MICRO-EPSILON

Operating Instructions

optoNCDT 1320

ILD1320-10	ILD1320-100
ILD1320-25	ILD1320-200
ILD1320-50	ILD1320-500

Intelligent laser-optical displacement measurement

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Contents

1 Safety

1.1 Symbols used

System operation assumes knowledge of the operating instructions.

The following symbols are used in these operating instructions:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation that may result in property damage if not avoided.
►	Indicates a user action.
i	Indicates a tip for users.
`Measurement`	Indicates hardware or a software button/menu.

1.2 Warnings

Do not expose yourself to unnecessary laser radiation.

- ► Switch off the sensor for cleaning and maintenance.
- ► Switch off the sensor for cleaning and maintenance if the sensor is integrated into a system.

Caution - the use of controls or settings or the performance of procedures not specified in the operating instructions may cause damage.

⚠ CAUTION

Connect the power supply according to the regulations for electrical equipment.

- Risk of injury
- Damage to or destruction of the sensor

NOTICE

Avoid knocks and impacts to the sensor.

- Damage to or destruction of the sensor

Only attach the sensor to the existing mounting holes/threaded holes on a flat surface; clamping of any kind is not permitted.

- Damage to or destruction of the sensor

The supply voltage must not exceed the specified limits.

- Damage to or destruction of the sensor

Protect the sensor cable from damage. Attach the cable load-free, catch the cable after approx. 25 cm and catch the pigtail on the plug, e.g. with cable ties.

- Destruction of the sensor
- Failure of the measuring device

Avoid constant exposure of the sensor to splashes of water.

- Damage to or destruction of the sensor

Avoid exposure of sensor to aggressive media (detergents, cooling emulsions).

- Damage to or destruction of the sensor

1.3 Notes on product marking

1.3.1 CE marking

The following apply to the product:

- Directive 2014/30/EU ("EMC")
- Directive 2011/65/EU ("RoHS")

Products which carry the CE marking satisfy the requirements of the EU Directives cited and the relevant applicable harmonized European standards (EN).

The product is designed for use in industrial and laboratory environments.

The EU Declaration of Conformity and the technical documentation are available to the responsible authorities according to the EU Directives.

1.3.2 UKCA marking

The following apply to the product:

- SI 2016 No. 1091 ("EMC")
- SI 2012 No. 3032 ("RoHS")

Products which carry the UKCA marking satisfy the requirements of the directives cited and the relevant applicable harmonized standards.

The product is designed for use in industrial and laboratory environments.

The UKCA Declaration of Conformity and the technical documentation are available to the responsible authorities according to the UKCA Directives.

1.4 Intended use

The optoNCDT 1320 is designed for use in industrial and laboratory applications.

It is used for

- Displacement, distance, position and thickness measurements
- Monitoring Quality and Checking Dimensions

The sensor must only be operated within the values specified in the technical data .

The sensor must be used in such a way that no persons are endangered and no machines or other physical items of property are damaged in the event of malfunction or total failure of the sensor.

Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper environment

Protection class:	IP67 (only applies when the sensor cable is connected)

i The protection class is limited to water (no penetrating liquids, detergents, or similar aggressive media).

Optical windows are excluded from the protection class. Contamination of the windows causes impairment or failure of the function.

Temperature range:	
- Operation:	0 ... +50 °C
- Storage:	-20 ... +70 °C
Humidity:	5 ... 95 % RH (non-condensing)
Ambient pressure:	Atmospheric pressure

2 Laser safety

The sensor works with a semiconductor laser at a wavelength of 670 nm (visible/red).

The sensors fall within laser class 2. The laser is operated in pulsed mode, the maximum optical power is ≤1 mW. The pulse frequency depends on the set measuring rate (0.25 ... 4 kHz). The pulse duration of the peaks is controlled depending on the measuring rate and the reflectivity of the object being measured and can be 0.3 ... 3999.6 µs.

CAUTION
Laser radiation Eyes could become irritated or damaged. Close your eyes, or immediately turn away if the laser beam hits the eye.

i Observe the national laser protection regulations.

Relevant regulations must be observed when operating the sensors. The following apply accordingly:

- With class 2 laser devices, the eye is not endangered by random, brief exposure to laser radiation, i.e. exposure times of up to 0.25 s.
- Class 2 laser devices may therefore be used without further protective measures if you do not intentionally look into the laser beam or into specular-reflected radiation for more than 0.25 s.
- Because the presence of the eyelid protective reflex should not normally be assumed, one should deliberately close the eyes or turn away immediately if the laser beam hits the eye.

Lasers of Class 2 are not subject to notification and a laser protection officer is not required.

The two laser warning signs (German / English) are attached to the sensor cable:

Fig. 2.1: Laser warning signs on the sensor cable

Fig. 2.2: Laser warning sign on the sensor housing

i If both information signs are covered over when the unit is installed, the user must ensure that supplementary information signs are attached at the installation location.

Operation of the laser is indicated visually by the LED on the sensor, see Chap. 5.3.

The housings of the optical sensors may only be opened by the manufacturer, see Chap. 11.

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

Observe national regulations, e.g., the German Occupational Health and Safety Ordinance on Artificial Optical Radiation (OStrV).

Recommendations for the operation of sensors that emit laser radiation in the visible or non-visible range can be found in DIN EN 60825-1 (from 07/2022), among others.

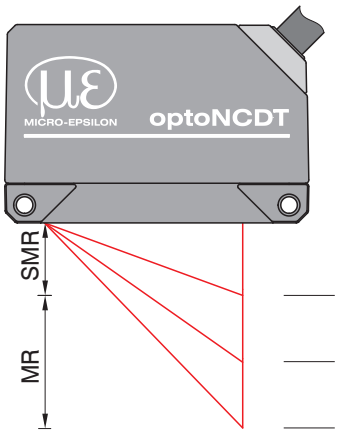
3 Functional principle, technical data

3.1 Brief description

The optoNCDT 1320 operates according to the principle of optical triangulation, i.e. a visible, modulated light spot is projected onto the surface of the measuring object.

The diffuse part of the reflection of this light spot is imaged on a spatial resolution element (CMOS) by a receiver optic arranged at a certain angle to the optical axis of the laser beam.

A signal processer in the sensor calculates the distances between the light spot on the target and the sensor from the output signal of the CMOS element. The distance value is linearized and output via the analog or RS422 interface.



Current output	Digital value
3 mA	262077
4 mA (SMR)	643
12 mA (MMR)	32765
20 mA (EMR)	64887
3 mA	262078

The digital values apply to distance values without zeroing or mastering.

MR = Measuring range
SMR = Start of measuring range
MMR = Mid of measuring range
EMR = End of measuring range

3.2 Auto Target Compensation (ATC)

The Auto Target Compensation (ATC) ensures stable regulation regardless of the color and brightness of the measured object. Thanks to the small measurement spot, even the smallest objects can be reliably detected.

3.3 Technical data

Model	ILD1320-10	ILD1320-25	ILD1320-50	ILD1320-100	ILD1320-200	ILD1320-500
Measuring range	10 mm	25 mm	50 mm	100 mm	200 mm	500 mm
Start of measuring range	20 mm	25 mm	35 mm	50 mm	60 mm	100 mm
Mid of measuring range	25 mm	37.5 mm	60 mm	100 mm	160 mm	350 mm
End of measuring range	30 mm	50 mm	85 mm	150 mm	260 mm	600 mm
Measuring rate [1]	5 adjustable stages: 4 kHz / 2 kHz / 1 kHz / 0.5 kHz / 0.25 kHz					
Linearity [2]	< ±10 µm	< ±25 µm	< ±50 µm	< ±100 µm	< ±200 µm	< ±600 µm … ±1200 µm
	< ±0.10 % FSO					< ±0.12 … ±0.24 % FSO
Repeatability [3]	1 µm	2.5 µm	5 µm	10 µm	20 µm	50 µm

[1] Factory setting 2 kHz, modifying the factory setting requires the IF2001/USB converter (see accessories)

[2] FSO = Full Scale Output; the specified data apply to white, diffuse reflecting surfaces (Micro-Epsilon reference ceramic for ILD sensors)

[3] Measuring rate 1 kHz, median 9

Model		ILD1320-10	ILD1320-25	ILD1320-50	ILD1320-100	ILD1320-200	ILD1320-500
Temperature stability [4]		±0.015 % FSO / K			±0.01 % FSO / K		
Light spot diameter [5]	SMR	100 x 130 µm	200 x 260 µm	250 x 340 µm	710 x 910 µm	710 x 910 µm	710 x 910 µm
	MMR	45 x 50 µm	55 x 60 µm	80 x 95 µm			
	EMR	158 x 200 µm	255 x 330 µm	300 x 380 µm			
	smallest Ø	45 x 40 µm with 24 mm	53 x 60 µm with 31 mm	70 x 85 µm with 42 mm	710 x 910 µm	710 x 910 µm	710 x 910 µm
Light source		Semiconductor laser < 1 mW, 670 nm (red)					
Laser class		Class 2 in accordance with IEC 60825-1: 2014					
Permissible ambient light [6]		30,000 lx			20,000 lx	7,500 lx	
Supply voltage		24V (11,2 … 30V) DC, P < 2W					
Power consumption		< 2 W (24 V)					
Signal input		1 x HTL laser on/off; 1 x HTL multifunction input: trigger in, zero setting, teach					
Digital interface [7]		RS422 (16 bit) / EtherCAT / PROFINET / EtherNet/IP					
Analog output		4 ... 20 mA (16 bit, freely scalable within the measuring range)					
Digital outputs		1 x error output: npn, pnp, push pull, push-pull negative					
Connection		integrated cable 3 m, open ends, minimum bending radius 30 mm (fixed installation)					
Mounting		Screw connection via two mounting holes					
Temperature range	Storage	-20 … +70 °C (non-condensing)					
	Operation	0 … +50 °C (non-condensing)					
Shock (DIN EN 60068-2-27)		15 g / 6 ms in 3 axes, 1000 shocks each					
Vibration (DIN EN 60068-2-6)		20 g / 20 … 500 Hz in 3 axes, 2 directions and 10 cycles each					
Protection class (DIN EN 60529)		IP67					
Material		Aluminum housing					
Weight		approx. 40 g (without cable), approx. 150 g (incl. cable)					
Control and indicator elements [8]		Select button: zero, teach, factory settings; web interface for setup with defined presets; 2 x color LEDs for power / status					

[4] The specified value is only achieved by mounting on a metallic sensor holder. Good heat dissipation from the sensor to the holder must be ensured.

[5] ±10 %; SMR = Start of measuring range; MMR = Mid of measuring range; EMR = End of measuring range

[6] Illuminant: light bulb

[7] For EtherCAT, PROFINET and EtherNet/IP, connection via interface module is required (see accessories)

[8] Access to web interface requires connection to PC via IF2001/USB (see accessories)

4 Delivery

4.1 Unpacking, included in delivery

- 1 ILD1320 sensor
- 1 Setup guide
- 1 digital calibration protocol accessible via web interface
- Accessories (2x M2 screws and 2 washers)

► Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.
► Check the delivery for completeness and shipping damage immediately after unpacking.
► If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Optional accessories are listed in the appendix.

Return of packaging

Micro-Epsilon Messtechnik GmbH & Co. KG offers customers the opportunity to return the packaging of products purchased from Micro-Epsilon by prior arrangement so that it can be reused or recycled.

To arrange the return of packaging, for questions about the costs and / or the exact return procedure, please contact us directly at

info@micro-epsilon.de

4.2 Storage

Temperature range:	-20 ... +70 °C
Humidity:	5 ... 95 % RH (non-condensing)

4.3 Structure of the serial number

Sensors in a new design have an extended measuring rate, a higher resolution D/A converter and an improved protection class , see Chap. 3.3. They can be recognized by the serial number with the following structure:

- 10xxxxxx = ILD1320-10, ILD1320-25, ILD1320-50
- 40xxxxxx = ILD1320-100, ILD1320-200, ILD1320-500

Serial numbers for sensors with the old design can be recognized by the following structure: JJMMxxxx (J = year, M = month)

5 Installation

5.1 Notes on operation

5.1.1 Reflectance of target surface

In principle, the sensor evaluates the diffuse portion of the reflections of the laser light spot.

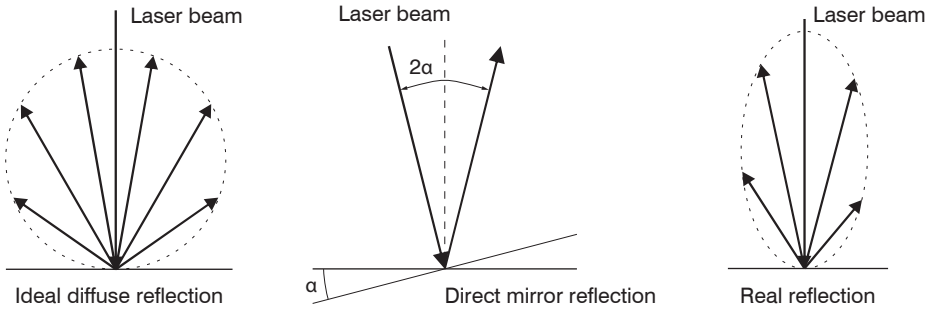


Fig. 5.1: Reflectance of target surface

Any statement about a minimum reflection factor is only possible with reservations, since small diffuse portions can be evaluated even of reflecting surfaces. This is done by determining the intensity of the diffuse reflection from the CMOS signal in real time and then controlling, see Chap. 3.2 However, a longer exposure time may be required for dark or shiny objects, such as black rubber. The exposure time is coupled to the measuring rate and can only be increased by lowering the measuring rate of the sensor.

5.1.2 Interferences

5.1.2.1 Ambient light

The sensors are very good at suppressing ambient light thanks to their built-in optical interference filter. However, ambient light disturbances can occur with shiny measuring objects and at a reduced measuring rate. In these cases it is recommended to provide shielding against ambient light. This applies in particular to measurement work performed in the vicinity of welding devices.

5.1.2.2 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 changes in combination with penetration depth changes may lead to measurement uncertainties.

5.1.2.3 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 µm accuracy range, the effect of temperature fluctuations on the sensor holder must be considered.

Rapid temperature changes are not detected immediately due to the damping effect of the sensor's heat capacity.

5.1.2.4 Mechanical vibrations

If resolutions in the µm range are to be achieved with the sensor, particular attention must be paid to stable or vibration-damped sensor and target mounting.

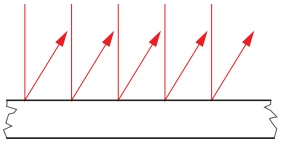
5.1.2.5 Movement blur

If the objects being measured are fast moving and the measuring rate is low, it is possible that movement blurs may result. Therefore, always select a high measuring rate for high-speed operations to prevent errors.

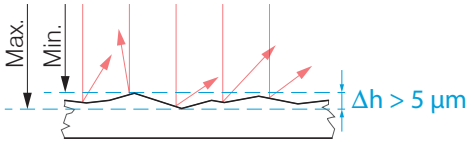
5.1.2.6 Surface Roughness

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

A suitable averaging number can improve the comparability of the optical and mechanical measurements.



Ceramic reference surface



Structured surface

Recommendation for parameter choice:

Select the averaging number so that a comparably large surface area is averaged as for the mechanical measurement.

