regulations (see directive 2002/96/EC).

#### 16. **Free Space for Optics**

Not to scale. Dimensions in mm (inches).



ø6

(.24 dia)

10

MR = Measuring range

SMR

30

(1.18)

45

(1.77)

50

(2.00)

60

(2.36)

α

31.2°

25.1 °

23.1 °

20.1 °

φ

27.9°

19.6°

14.4°

9.4 °

ε

MR

20

(0.79)

50

(2.00)

100

(3.94)

200

(7.87)

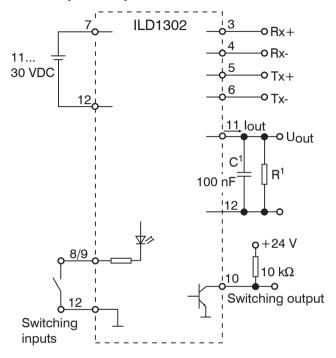
SMR = Start of measuring range

# 17. Available Cables

All cables are cable carriers suitable.

Туре	Cable length	Characteristics	
PC1402-3/I, PC1402-6/I, PC1402-8/I	3 m 6 m 8 m	Interface and supply cable for current output, one end of the cable has a molded M12 female connector, the other end has free leads with ferrules.	
PC1402-3/U, PC1402-6/U, PC1402-8/U	3 m 6 m 8 m	Interface and supply cable for voltage output (250 Ohm load, U $_{\rm out}=1\dots5$ V), one end of the cable has a molded M12 female connector, the other end has free leads with ferrules.	
PC1402-3/USB/IND PC1402-8/USB/IND	3 m 8 m	Power and output cable, one end of the cable has a molded M12 female connector, the other end a 9 pol D-SUB for RS422/USB converter and open leads; a RS422/USB converter is not enclosed.  Disconnect or connect the D-sub connection between RS422 and USB converter when the sensor is disconnected from the power supply only.	
PC1402-3/CSP, PC1402-8/CSP, PC1402-10/CSP	3 m 8 m 10 m	Connecting cable with straight connector on both sides to connect an ILD1302 sensor to a CSP2008	
PC1402-3/IF2008, PC1402-6/IF2008, PC1402-8/IF2008	3 m 6 m 8 m	Connecting cable, one end of the cable has a molded M12 female connector, the other end a D-SUB to connect an ILD1302 sensor to an IF2008 PCI interface card	

# 18. Input /Output Circuit



1) Components contained in PC 1402-x/U; are required for voltage output.

 $\begin{aligned} R &= 250~\Omega : U_{\text{OUT}} 1~...~5~V \text{ with } U_{\text{B}} > 11~V \\ R &= 500~\Omega : U_{\text{OUT}} 2~...~10~V \text{ with } U_{\text{B}} > 17~V \end{aligned}$ 

# **Appendix**

The system ground must be connected with the terminal ground (USB converter, pin 5) before connecting the RX and TX lines.

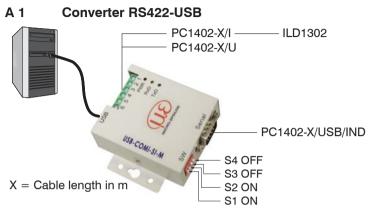


Fig. 22 Principle setup

Cross the lines for connections between sensor and PC.

ILD 130	2	Converter	
Signal	Color PC1402-X/I PC1402-X/U	Signal	Pin
RX-	Yellow	TX-	1
RX+	green	TX+	2
TX+	gray	RX+	3
TX-	pink	RX-	4
GND (Pin 12)	blue	Ground	5

Fig. 23 Pin assignment and wiring

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



MICRO-EPSILON MESSTECHNIK GmbH & Co. KG Königbacher Str. 15 · 94496 Ortenburg / Germany Tel. +49 (0) 8542 / 168-0 · Fax +49 (0) 8542 / 168-90 info@micro-epsilon.de · www.micro-epsilon.com

X9751212-A101014GBR
© MICRO-EPSILON MESSTECHNIK