5.1.2.7 Angular influences

Target tilt angles around both the X and y-axis of less than 5° in the case of diffuse reflection only cause problems with surfaces that produce strong direct reflection.

These influences are particularly important when scanning profiled surfaces. In principle, angular behavior during triangulation is also affected by the reflectivity of the target surface.

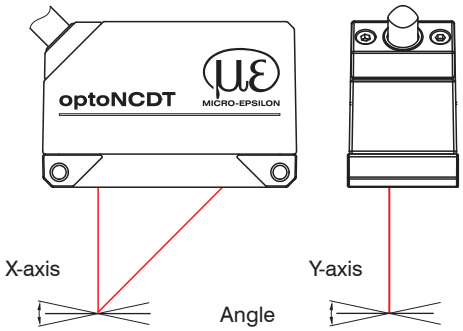


Fig. 5.2: Measurement error caused by tilt angle with diffuse reflection

5.1.3 Optimization of measurement accuracy

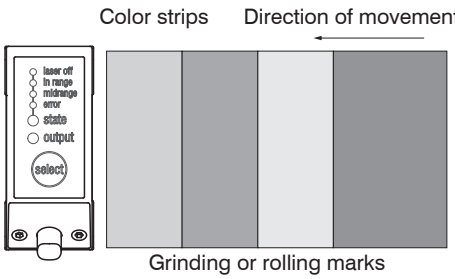


Fig. 5.3: Sensor arrangement for sanded or striped surfaces

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.

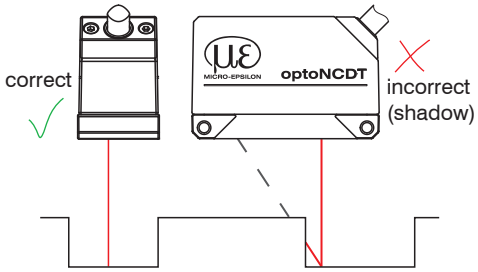


Fig. 5.4: Sensor arrangement for holes and edges

In case of bore holes, blind holes and edges in the surface of moving parts, the sensor must be arranged in such a way that the edge does not obscure the laser spot.

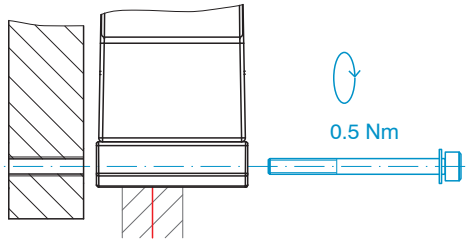
5.2 Mechanical fastening, dimensional drawing

The sensor is an optical system that measures in the µm range. If the laser beam does not strike the object surface at a perpendicular angle, measurements might be inaccurate.

i Ensure careful handling during installation and operation.

► Mount the sensor using 2 M3 screws or the through bores for M2 with the screws from the accessories.

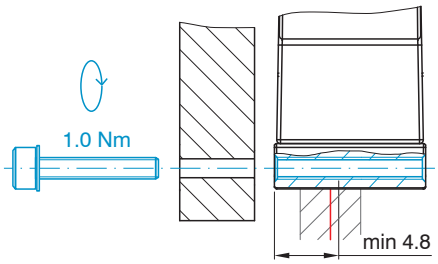
Through-bolt connection



Through-bolt length	Screw-in depth	Screw	Washer	Tightening torque per screw
	Minimum	ISO 4762-A2	ISO 7089-A2	μ = 0.12
mm	mm	2 pieces		Nm
20	5.0	M2 x 25	A2.2	0.5

Tab. 5.1: Mounting conditions for through-bolt connection

Direct fastening



Screw-in depth		Screw	Tightening torque per screw
Minimum	Maximum	ISO 4762-A2	μ = 0.12
mm	mm	2 pieces	Nm
4.8	8.5	M3	1.0

Tab. 5.2: Mounting conditions for direct fastening

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

i Mount the sensor only to the existing through-bores on a flat surface. Any type of clamping is not permitted. Do not exceed torques.

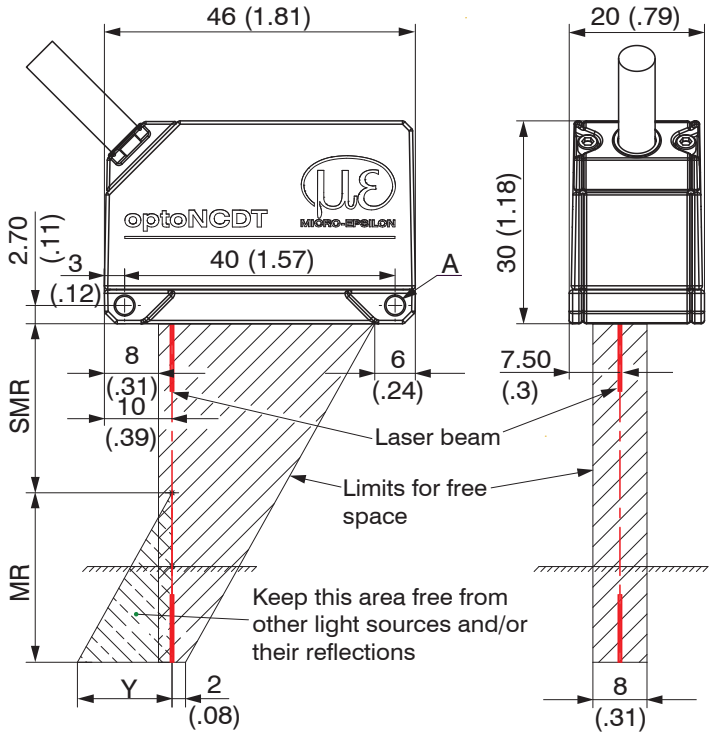


Fig. 5.5: Dimensional drawing, optical clearance

The indicated free space in the reception area, must be kept free of foreign objects and ambient light from other laser sensors at least until the end of the measuring range.

MR = Measuring range
SMR = Start of measuring range
MMR = Mid of measuring range
EMR = End of measuring range
FSO = Full Scale Output

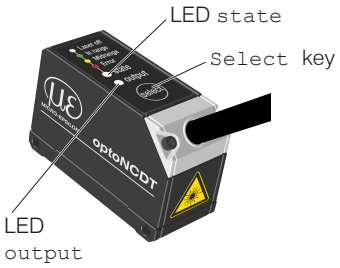
A: 2x M3 for direct fastening or 2x M2 as through-bore for through-bolt connection

ILD1320-		10	25	50	100	200	500
MR	mm	10	25	50	100	200	500
SMR	mm	20	25	35	50	60	100
EMR	mm	30	50	85	150	260	600
Y	mm	10	21	28	46	70	190

MR = Measuring range
SMR = Start of measuring range
MMR = Mid of measuring range
EMR = End of measuring range
FSO = Full Scale Output

5.3 Control and indicator elements

State LED	Meaning
green	Target within the measuring range
yellow	Measuring object in the mid of the measuring range
red	Error, e.g. measuring object outside the measuring range, reflection too low
Off	Laser switched off
Output LED	**Meaning**
green	RS422 measured value output
yellow	The current output is switched off (data output `Web interface`).
red	Measured value output current 4 ... 20 mA
Off	Sensor off, no supply



The programmable `Select` button calls up the `Reset`, `Teach` or `Zero setting` functions. In the factory settings, the `Select` button is only active 5 minutes after the supply voltage is switched on. It is then automatically locked.

5.4 Electrical connections

5.4.1 Connection possibilities

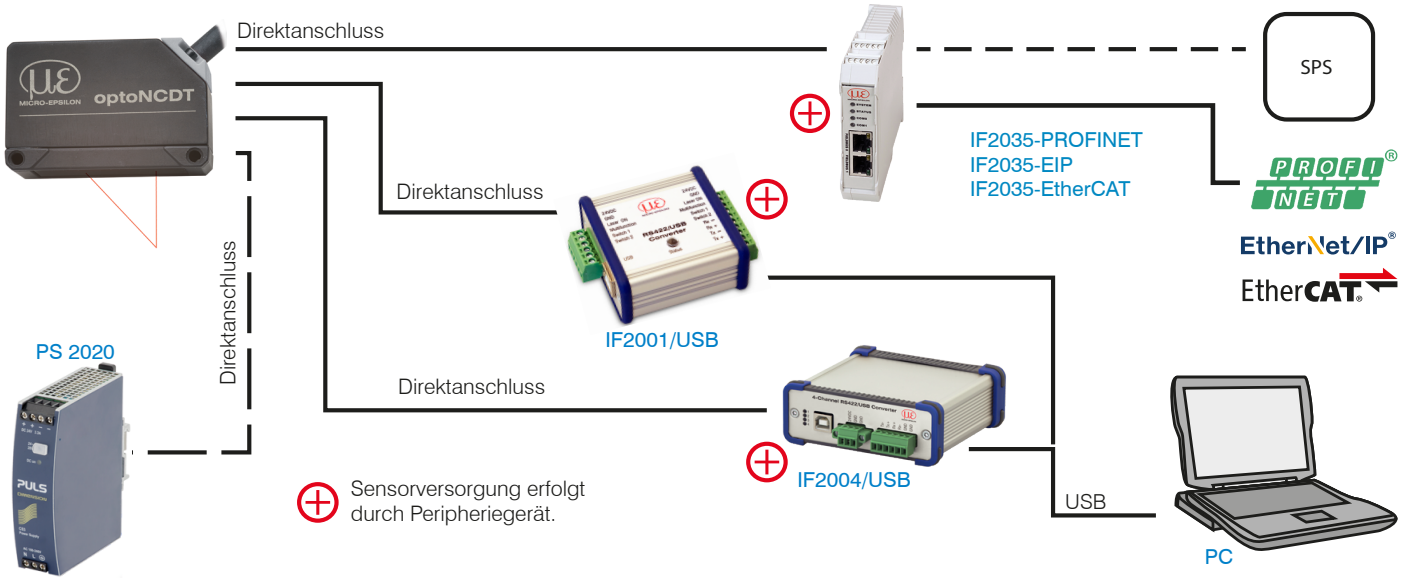


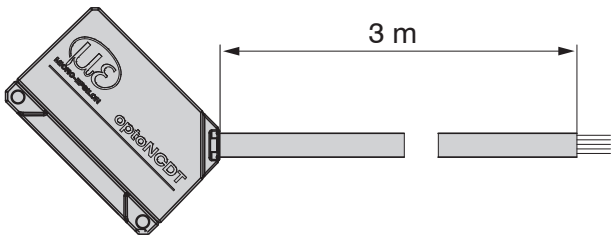
Fig. 5.6: Connection example ILD1320

The periphery devices can be connected to the connection braids. The IF2001/USB converter also provides the supply voltage (24 VDC) for the sensor. The converter is powered, for example, by the optionally available PS 2020 power supply unit.

Periphery device	Sensor channels	Application/end device
IF2001/USB, RS422-USB converter	one	PC
IF2004/USB	one	PC
IF2035-PROFINET / -EtherNet/IP / -EtherCAT	one	PLC
PLC, ILD1320 or similar	---	Function input: Trigger
Button, key, PLC and the like	---	Laser On/Off switching input

Tab. 5.3: Max. sensor channels on the periphery devices

5.4.2 Pin assignment



The shielding of the cable is connected to the sensor housing. The sensor cable is not qualified for drag chain use. One end is molded onto the sensor, the other end has braids with ferrules.

Fig. 5.7: ILD1320 with open ends

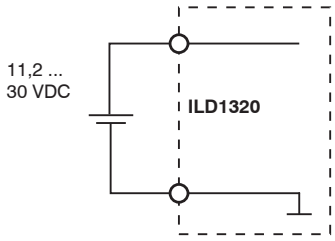
Signal	Wire color Sensor cable	Explanation	Comments, circuitry
RS422 Rx+	Green	Serial input	Internally terminated with 120 ohms
RS422 Rx-	Yellow		
RS422 Tx+	Gray	Serial output	Terminate with 120 ohms at the receiver
RS422 Tx-	Pink		
V_+	Red	Operating voltage	11.2 ... 30 VDC, typ. 24 VDC, $P < 2$ W

Signal	Wire color Sensor cable	Explanation	Comments, circuitry
Laser on/off	Black	Switching input	Laser active when the input is connected to GND
Function input	Violet		Trigger, zero, teaching
Error	Brown	Digital outputs	I_{max} = 100 mA, U_{max} = 30 VDC Switching behavior programmable: (NPN, PNP, push-pull, push-pull negated)
I_{OUT}	White	4 ... 20 mA	R_{load} = 250 ohm results in U_{OUT} 1 ... 5 V for V_+ > 11.2 V R_{load} = 500 ohm results in U_{OUT} 2 ... 10 V for V_+ > 17 V
GND	Blue	Reference ground	Supply and signal ground
Connector housing	Shield	Sensor housing	Connect to potential equalization

5.4.3 Supply voltage

Nominal value: 24 VDC (11.2 ... 30 V, P < 2 W).

- ► Only turn on the power supply after wiring has been completed.
- ► Connect the "red" and "blue" wires on the sensor to a 24 V power supply.



Wire color	Power supply
Red	V_+
Blue	Ground

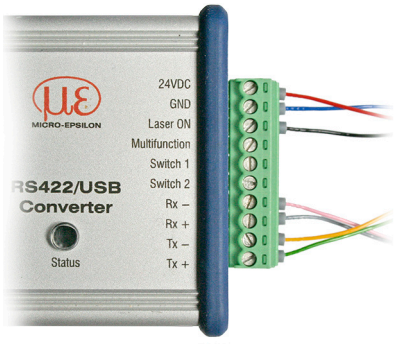
Tab. 5.4: Supply voltage connection

Voltage supply only for measuring devices, not to be used for drives or similar sources of impulse interference at the same time. MICRO-EPSILON recommends using the optionally available PS2020 power supply unit for the sensor.

5.4.4 RS422 connection with USB converter IF2001/USB

For the connection between sensor and PC, the lines must be crossed.

Sensor		Terminal device (Converter) type IF2001/USB from Micro-Epsilon
Signal	Sensor cable	
GND	Blue	GND
Tx -	Pink	Rx -
Tx +	Gray	Rx +
Rx -	Yellow	Tx -
Rx +	Green	Tx +



Symmetric differential signals acc. to EIA-422, not electrically isolated from supply voltage.
Use a shielded cable with twisted wires.

Tab. 5.5: Pin assignment IF2001/USB

5.4.5 Turning on the Laser

The measuring laser on the sensor is switched on via an HTL switching input. This is advantageous when it comes to switching the sensor off for maintenance work or the like. Both a switching transistor with an open collector (for example in an optocoupler) and a relay contact are suitable for switching.

i The laser remains switched off as long as the black and blue wires are not electrically connected.

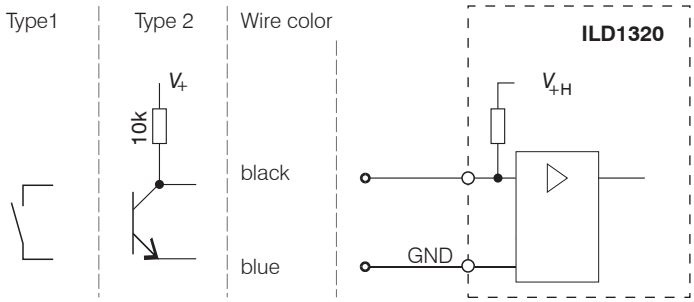


Fig. 5.8: Basic circuit for switching on the laser

An external resistor is not required for current limitation. For permanent "Laser on", the "Black" and "Blue" wires must be connected.

Response time: The sensor needs approx. 1 ms until correct measurement data is sent after the laser is switched on again.

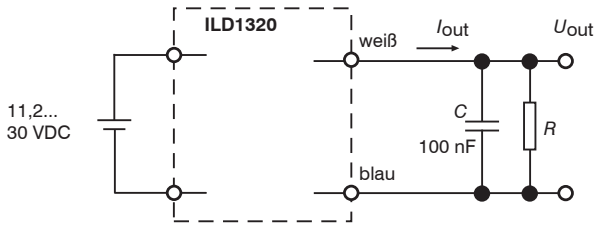
5.4.6 Analog output

The sensor provides a current output of 4 ... 20 mA.

i	The current output must not be used continuously in short-circuit operation without a load. Continuous short-circuit operation leads to thermal overloading and thus causes the output to switch off automatically.

► Connect the "white" and "blue" wires on the sensor to a measuring device.

Sensor	
Signal	**Sensor cable**
I_{OUT}	White
GND	Blue

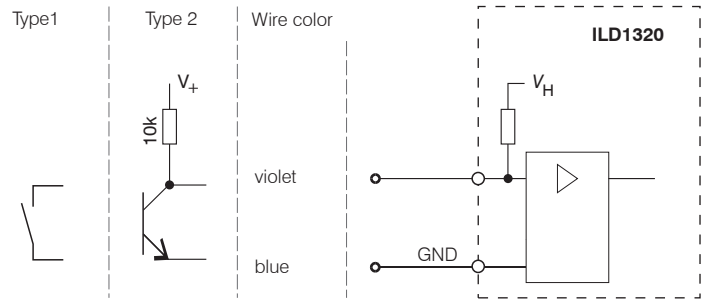


With the adjacent circuit, you receive an analog voltage at the output in the range from 1 ... 5 V.
R = 250 ohm:
U_{OUT} 1 ... 5 V at U_B > 11.2 V
R = 500 ohm:
U_{OUT} 2 ... 10 V at U_B > 17 V

Tab. 5.6: Wiring for voltage output

5.4.7 Multifunction input

The multifunction input enables triggering, zeroing/mastering and teaching. The function depends on the programming of the input and on the timing of the input signal.



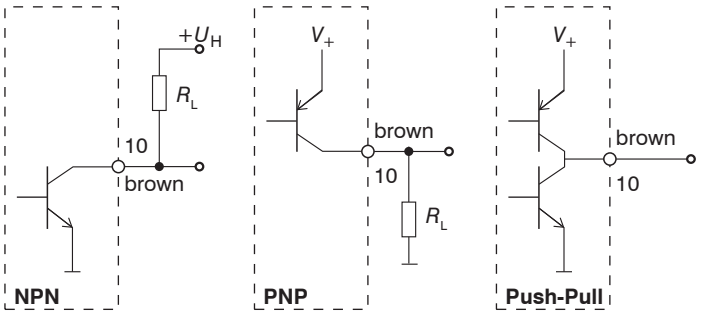
Input is not electrically separated.
24V logic (HTL):
Low level ≤ 2 V
High level ≥ 8 V (max 30 V)
Internal pull-up resistor, an open input is detected as High.
Connect the input to GND to trigger the function.

Fig. 5.9: Basic circuit for multifunction input

5.4.8 Digital outputs

The switching behavior (NPN, PNP, push-pull, push-pull negated) of the switching output (error) depends on the programming.

The NPN output is suitable, for example, for adaptation to TTL logic with an auxiliary voltage V_H = +5 V. The switching output is protected against polarity reversal, overload (< 100 mA) and excessive temperature.



Output is not electrically separated.
24V logic (HTL),
I_{max} = 100 mA,
$V_{H, max}$ = 30 V saturation voltage at
I_{max} = 100 mA:
Low < 2.5 V (output - GND),
High < 2.5 V (output - V_+)

Fig. 5.10: Basic circuit for switching output

Switching behavior		
Designation	**Output active (error)**	**Output passive (no error)**
NPN (Low side)	GND	approx. V_H
PNP (High side)	V_+	approx. GND
Push-pull	V_+	GND
Push-pull, negated	GND	V_+

Tab. 5.7: Switching output behavior

Activates the switching output when there is no measuring object, when the object is too close/far or when no valid measurement value can be determined.

5.4.9 Sensor cable

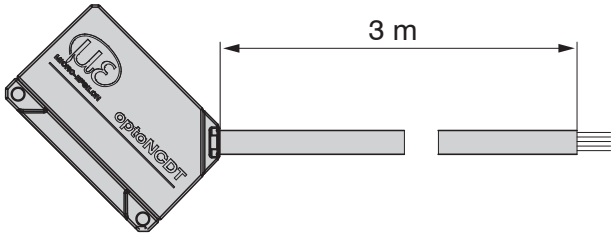


Fig. 5.11: ILD1320 with open ends

- ► Do not bend the sensor cable more tightly than 30 mm (immovably routed) or 60 mm (movable).

i	The permanently connected sensor cables are not suitable for drag chains.

i	Unused open cable ends must be insulated or bluntly cut to protect against short circuits or sensor malfunctions.

- ► Avoid excessive pull on the cables. If a cable of over 5 m in length is used and it hangs vertically without being secured, make sure that some form of strain relief is provided close to the connector.
- ► Connect the cable shield to the potential equalization (PE, protective earth conductor) on the evaluator (control cabinet, PC housing) and avoid ground loops.
- ► Never lay signal lines next to or together with power cables or pulse-loaded cables (e.g., for drives or solenoid valves) in a single bundle or duct. Always use separate ducts.

Recommended strand cross-section for self-made connection cables: ≥ 0.14 mm².

6 Operation

6.1 Getting Ready for Operation

- Mount the sensor according to the installation instructions, see Chap. 5.
- Connect the sensor to downstream display or monitoring units and the power supply.

The laser diode in the sensor is only activated when the black wire is connected to the blue wire at the Laser on/off input, see Chap. 5.4.5.

After switching on the supply voltage, the sensor runs through an initialization sequence. This is indicated by the momentary activation of all LEDs. After initialization has been completed, the sensor sends a "->" via the RS422 interface. Initialization takes a maximum of 10 seconds.

During this time, only the `Reset` or `Bootloader` command is executed via the `Select` button.

The sensor requires a warm-up time of typically 20 minutes for reproducible measurements.

If the `Output` LED is off, no power is being supplied.

If the `State` LED is off, the laser light source is switched off.

6.2 Parameterization via web interface

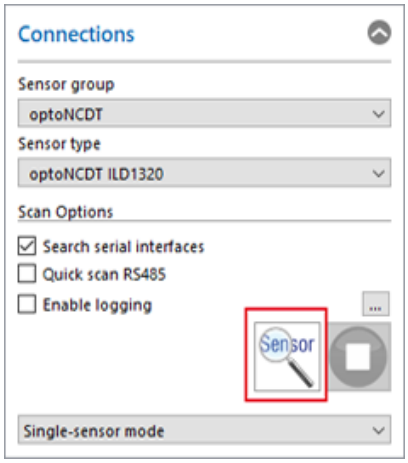
6.2.1 Requirements

A web server is implemented in the sensor; the web interface contains, among other things, the current settings of the sensor and the peripherals. Operation is only possible as long as there is an RS422 connection to the sensor. The sensor is connected to a PC/notebook via an RS422 converter, the supply voltage is applied.

`sensorTOOL` by Micro-Epsilon is software that you can use to apply settings to the sensor and to view and document measurement data.

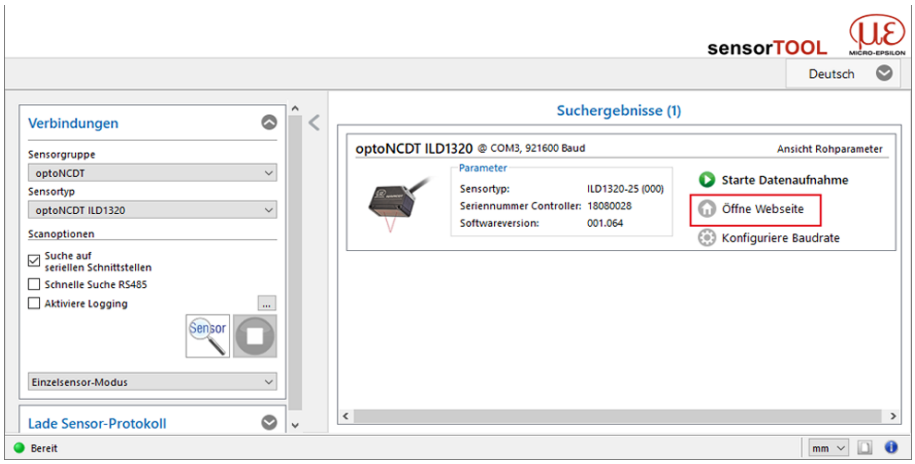
You can find these online at https://www.micro-epsilon.de/fileadmin/download/software/sensorTOOL.exe.

- Start the `sensorTOOL` program.



- Click on the Sensor button.

The program searches for connected sensors of the ILD1320 series on the available interfaces.



You need a web browser compatible with HTML5 on a PC/notebook.

► Select a desired sensor. Click the `Open Website` button.

6.2.2 Access via web interface

► Start the sensor's web interface.

Interactive web pages for configuring the sensor now appear in the web browser.

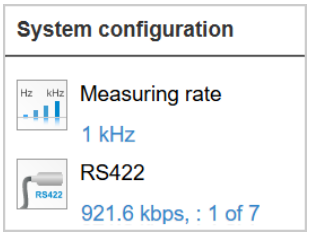
The appearance of the web sites can change depending on the functions. Each page contains parameter descriptions and tips on completing the web page.

The sensor is active and supplies measurement values.

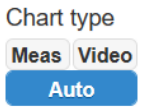
Fig. 6.1: Home page of web interface

- `Search settings` permits quick access to functions and parameters.
- `Home`: The web interface automatically starts in this view with measurement chart, `System configuration` and `Signal quality`. .
- `Settings`: This menu includes all sensor parameters.
- `Measurement chart`: Measurement chart with digital signal or video signal display. .
- `Info`: Includes information about the sensor, such as serial number, software status and an overview of sensor parameters.
- Web interface language selection

i Depending on the selected measuring rate and the PC used, measured values may be reduced dynamically in the display. This means that not all measured values are sent to the web interface for display and saving.

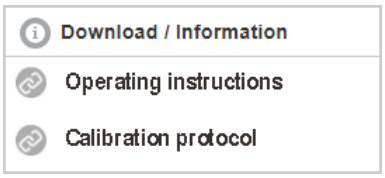


The `System configuration` section in the Home tab shows the current settings for the Measuring rate and the RS422 interface in blue.



The `Chart type` section enables you to switch between the graphical presentation of a measurement value and the video signal.

6.2.3 Calibration protocol



In the menu item `Info`, you will find the calibration protocol for download under `Download / Information`.

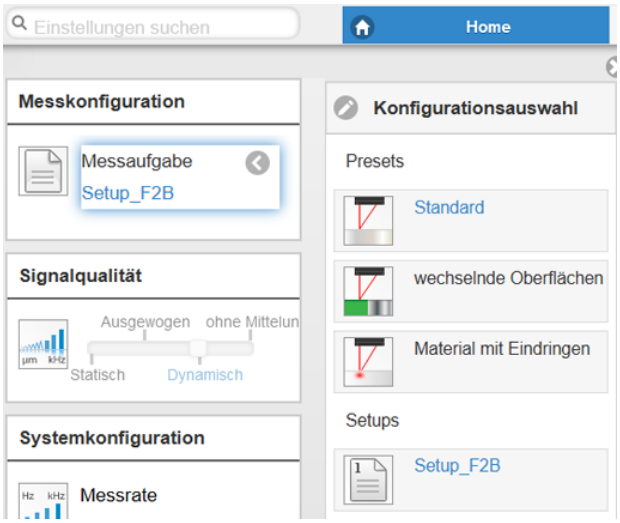
6.3 Presets, setups, selection of measurement configuration

6.3.1 Definition

- Preset: Manufacturer-specific program with settings for frequent measurement tasks; cannot be overwritten.
- Setup: User-specific program with relevant settings for a measurement task.
- Initial setup at boot (sensor start): a favorite can be selected from the setups, which is automatically activated at sensor start. If no favorite is determined from the setups, the sensor activates the Standard preset at startup.

Upon delivery of the sensor from the factory

- the presets *Standard*, *Multi-Surface* and *Light Penetration* are possible
- no setups are available.



You can select a preset in the tab

- `Home > Measurement configuration`

You can select a setup in the tab

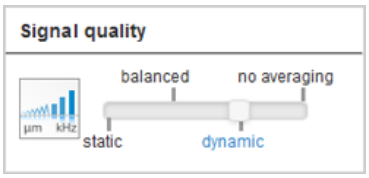
- `Home > Measurement configuration` or
- `Settings > System settings > Load & Save > Saved measurement settings`

A maximum of 8 setups can be permanently stored in the controller.

Tab. 6.1: Extract from the web interface, Home tab

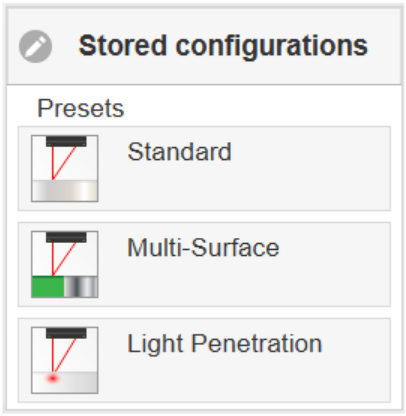
For all presets, the averaging can be individually adapted to the measurement task via the `Signal quality` slider.

i If the sensor starts up with a user-defined measurement setting (setup), see Chap. 7.6.4, the signal quality cannot be changed.



Averaging	Description
Static Moving, 128 values	In the `Signal quality` section you can switch between four predefined basic settings (static, balanced, dynamic and without averaging). The reaction in the chart and the system configuration is immediately visible.
balanced Moving, 64 values	
dynamic Median, 9 values	
without averaging	

These presets enable quick startup of the respective measurement task. Selecting a preset which is suitable for the target surface activates a predefined configuration of settings that will produce the best results for the material selected.



Selection of configuration	
Standard	Ceramics, metals
Multi-Surface [9]	PCBs, hybrid materials
Light Penetration [9]	Plastics (Teflon, POM), materials with strong laser penetration depth

i i After programming, save all settings permanently to a parameter set so that they will be available again the next time you switch on the sensor. To do this, use the `Save settings` button.

6.3.2 Display of measurement values in the web browser

► Use the `Measurement chart` tab to display the measured values.

[9] Available for the ILD1320-10/25/50 sensor models.

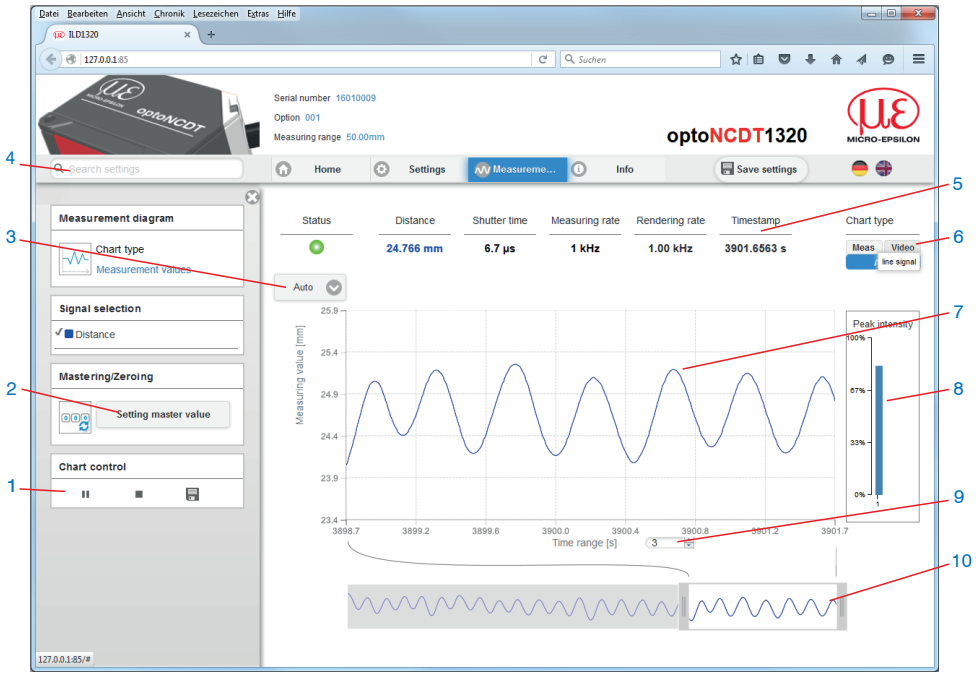


Fig. 6.2: Website Meas (distance measurement)

1 `Stop` halts the diagram; data selection and the zoom function are still possible.
`Pause` or `Start` pauses or starts recording.
`Save` opens the Windows selection dialog for the file name and storage location to save the last 10,000 values in a CSV file (separation using semicolon).

2 This function starts or stops a relative measurement. The master value can also be defined here in a submenu.

3 To scale the measurement value axis of the graph (y-axis), you can use `Auto` (= automatic scaling) or `Manual` (= manual scaling).

4 The search function permits time-saving access to functions and parameters.

5 The text boxes above the graph display the current values for distance, exposure time, current measuring rate, display rate, and timestamp.

6 Selecting a chart type. In `Auto` mode, the chart type that best suits the respective setting is selected automatically.

7 Mouseover function. When the chart has been stopped and you move the mouse over the graph, points on the curve are marked with a circle and the associated values are displayed in the text boxes above the graph. Peak intensity is also updated.

8 Peak intensity is displayed as a bar chart.

9 The x-axis can be scaled in the input field under the time axis.

10 Scaling the x-axis: During an ongoing measurement, you can use the left-hand slider to enlarge the entire signal (zoom). When the chart has been stopped, the right-hand slider can also be used. You can also move the zoom window with the mouse in the center of the zoom window (four-sided arrow).

i If you allow the diagram display to run in a separate browser tab or window, it is not necessary to restart the display each time.

► Click on the `Start` button to display the measurement results.

6.3.3 Video signal display in the web browser

► Display the video signal using the `Video` function in the `Chart type` section.

The graph displayed in the large window on the right shows the video signal from the receiver line. The video signal in the window displays the intensity distribution of the pixels in the receiving row. Left 0 % (small distance) and right 100 % (large distance).

The corresponding measured value is marked by a vertical line (peak marking).

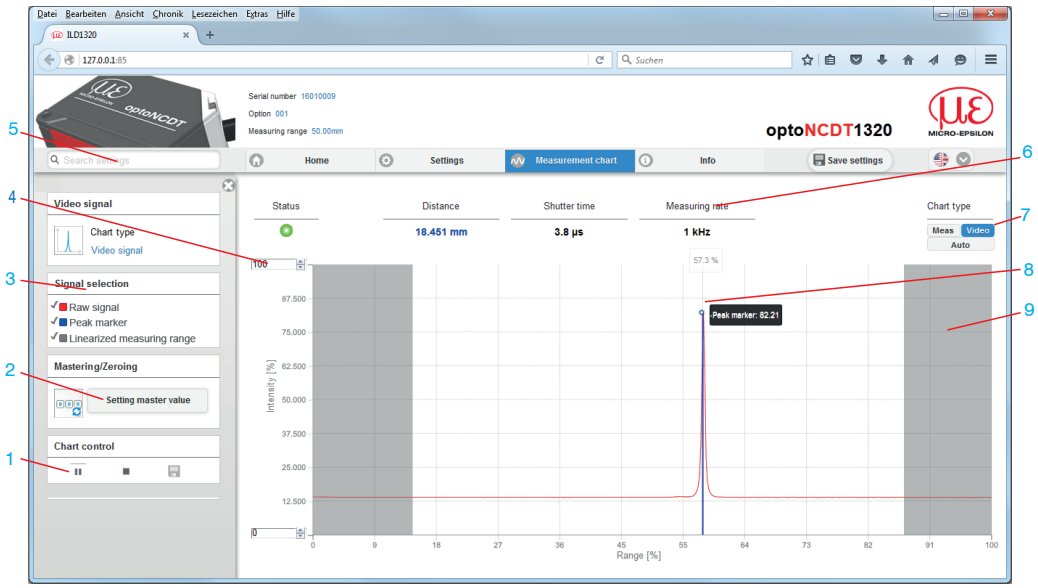


Fig. 6.3: Video signal web page

1 `Stop` pauses the chart; you can still use the data selection and zoom functions. `Pause` or `Start` pauses or starts recording. `Save` opens a Windows selection dialog for the file name and storage location to save the video signal in a CSV file.

2 This function starts or stops a relative measurement. The master value can also be defined here in a submenu.

3 In the left-hand window, the video curves to be displayed can be switched on or off during or after the measurement. Inactive curves are grayed out and can be added by clicking on the check mark. If you want to have displayed one single signal, click on its name.

- Raw signal (uncorrected CMOS signal, red)
- Peak marking (vertical blue line), corresponds to the evaluated measurement value
- Linearized measuring range (limited by gray hatching), not changeable

4 To scale the intensity axis in the graph for the measured values (Y axis), you can use `Auto` (= automatic scaling) or `Manual` (= manual scaling).

5 The search function permits time-saving access to functions and parameters.

i ASCII commands to the sensor can also be entered directly in the search field.

6 The text boxes above the graph display the current values for distance, exposure time, current measuring rate, display rate, and timestamp.

7 Selecting a chart type. In `Auto` mode, the chart type that best suits the respective setting is selected automatically.

8 Mouseover function. When stopped, moving the mouse over the graph marks curve points with a circle symbol and displays the associated intensity. The corresponding x-position in % appears above the graphic field.

9 The linearized range lies between the gray shades in the chart and cannot be changed. Only peaks whose middles lie within this range can be calculated as a measured value. The masked area can be restricted if required and is then limited on the right and left by an additional light blue shade. The peaks remaining in the resulting range are used for the evaluation.

The display shows how the adjustable measurement task (target material), peak selection and possible interfering signals due to reflections or similar affect the video signal.

There is no linear relationship between the position of the peak in the video signal display and the output measured value.

6.4 Programming via ASCII commands

As an additional feature, you can configure the controller via an ASCII interface, physically RS422. For this purpose, the controller must be connected to a serial RS422 interface by means of a suitable interface converter or by means of a plug-in card to a PC/PLC.

i Observe the correct RS422 basic setting in the programs used.

After establishing the connection, you can transmit the commands from the appendix via a terminal program to the controller.

6.5 Time response, measurement value flow

The sensor requires 3 cycles to measure and process without triggering:

The cycle time is 500 µs at a measuring rate of 2 kHz. The measured value N is available at the output after three cycles. The delay time between detection and start of output is therefore 1500 µs. As the cycles are processed in parallel, the next measured value (N+1) is output after a further 500 µs.

7 Set sensor parameters, web interface

7.1 Preliminary remarks concerning the setting options

You can parameterize the sensor in various ways:

- Using the web browser and sensor web interface
- With ASCII command set and terminal program via RS422

> i If you do not permanently save the programming in the sensor, the settings will be lost after the sensor is switched off.

Legend of the menu structure:

Fields with gray background require a selection.

Value Fields with dark border require entry of a value.

7.2 Overview of parameters

You can set or change the following parameters in the optoNCDT 1320, see `Settings` tab.

Inputs	Laserpower, Multi-function input, Key function
Signal processing	Measuring task, Measuring rate, Counter reset, Triggering (data recording, data output), Evaluation range (ROI), Peak selection, Error handling, Averaging, Zeroing/Mastering, Data reduction
Outputs	RS422, Analog output, Digital outputs
System settings	Unit on the website, Key lock, Load & Save, Import & Export, Access authorization, Reset sensor (factory settings)

7.3 Inputs

► In the `Settings` tab, switch to the `Signal processing` menu.

Laser on/off	*On/Off*		*Laser on/off is only effective when Pin 8 is connected to GND.*
Multifunction input	*Zero*	*High / Low*	*Defines the function of the switching input. The trigger influences the output of a measured value. Zeroing sets the output value to half the analog output value. Teaching scales the analog output. HTL is defined as the active input level.*
	Trigger In	*High / Low*	
	Teaching		
	Inactive		
Key function	*Zero*		*Defines the function of the sensor button.* *Inactive means key lock.*
	Teaching		
	Inactive		

7.4 Signal Processing

7.4.1 Preliminary remarks

► In the `Settings` tab, switch to the `Signal processing` menu.

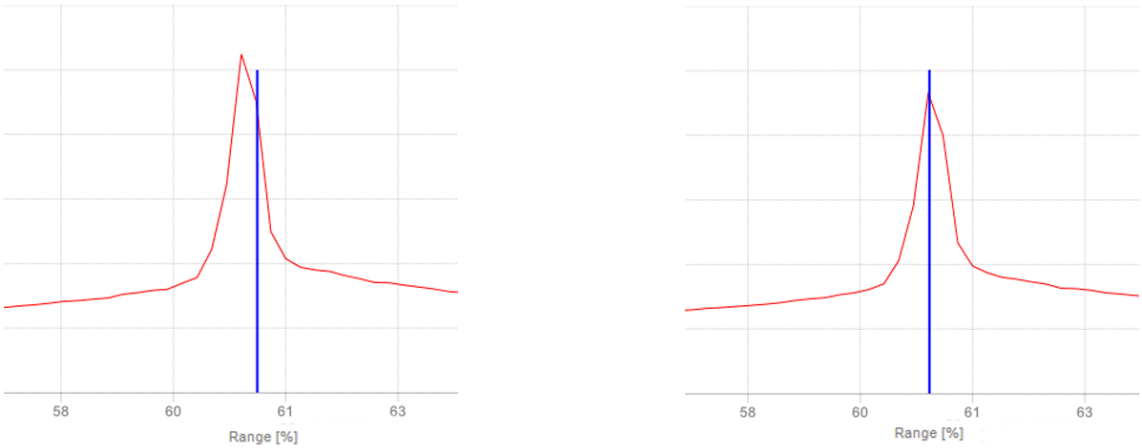
According to the previous setting in the `Chart type` area, a diagram is displayed on the right hand-side. The diagram is active and all settings become immediately visible. Notes on the chosen settings are displayed below.

In the left area, the menus for the `Signal processing` are displayed.

7.4.2 Measurement task

The measurement task involves selecting the measuring object (target). Selecting a target loads a predefined sensor configuration that produces the best results for the selected material.

Measurement task	*Standard*	*Suitable for materials made of ceramic, metal or filled plastics*
	Changing surfaces[10]	*Suitable for circuit boards (PCB) or hybrid materials*
	Material with penetration[10]	*Suitable for plastics (POM, Teflon), materials with strong laser penetration depth*



Tab. 7.1: Video signals (excerpt) with target material POM

The selection of the target properties can be observed in the right-hand diagram `Video signal` by the position of the blue peak marker in relation to the video signal (raw signal). This should be as close as possible to the peak of the video signal.

In the `Standard` setting, the peak marking (measured value) in the example of Plastic POM does not correspond to the focal point of the actual peak, as its base is asymmetrically distorted by the penetration of the laser light. This is only possible when the task is correctly set to `Material with penetration`.

The `Changing surfaces` setting strikes a balance between Penetration and Standard, achieving optimal results for both materials. This can also be seen in the Distance (Meas) diagram, which shows the different distance values for the individual measurement tasks.

7.4.3 Measuring rate

The measuring rate indicates the number of measurements per second.

► Select the required measuring rate.

Measuring rate	*250 Hz / 500 Hz / 1 kHz / 2 kHz /4 kHz*	*Use a high measuring rate for bright and mat measuring objects. Use a low measuring rate for dark or shiny measuring objects (e.g. black painted surfaces) to improve the measurement result.*

At a maximum measuring rate of 4 kHz, the CMOS element is exposed 4000 times per second. The lower the measuring rate, the longer the maximum exposure time.

The *Measuring rate* is set to 1 kHz at the factory.

7.4.4 Triggering

7.4.4.1 General

The output of measurement values of the optoNCDT 1320 can be controlled through an external electrical trigger signal or commands. Both analog and digital outputs are affected by this. The measured value at the time of the trigger event is output with a delay, see Chap. 5.4.7.

- Triggering has no effect on the time response, so that there are always 3 cycles + 1 cycle (jitter) between the trigger event (level change) and the start of the output.

[10] Available for the ILD1320-10/25/50 sensor models

- The multifunction input is used as the external trigger input.
- Factory setting: no triggering, the sensor starts data transmission immediately after being switched on.
- The pulse duration of the "Trigger in" signal is at least 50 µs.

Triggering (data output)	*Level*				*Measurement values are output continuously as long as the selected level applies. Level selection. The pulse duration must be at least as long as one cycle. The subsequent pause must be at least as long as one cycle.*
	Edge	*Infinite*			*Edge selection. "0" Stop triggering, "1 ... 16382" values per trigger, "16383" infinite trigger*
		Manual selection	*Number*	*value*	
	Software	*Edge*			A software trigger is started by pressing the `Start triggering` button. "0" Stop triggering, "1 ... 16382" values per trigger, "16383" infinite trigger
		Manual selection	*Number*	*value*	
	Inactive				*Stop triggering*

The following applies to triggering:

$f_T < f_M$ f_T Trigger frequency

f_M Measuring rate

The following are used as triggering conditions:
Level triggering with high level / low level.
Continuous measured value output for as long as the selected level is active. Afterwards, the data acquisition/output stops.
The pulse duration must be at least as long as one cycle. The subsequent pause must also be at least as long as one cycle.

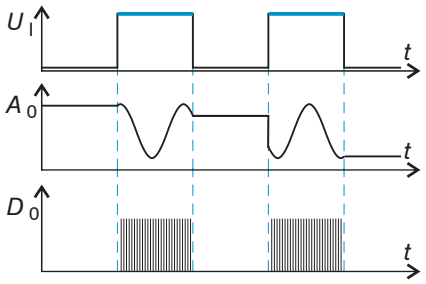


Fig. 7.1: Trigger level High (top) with analog output A_0 and digital output signal D_0 (bottom)

Edge triggering with rising or falling edge.
Starts measured value output as soon as the selected edge is present at the trigger input. The sensor outputs the specified number of measured values when the triggering condition is met. Value range between 1 ... 16383. After completion of data output the analog output remains at the last value (Sample & Hold).
The pulse duration must be at least 50 µs.

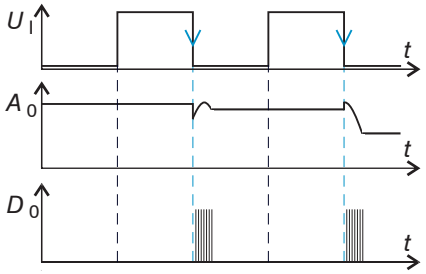


Fig. 7.2: Trigger edge HL (above) with analog output A_0 and digital output signal D_0 (below).

Software triggering.

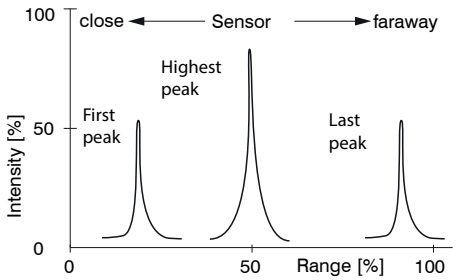
Starts the measured value output as soon as a software command (instead of the trigger input) is received. The trigger time is defined less precisely. The sensor outputs the previously set number of measured values or initiates a continuous measured value output after the trigger event. If "0" is selected for the number of measured values, the sensor stops triggering and continuous value output.

The measured value output can also be stopped using a command.

7.4.4.2 Triggering measured value output

The measured values are computed continuously and independently of the trigger event. A trigger event merely triggers output of the values via a digital or analog interface. Therefore, any values measured immediately before the trigger event are included in the calculation of the mean values (averages).

7.4.5 Peak selection

Peak selection	*First peak / Highest peak / Last peak / Widest peak*	*Defines which signal in the array signal is used for the evaluation.* *First peak: Nearest peak to sensor.* *Highest peak: Standard, peak with the highest intensity.* *Last peak: Peak furthest away from sensor. Widest peak: Peak with largest area.*	

If a measuring object contains multiple transparent layers, a correct measurement result is determined only for the first peak.

7.4.6 Error handling

The error handling function regulates the behavior of the analog output and RS422 interface in the event of an error.

Error handling	*Error output, no measurement value*	*The analog output supplies 3 mA instead of the measured value. The RS422 interface outputs an error value.*	
	Hold last value infinitely	*The analog output and RS422 interface remain on the last valid value.*	
	Hold last value	*1 ... 1024*	*value*

If no valid measured value can be determined, an error is output. Alternatively, if this interferes with further processing, the last valid value can be held, i.e. output repeatedly, for a certain amount of time. After the selected number of cycles have elapsed, an error value is output.

7.4.7 Zeroing and mastering

7.4.7.1 General

Use zeroing and mastering to define a nominal value within the measuring range. This shifts the output range. This feature can be useful, for example, when several sensors carry out measurements simultaneously in thickness and planarity measurements.

Zeroing/mastering	*Inactive*		*Normal measurement value, or zero setting/mastering is canceled.*
	Active	*Value*	*Specification, e.g. of the thickness of a master piece* *Range of values 0 to max. + 2 x measuring range*

Mastering (setting masters) is used to compensate for mechanical tolerances in the sensor measurement setup or to correct chronological (thermal) changes to the measuring system. The master value, also called calibration value, is defined as the target value.

The measured value provided at the sensor output when measuring a master object is the "Master value".

Zeroing is a special feature of mastering, since the master value is `0` here.

During mastering, the sensor characteristic is moved in parallel. Moving the characteristic reduces the relevant measuring range of a sensor (the further master value and master position are located, the greater the reduction).

Mastering / Zeroing Sequence:

- ► Place measuring object and sensor into their desired positions to one another.

► Send the master command.

The master command waits for a maximum of 2 seconds for the next measurement value and uses this as master value. If no value is measured within this time, e.g. in case of external triggering, the command returns with the error `E220 Timeout`.

After setting the master, the sensor will issue new readings that relate to the master value. By resetting with the `Inactive` button, the status before mastering is restored.

Note	`Mastering` or `Zeroing` requires a target object to be present in the measuring range. `Mastering` and `Zeroing` influence the digital and the analog output.

An invalid master value, e.g. no peak present, is acknowledged with the Error *E602 Master value is out of range*.

7.4.7.2 Zeroing/Mastering using the Select button

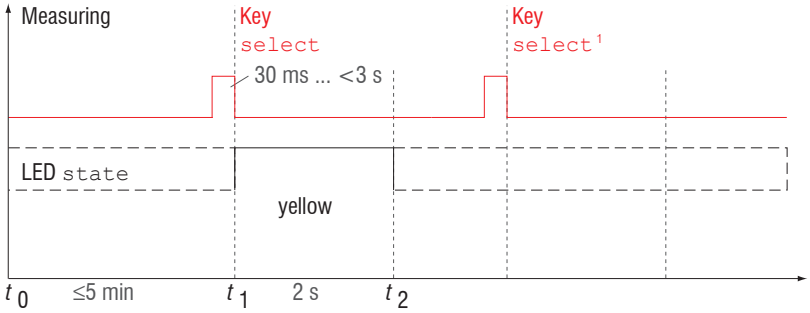


Fig. 7.3: Flowchart for Zeroing/Mastering using the `Select` button

i	The key `Select`[11] is locked after 5 minutes according to the factory setting. You can deactivate the key lock via the web interface .

The LED `State` lights up green, red, yellow, depending on the position of the measuring object. If the `State` LED is red, zeroing is not performed, flashing frequency 8 Hz for 2 s.

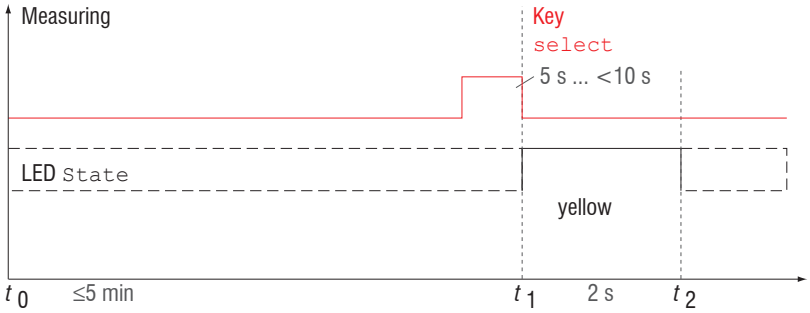


Fig. 7.4: Flowchart for resetting zeroing/mastering

The `Zero setting` function can be used several times in succession. A break of 1s is required before repeating the `Zero setting` function. The Zeroing/Mastering function can also be combined with the multifunction input.

[11] The `Select` key has no effect because the key lock is active.

7.4.7.3 Zeroing/Mastering via hardware input

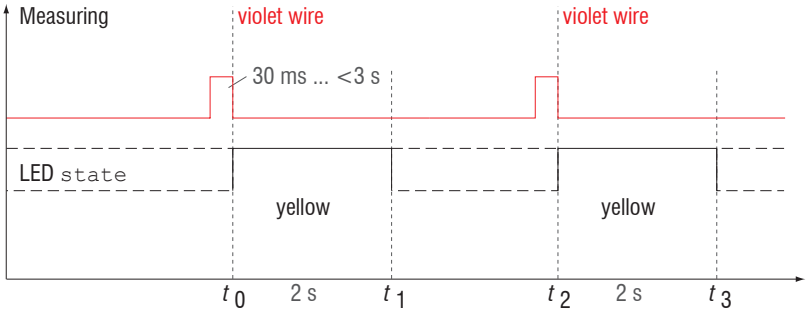


Fig. 7.5: Flowchart for Zeroing/Mastering (hardware input)

i A pulse is possible at the function input of the violet wire of the sensor cable. Details about the hardware input can be found in the Electrical connections .

The LED `State` lights up green, red, yellow, depending on the position of the measuring object. If the `State` LED is red, zeroing is not performed, flashing frequency 8 Hz for 2 s.

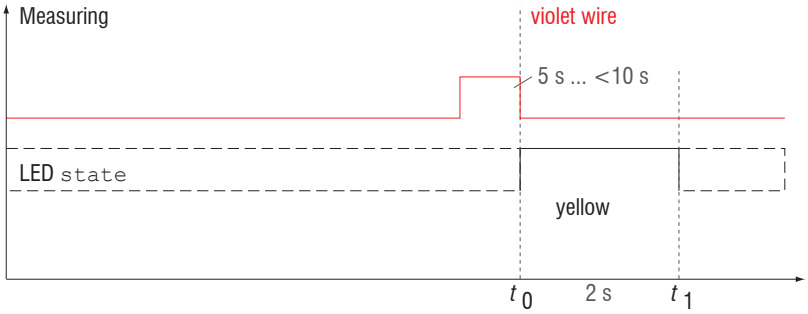


Fig. 7.6: Flowchart for resetting Zeroing/Mastering

The Zeroing/Mastering function can be applied several times in a row. A break of 1s is required before repeating the function. The function can also be combined with the `Select` button.

7.5 Outputs

7.5.1 Overview

RS422	Baud rate	*9.6/ 19.2 /56.0 / 115.2 / 230.4 / 1000 kBps*		*Transmission speed, binary data format*
	Output data	*Distance / Exposure time / Intensity / Sensor state / Measurement counter / Non-linearized focal point / Time stamp / Video raw signal*		*The data intended for transmission must be activated with the checkbox.*
Analog output	*Standard scale*			*Start of measuring range 4 mA, at the end of measuring range 20 mA*
	Two-point scale	*Start of range*	*value*	*In every case, 2 points are taught which characterize the start and the end of the new measuring range. Two-point scaling allows the output signal to be reversed.*
		End of range	*value*	
Digital outputs	*Inactive*			*Controls the switching behavior of the digital output (error), see Chap. 5.4.8*
	Full-scale error	NPN / PNP / Push pull / Push pull negative		
Data output	*Web interface / Analog / RS422*			*Decides on the interface used for outputting the measured value. A parallel output of measured values via multiple channels is not possible. If Web interface is selected, no measurement values are output via RS422 or the current output.*

7.5.2 Digital output, RS422

7.5.2.1 Values, ranges

The digital measurements are output at the sensor as unsigned digital values (raw values). 16 or 18 bits per value are transmitted. Below you will find a compilation of the output values and the conversion of the digital value.

value	Length	Variables	Value range	Formula
Distance	16 bits	*x* = digital value	[0; <643] SMR reserve [643; 64887] Measuring range [>64887; 65520] EMR reserve	$d\ [\mathrm{mm}] = \frac{1}{100}\left(\frac{102}{65520}x - 1\right) * MR\ [\mathrm{mm}]$
		MR = measuring range [mm]	{10/25/50/100/200/500}	
		d = distance [mm]	[-0.01*MR*; 1.01*MR*]	
Distance (with mastering)	18 bits	*x* = Digital value	[0; 229320]	The output range is also encoded with 64235 values at 18 bits and shifted by the master value, see Chap. 7.5.3.1. The reserves for SMR and EMR are each coded with 643 values. $d\ [\mathrm{mm}] = \frac{1}{100}\left(\frac{102}{65520}x - 51\right) * MR\ [\mathrm{mm}]$
		MR = Measuring range [mm]	{10/25/50/100/200/500}	
		MP = Master position [mm]	[0; *MR*]	
		MV = Master value [mm]	[0; *2MR*]	
		d = distance [mm]		
		MV < *MP* - 0.5*MR*:	[-0.5*MR* + *MV*; *MR* - *MP* + *MV*]	
		MV ≥ *MP* - 0.5*MR*:	[-*MP* + *MV*; *MR* - *MP* + *MV*]	
Exposure time	18 bits	x = digital value	[1; 262143]	$\mathrm{BZ}\ [\mu\mathrm{s}] = \frac{1}{10}\ \mathrm{x}$
		BZ = Exposure time [µs]	[0.1; 26214.3]	
Intensity	16 bits	x = digital value	[0; 65472]	$\mathrm{I}\ [\%] = \frac{25}{16368}\ \mathrm{x}$
		I = Intensity [%]	[0; 100]	
Sensor status	18 bits	x = digital value	[0; 242143]	Bit 0 (LSB): peak starts before ROI
		Bit coding	[0; 1]	Bit 1: peak ends after ROI
				Bit 2: No peak found
		SMR = Start of measuring range		Bit 5: Distance before SMR (extended)
		EMR = End of measuring range		Bit 6: Distance after EMR (extended)
				Bit 15: Measurement value is triggered
				Bit 16, 17: Status LED;
				- 00 – off 10 – red
				- 01 – green 11 – yellow
Measurement counter	18 bits	x = digital value	[0; 262143]	

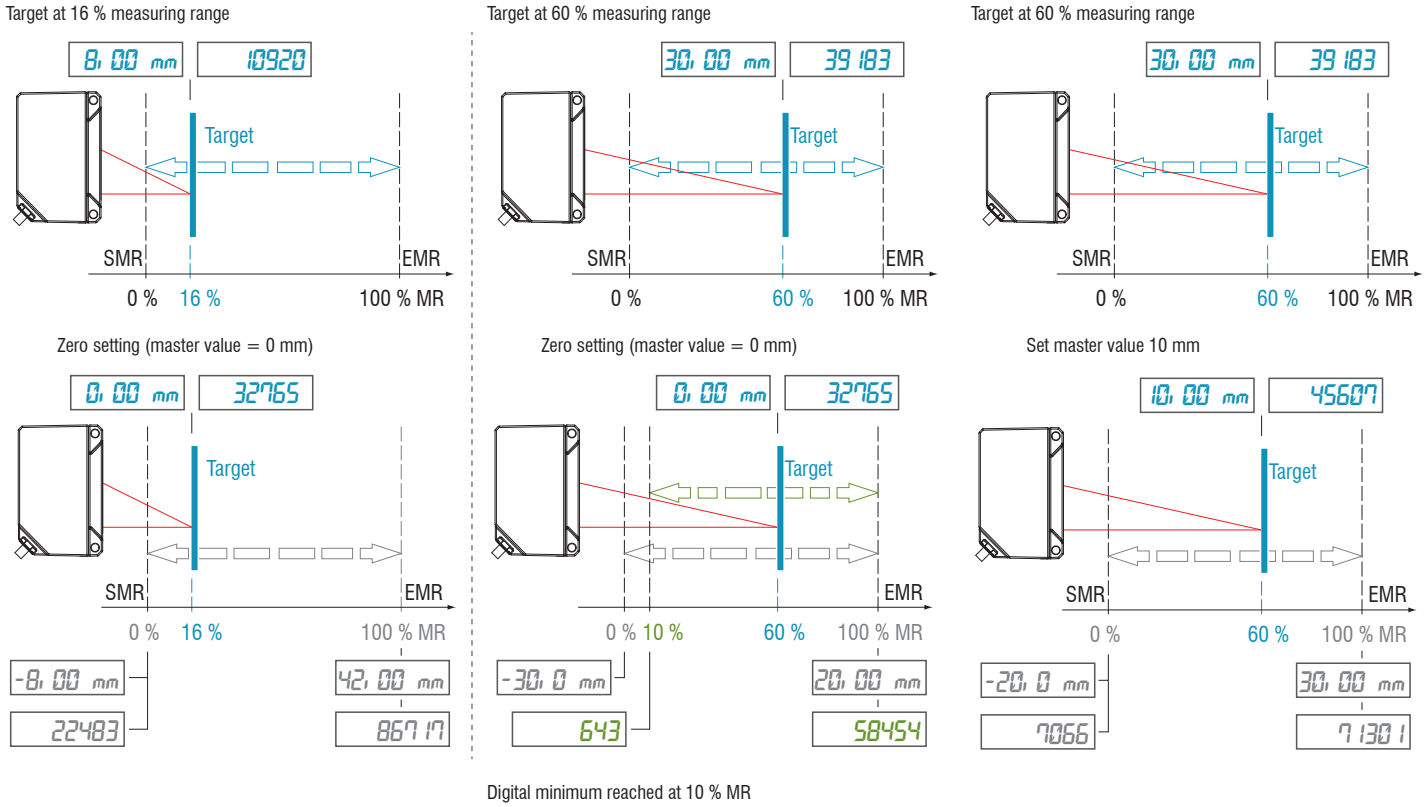
value	Length	Variables	Value range	Formula
Timestamp	2 words, à 16 Bit	x = digital value Lo	[0; 65535]	$t\,[ms] = \frac{1}{100}\,(65536y + x)$
		y = digital value Hi	[0; 65535]	
		t = time stamp [ms]	[0; 11h55m49.67s]	
Non-linear-ized focal point	18 bits	x = digital value	[0; 262143]	$US\,[\%] = \frac{100}{262143}\,x$
		US = Focal point [%]	[0; 100]	
Video raw signal	16 bits	512 pixels	[0; 65535]	

State information transferred in the distance value

Distance value	Description	Distance value	Description
262075	Data volume too large for selected baud rate	262080	Measurement value cannot be evaluated
262076	No peak is present	262081	Peak is too wide
262077	Peak is before the measuring range (MR)	262082	Laser is off
262078	Peak is after the measuring range (MR)		

7.5.2.2 Behavior of the digital output

Measured values based on the Zeroing/Mastering function are coded with 18 bits. The master can assume twice the measuring range. The examples show the behavior of the digital value with an ILD1320-50, measuring range 50 mm.



Digital minimum reached at 10 % MR

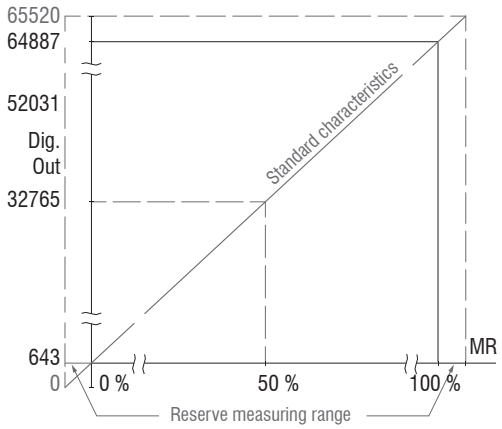


Fig. 7.7: Digital values without zeroing/ mastering

► Set target at 80 % measuring range (40 mm), set master value 100 mm

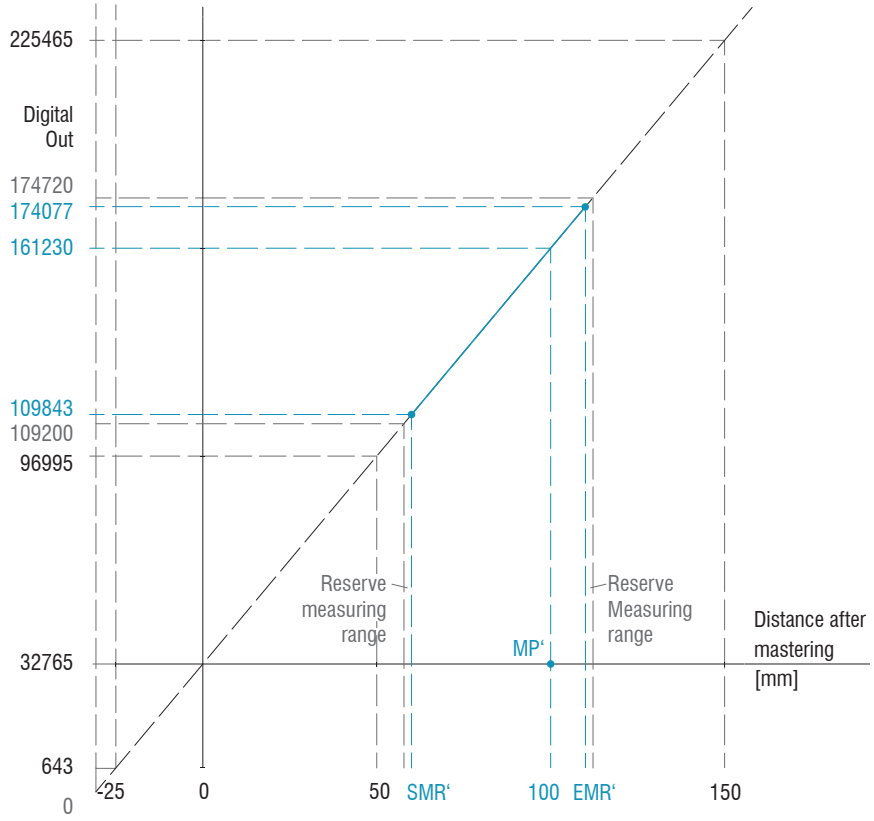


Fig. 7.8: Digital values of an ILD1320-50 after mastering with 100 mm master value

7.5.3 Analog output

7.5.3.1 Output scaling

- Max. output range: 4 mA ... 20 mA
- Output span ΔI_{OUT}: 16 mA = 100 % FSO
- Error value: 3.0 mA (±10 µA)

Teaching scales the analog output. This allows you to optimize the resolution for the analog output. The behavior of the current and switching output changes. In every case, 2 points are taught which characterize the start and the end of the new measuring range. Teaching is via the built-in `Select` button, the `Multifunction input` or via the web interface.

i In conjunction with a user-defined output characteristic curve, you can use the switching output, see Chap. 5.4.8, as a sliding limit switch.

The measuring object positions for `Teach 1` (start of range) and `Teach 2` (end of range) must be different.

The teaching process requires a valid measurement signal. In case of

- no object,
- object cannot be evaluated,
- too close to the sensor - outside SMR or
- too far from the sensor - outside EMR

the teaching process is aborted.

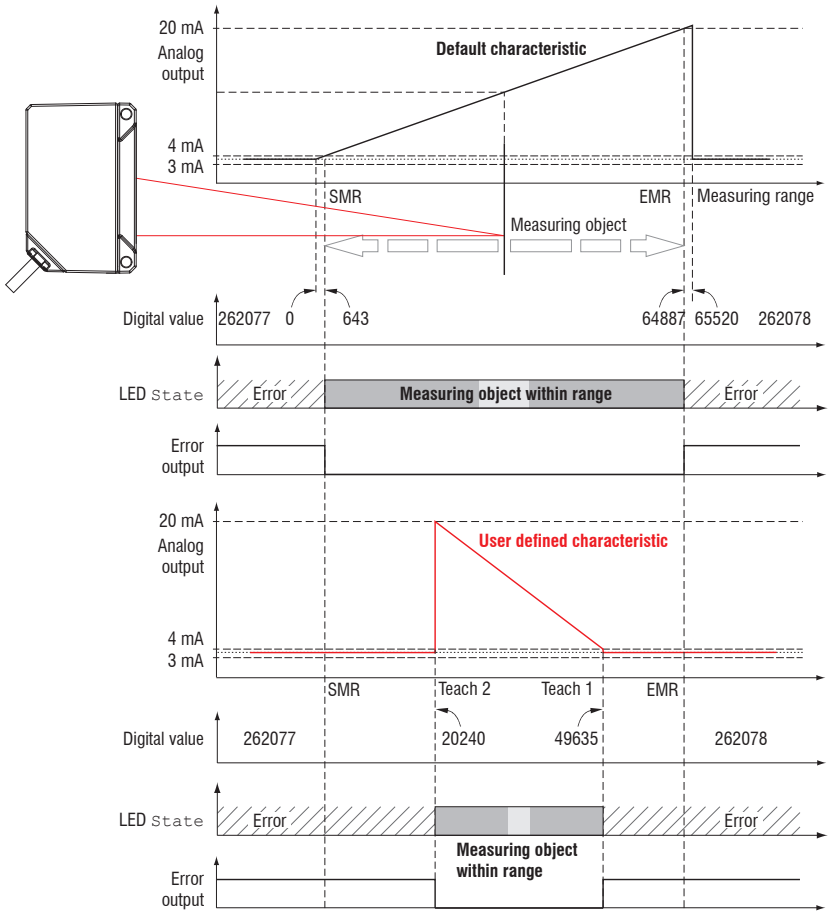


Fig. 7.9: Standard characteristic (black), reversed, user-specific characteristic (red)

7.5.3.2 Output scaling with the Select button

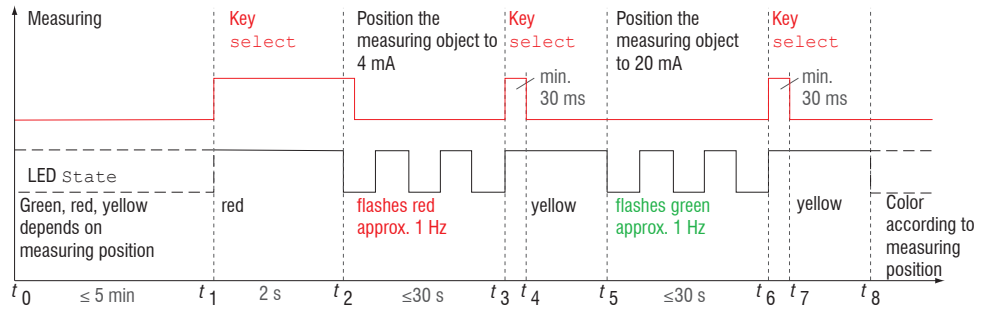


Fig. 7.10: Flowchart for output scaling

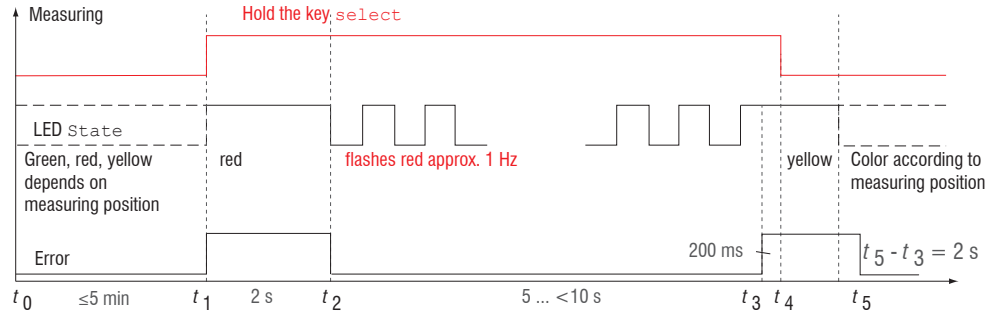


Fig. 7.11: Flowchart for resetting the output scaling

When resetting the output scaling, the `State` LED displays an error when the `Select` button is pressed for longer than 10 s or not within the frame. The `State` LED then flashes red at 8 Hz for two seconds.

7.5.3.3 Output scaling via hardware input

Scaling of the analog output is possible via a pulse at the function input, the violet wire on the sensor cable.

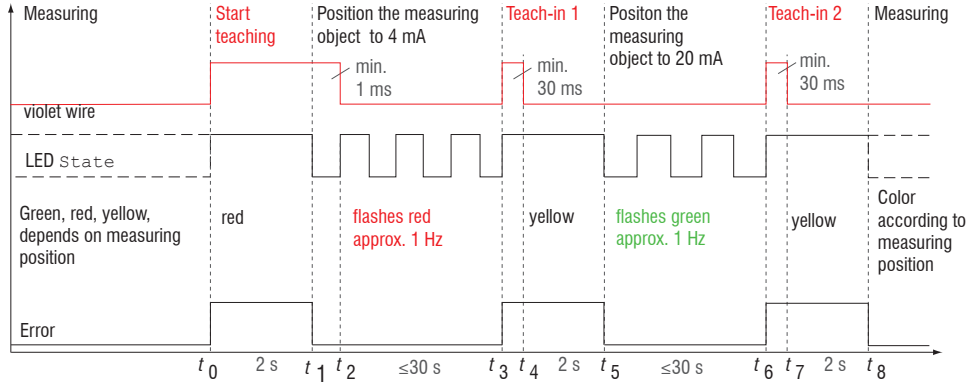


Fig. 7.12: Flowchart for output scaling (Select button)

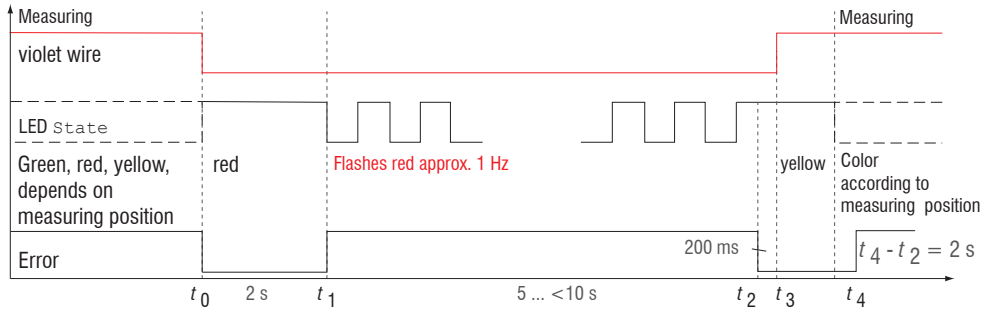


Fig. 7.13: Flowchart for resetting the output scaling

7.5.3.4 Calculation of measured value from analog current

Current output (without zeroing, without teaching)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 4)}{16} * MR\ [mm]$
MR = Measuring range [mm]	{10/25/50/100/200/500}	
d = Distance [mm]	[-0.01MR; 1.01MR]	

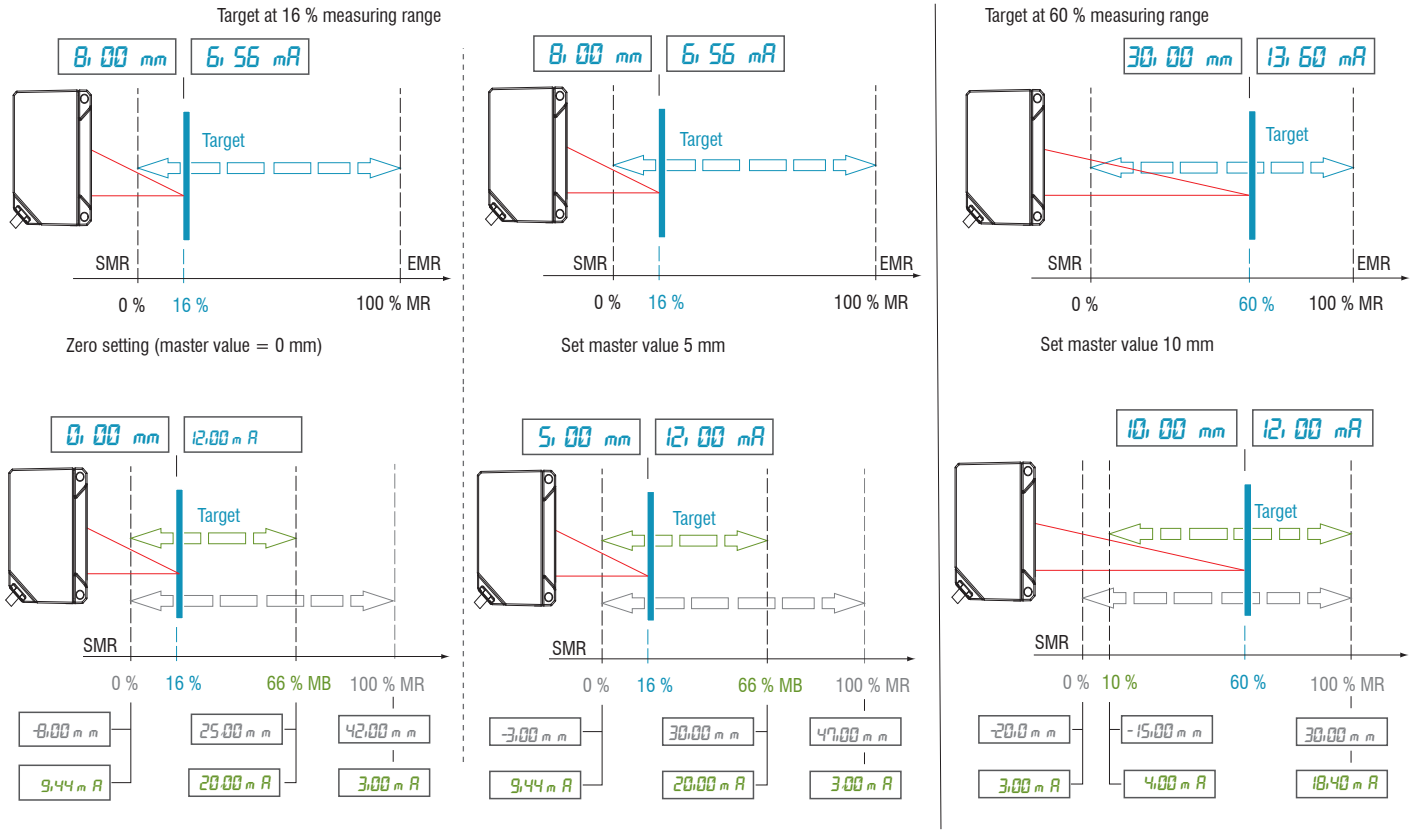
Current output (with zero setting), reference value mid of measuring range		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 12)}{16} * MR\ [mm]$
MR = Measuring range [mm]	{10/25/50/100/200/500}	
MP = Master position [mm]	[0; MR]	
d = Distance [mm]	for MP ≤ 0.5 MR: [-MP; 0.5 MR]	
	for MP > 0.5 MR: [-0.5 MR; MR - MP]	

Current output (with teaching)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 4)}{16} * \lvert n\ [mm] - m\ [mm] \rvert$
MR = Measuring range [mm]	{10/25/50/100/200/500}	
m, n = Teach range [mm]	[0; MR]	
d = Distance [mm]	[m; n]	

Current output (with zero setting and teaching)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 12)}{16} * \lvert n\ [mm] - m\ [mm] \rvert$
MR = Measuring range [mm]	{10/25/50/100/200/500}	
MP = Master position [mm]	[0; MR]	
m, n = Distance [mm] [12]	[0; MR]	
d = Distance [mm]	[m; n]	

7.5.3.5 Behavior distance value and analog output

The Zeroing/Mastering function sets the analog output to half of the output range, i.e. 12 mA, regardless of the master value. The examples show the behavior of the current output and the distance value using the example of an ILD1320-50, measuring range 50 mm.



MR = Measuring range, SMR = Start of measuring range, EMR = End of measuring range

[12] If one of the teach points (m, n) is outside the measuring range (MR) due to zeroing, the sensor outputs an error message.

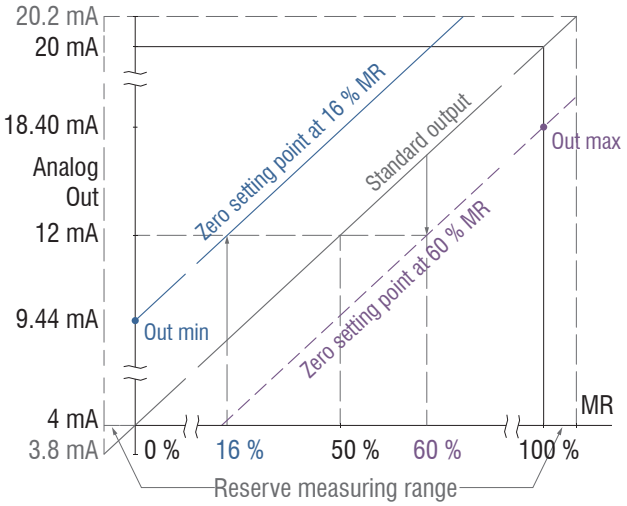


Fig. 7.14: Analog signal with Zeroing/Mastering

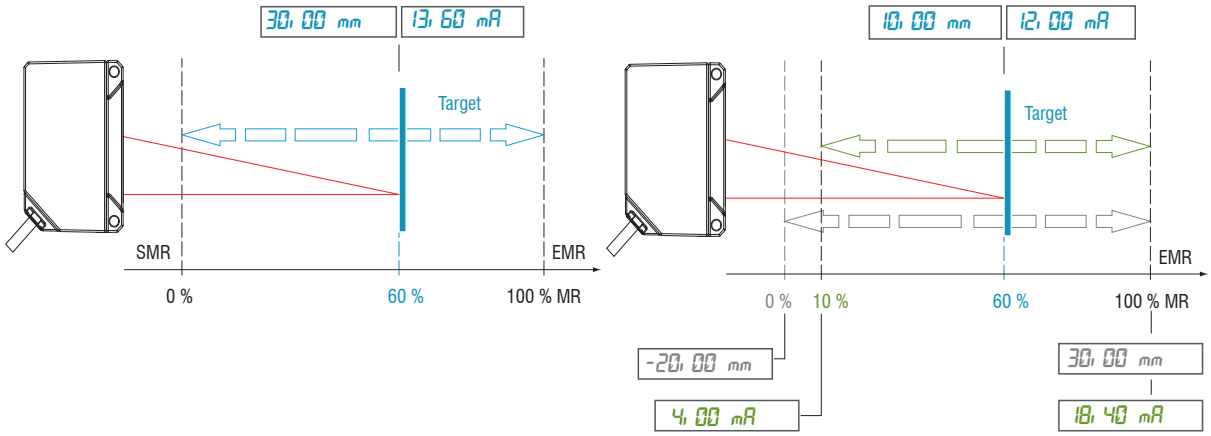
Master point	Master value	Out min	Out max
16 % (8 mm)	0 mm	9.44 mA (-8 mm)	20.0 mA (33 mm)
60 % (30 mm)	10 mm	4.00 mA (-15 mm)	18.40 mA (30 mm)

7.5.3.6 Analog output mastering and teaching

Please observe the following order:

1. Mastering or zeroing, `Signal processing` menu
2. Teach output, `Outputs` menu

The Zeroing function sets the analog output to half of the output range , see Chap. 7.5.2.2 .



- Target with 60 %, setting master value to 0 mm
- Setting start of range (m) to 20 mm and end (n) to 40 mm

i n < m generates an inverse characteristic curve.

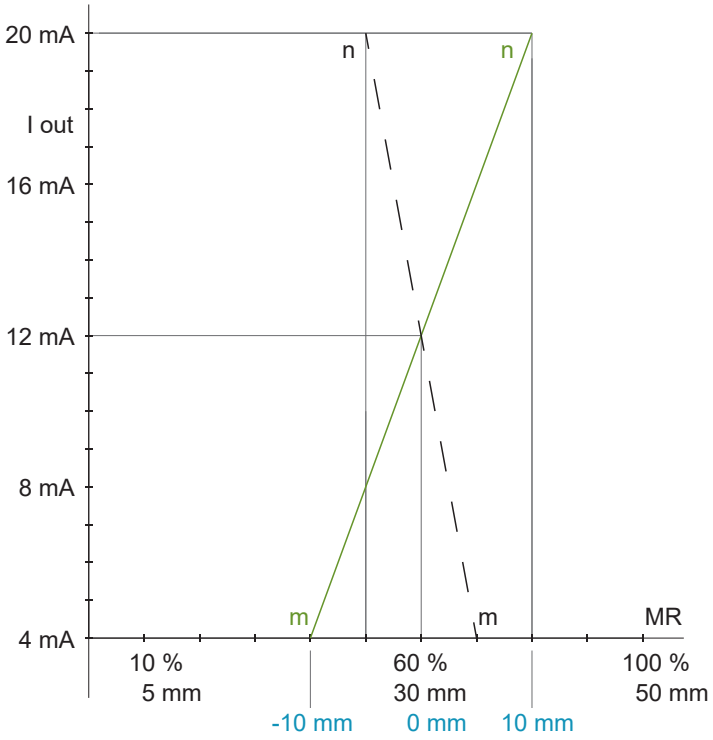


Fig. 7.15: Output characteristics after zeroing and scaling with an ILD1320-50

7.5.4 Error output

The switching output can be used for error or limit value monitoring at the output value.

Error output (switching output)	*Inactive*			*Controls the switching behavior of the switching output (error). Analog scale range: The switching output switches when the scaled analog range is exceeded. Measuring range: Switching output switches if the peak is not (completely) within the evaluation range (ROI), e.g.* Measured object outside the measuring range or no measured object present. *Defined threshold: The switching output switches when the limit value is exceeded.*
	Analog scale range / Measuring range	*NPN / PNP / Push Pull / Push Pull Neg*		
	Defined threshold	*NPN / PNP / Push Pull / Push Pull Neg*		
		Limit value	*value*	
		Hysteresis	*value*	
		Minimum hold time	*value*	

The error output is activated depending on the set switching behavior, see Chap. 5.4.8.

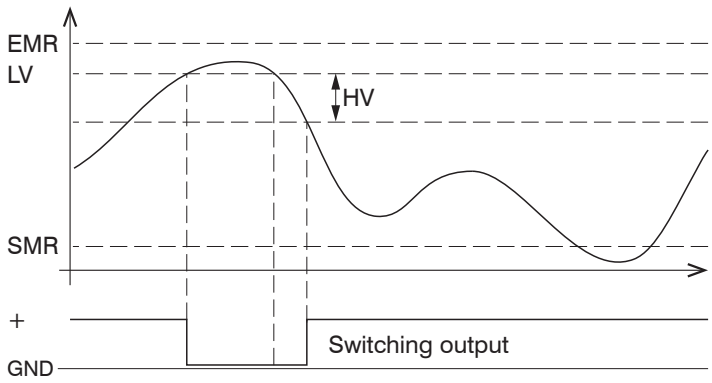


Fig. 7.16: Error output with limit value function, switching behavior (NPN)

The switching output is activated (conductive) when the limit value is exceeded and deactivated again when the hysteresis value is subsequently undershot.
The switching output with `Measuring range` or `Limit value` function works independently of the analog output.

EMR = End of measuring range
LV = Limit value
HW = Hysteresis value
SMR = Start of measuring range

7.5.5 Data output

The sensor interface used can be selected via the data output.

		Output LED	Web interface		Current output	Digital output
			Setting	Measurement chart		
Active interface	Web interface	Yellow	Yes	yes		
	Analog (factory setting)	red	possible	possible	yes	
	RS422	green	possible			yes

Tab. 7.2: Options for data output

Data output	*Web interface / Analog / RS422*	*Decides on the interface used for outputting the measured value. Parallel physical output of measurement values via RS422 and analog is not possible.* *If Web interface is selected, no measurement values are output via RS422 or the current output.*

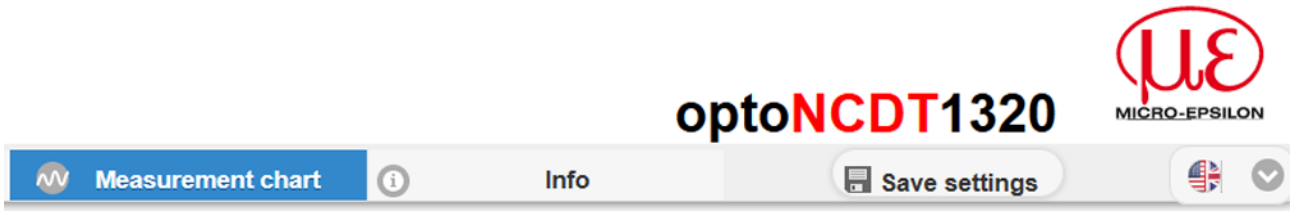
7.6 System Settings

7.6.1 General

After programming, all settings must be saved permanently under a parameter set so that they are available again the next time the sensor is switched on.

7.6.2 Unit, language

The web interface supports units in millimeters (mm) and inches in the display of the measurement results. German, English, Chinese or Japanese can be selected as web interface language. Switch the language in the menu bar.



7.6.3 Key lock

The key lock for the `Select` key prevents unauthorized / unintended button operation. The key lock is activated when the user level `Operator` has been selected. The key lock can only be deactivated in the user level `Professional`. If a Professional logs into the system, the sensor key lock is automatically released.

Key lock	*Automatic*	*Range from 1 ... 60 [min]*	*value*	*The key lock is activated after the defined time has elapsed. Click on the `refresh` button to extend the time until the key lock is activated.*
	Active			*The `Select` button does not respond to inputs, regardless of the user level.*
	Inactive			*The `Select` button is active, regardless of the user level.*

7.6.4 Loading, saving

All the sensor settings can be saved permanently in user programs, which are known as setups.

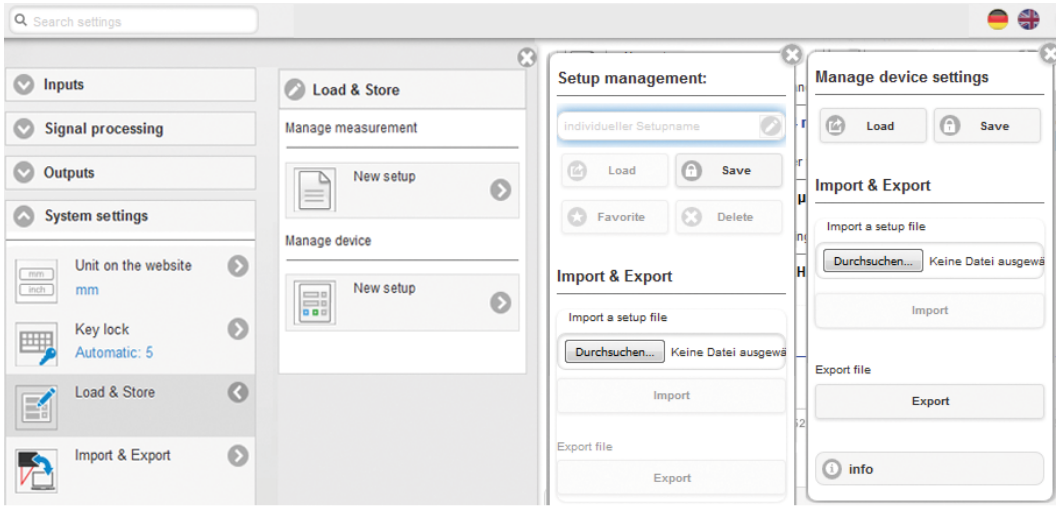


Fig. 7.17: Managing user programs

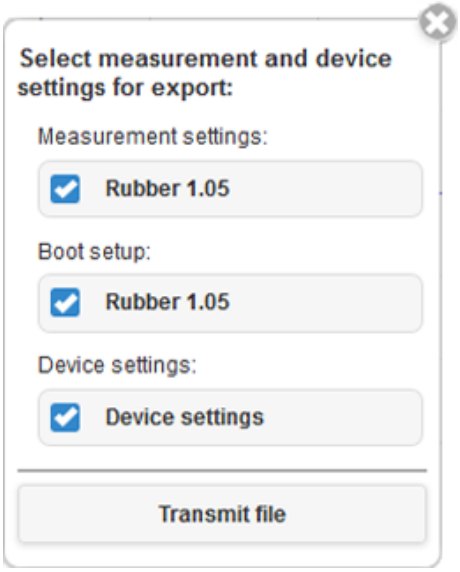
Manage setup in the sensor, options and procedure			
Saving the settings	**Activating existing setup**	**Saving changes in the active setup**	**Determining setup after booting**
`New setup` menu	`Load & Save` menu	Menu bar	`Load & Save` menu
Enter the name for the setup in the `Individual setup name` field, e.g. `Shaft 4_02` and confirm the entry with the `Save` button.	Left-click on the setup. The following dialog opens: `Measurement settings`. Click on the `Load` button.	Click on the button Save settings	Left-click on the setup. The following dialog opens: `Measurement settings`. Click on the `Favorite` button.

Exchange setup with PC/notebook, options	
Saving setup on PC	**Loading setup from PC**
`Load & Save` menu	`Load & Save` menu
Left-click on the setup. The `Measurement settings` dialog opens. Click on the `Export` button.	Left-click on `New setup`. The `Measurement settings` dialog opens. Click `These settings Import/Export`. A Windows dialog for file selection opens. Select the desired file and click the `Open` button. Click on the `Import` button.

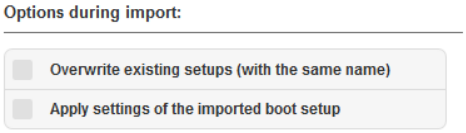
7.6.5 Import, export

A parameter set includes the current settings, setup(s) and the initial setup when booting the sensor.

The `Import & Export` menu allows you to easily exchange parameter sets with a PC/notebook.

Exchange of parameter sets with PC/notebook, possibilities		
Storing parameter set on PC	**Loading parameter set from PC**	
`Import & Export` menu	`Import & Export` menu	
Left-click on the `Create file` button. The `Choose export data` dialog opens. Compose a parameter set by selecting/deselecting the checkboxes. Click on the `Transmit file` button. A Windows dialog for data transfer opens. Confirm the dialog with `OK`. The operating system stores the parameter set in the `Download` area. The file name for the adjacent example is `<...\ Downloads\ILD1220_50BASICSETTINGS_MEASSETTINGS_Wave 4_02... .JSON>`	Click on the `Browse...` button. A Windows dialog for file selection opens. Select the desired file and click on the `Open` button. The `Choose import data` dialog opens. Determine the operations to be performed by selecting/deselecting the checkboxes. Click on the `Transmit file` button.	

In order to avoid that an already existing setup is overwritten unintentionally during import, an automatic security request is carried out (see adjacent figure).



7.6.6 Access authorization

Assigning passwords prevents unauthorized changes to sensor settings. The password protection is not activated in the delivery condition. The sensor operates at user level `Professional`. After the sensor has been configured, you should enable password protection. The standard password for the expert level is `000`.

i A software update will not change the default password or a user-defined password. The Professional password is independent of the setup and is therefore not loaded or saved together with the setup.

Users have the following functions available:

Action	User	Professional
Password required	no	yes
Read inputs, signal processing, outputs, system settings	yes	yes
Change inputs, signal processing, outputs, system settings	no	yes
Change password	no	yes
Toggling between measurement chart and video signal	no	yes
Scale graphs	yes	yes
Restore factory settings	no	yes

Tab. 7.3: Rights in the user hierarchy

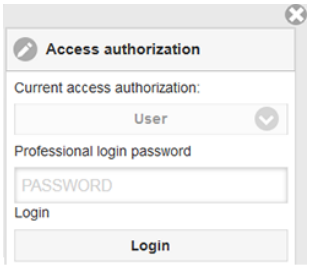


Fig. 7.18: Switch to user level Professional

Enter the standard password `000` or a user-defined password in the `Password` field and confirm your entry with `Login`.
Switch to the operating mode `Operator` by clicking on the `Logout` button.

User management allows you to assign a user-defined password in the operating mode `Professional`.

Password	*value*	*All passwords are case-sensitive; numbers are allowed. Special characters are not permitted. The maximum length is limited to 31 characters.*
User level on restart	*User / Professional*	*Defines the user level that is enabled when the sensor starts the next time. Micro-Epsilon recommends the selection* `Operator`.

After the sensor has been configured, you should enable password protection. Please write down the password for later use.

7.6.7 Reset sensor

Reset sensor	Sensor settings	*Button*	*Deletes the baud rate, language, unit, key lock and echo mode settings and loads the default parameters.*
	Measurement settings	*Button*	*Deletes the settings for measuring rate, trigger, region of interest, peak selection, error handling, averaging, zeroing/ mastering, data reduction and the setups. Loads the 1st preset.*
	Reset all	*Button*	*Deletes the settings for the sensor, the measurement settings, the access authorization, password and the setups. Loads the 1st preset.*
	Reboot sensor	*Button*	*Reboots the sensor with the settings from the favorites setup.*

8 Digital interface RS422

8.1 Preliminary remarks

The RS422 interface has a maximum baud rate of 1 MBaud. The baud rate is set to 921.6 kBaud on delivery.

Data format: Measured values in binary format, commands as ASCII character string, little-endian

Interface parameters: 8 data bits, no parity, one stop bit (8N1).

i Only disconnect or connect the sensor to the USB converter when the power is switched off.

8.2 Measurement data format

Up to 18 bits per output value are transmitted. An output value is distributed over three bytes, which differ in the highest bits. The transfer of further output values is optional.

Output value 1:								
	Preamble		Data bits					
L-Byte	0	0	D5	D4	D3	D2	D1	D0
M-Byte	0	1	D11	D10	D9	D8	D7	D6
H-byte	1	0	D17	D16	D15	D14	D13	D12

Output value 2 .. 32:								
	Preamble		Data bits					
L-Byte	0	0	D5	D4	D3	D2	D1	D0
M-Byte	0	1	D11	D10	D9	D8	D7	D6
H-byte	1	1	D17	D16	D15	D14	D13	D12

Output sequence: L byte, M byte, H byte.

Depending on the measuring rate, baud rate and output data rate, all output data can be output in one block. If the output is not possible, a runtime error is issued. Data selection and output sequence can be queried with the `GETOUTINFO_RS422` command. The output of distance measurement values and other measured values via RS422 requires a subsequent conversion into the relevant unit, see Chap. 7.5.2.1.

8.3 Conversion of the binary data format

During conversion, the H byte, M byte and L byte must be recognized on the basis of the first two bits (identifier bits), the identifier bits removed and the remaining bits recombined to form a 16 or 18-bit data word.

D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Fig. 8.1: Result of the conversion

The conversion must always be done in the user program. D16 and D17 are used to evaluate the error codes or for the measured value counter, for example.

i The sensor can continue to supply measured values to the RS422 output even while the sensor is communicating.

The IF2001/USB from Micro-Epsilon is suitable for data exchange with a PC. The IF2001/USB combines the three bytes of the data word and stores them in the FIFO. The 18 bits are used for measurement and error values. Further information can be found in the descriptions of the IF2001/USB interface card and the associated MEDAQlib driver program.

You can find the current program routine at: www.micro-epsilon.de/link/software/medaqlib.

9 Cleaning

We recommend cleaning the protective glass at regular intervals.

Do not expose yourself to unnecessary laser radiation.

► Switch off the sensor for cleaning and maintenance.

Dry cleaning

This can be accomplished with an anti-static lens brush or by blowing off the windows with dehumidified, clean, oil-free compressed air.

Wet cleaning

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

NOTICE
► Never use commercially available glass cleaners or other cleaning agents.

10 Software support with MEDAQLib

MEDAQLib is a documented driver DLL. This allows you to integrate sensors from Micro-Epsilon in conjunction with a converter or interface module into existing or customer-specific PC software.

MEDAQLib

- contains a DLL that can be imported into C, C++, VB, Delphi and many other programs,
- takes care of data conversion for you,
- works regardless of the type of interface used,
- uses the same functions for communication (commands),
- provides a uniform transmission format for all Micro-Epsilon sensors.

For C/C++ programmers, an additional header file and a library file are integrated into MEDAQLib.

- You can download the MEDAQLib installation files to your computer via the link https://www.micro-epsilon.com/link/software/medaqlib.
- For further information on MEDAQLib, please visit https://www.micro-epsilon.com/service/software-sensorintegration/medaqlib.

11 Disclaimer

All components of the device have been checked and tested for functionality in the factory. However, should any defects occur despite careful quality control, these shall be reported immediately to Micro-Epsilon or to your distributor / retailer.

Micro-Epsilon undertakes no liability whatsoever for damage, loss or costs caused by or related in any way to the product, in particular consequential damage, e.g., due to

- non-observance of these instructions/this manual,
- improper use or improper handling (in particular due to improper installation, commissioning, operation and maintenance) of the product,
- repairs or modifications by third parties,
- the use of force or other handling by unqualified persons.

This limitation of liability also applies to defects resulting from normal wear and tear (e.g., to wearing parts) and in the event of non-compliance with the specified maintenance intervals (if applicable).

Micro-Epsilon is exclusively responsible for repairs. It is not permitted to make unauthorized structural and / or technical modifications or alterations to the product. In the interest of further development, Micro-Epsilon reserves the right to modify the design or the firmware.

In addition, the General Terms of Business of Micro-Epsilon shall apply, which can be accessed under Legal details | Micro-Epsilon https://www.micro-epsilon.com/legal-details/.

12 Service, repair

If the sensor or sensor cables are defective:

- If possible, save the current sensor settings in a parameter set to reload them into the sensor after the repair.
- Please send us the affected parts for repair or exchange.

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

MICRO-EPSILON MESSTECHNIK
GmbH & Co. KG
Koenigbacher Str. 15
94496 Ortenburg / Germany

Tel: +49 (0) 8542 / 168-0
Fax: +49 (0) 8542 / 168-90
info@micro-epsilon.com
www.micro-epsilon.com/contact/worldwide/
https://www.micro-epsilon.com

13 Decommissioning, disposal

In order to avoid the release of environmentally harmful substances and to ensure the reuse of valuable raw materials, we draw your attention to the following regulations and obligations:

- Remove all cables from the sensor and/or controller.
- Dispose of the sensor and/or the controller, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.
- You are obliged to comply with all relevant national laws and regulations.

For Germany / the EU, the following (disposal) instructions apply in particular:

- Waste equipment marked with a crossed garbage can must not be disposed of with normal industrial waste (e.g. residual waste can or the yellow recycling bin) and must be disposed of separately. This avoids hazards to the environment due to incorrect disposal and ensures proper recycling of the old appliances.

- A list of national laws and contacts in the EU member states can be found at https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en. Here you can inform yourself about the respective national collection and return points.

- Old devices can also be returned for disposal to Micro-Epsilon at the address given in the legal details at https://www.micro-epsilon.com/legal-details.

- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.

- Under the registration number WEEE-Reg.-Nr. DE28605721, we are registered at the foundation Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg, as a manufacturer of electrical and/or electronic equipment.

14 Optional accessories

IF2001/USB		IF2001/USB 1-channel RS422/USB converter Connections: 1 x 10-pin socket strip (cable clamp) type: Würth 691361100010, 1 x 6-pin socket strip (cable clamp), type: Würth 691361100006
IF2035-EtherCAT IF2035-PROFINET IF2035-EtherNet/IP		Interface module for connection to EtherCAT, PROFINET or EtherNet/IP of a Micro-Epsilon sensor with RS485 or RS422 interface; DIN rail housing, incl. device description file for software integration in the PLC
PS2020		Power supply unit for DIN rail mounting Input 230 VAC, output 24 VDC/2.5 A
IF2004/USB		1-channel [13] RS422 to USB converter including driver, connections: 1× terminal block

[13] Only one channel possible for the ILD 1320.

15 Factory settings

Password	„000“
Measuring rate	1 kHz
Measuring range	100 % FSO: I = 20 mA, digital 64887
	0 % FSO: I = 4 mA, digital 643
Peak selection	Highest peak
Error handling	Error output, no measurement value

Measurement value averaging	Median 9
Language	German
Output	Current output
RS422	921.6 kBaud
Trigger mode	No trigger

Tab. 15.1: Factory setting Standard sensors

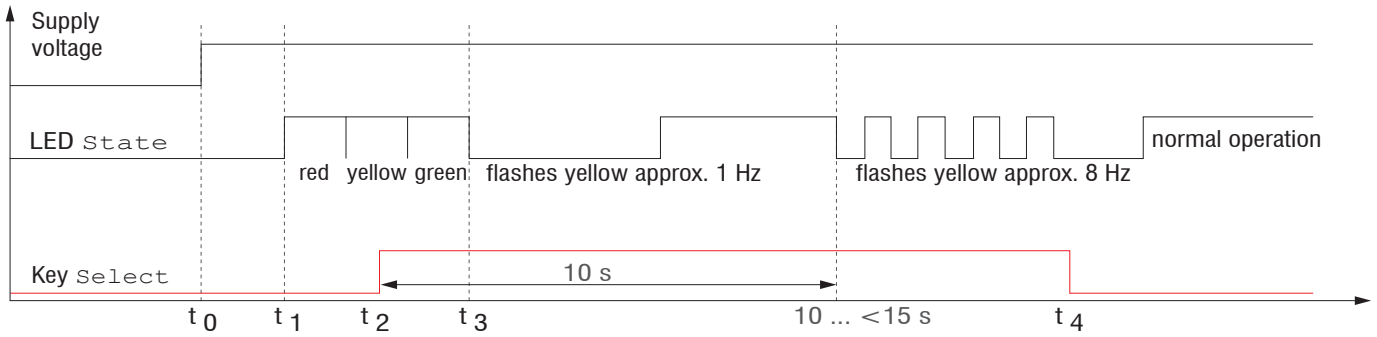


Fig. 15.1: Flowchart for booting with factory settings

t_0 : Supply voltage is applied

t_1 ... t_3 : Both LEDs signal the start sequence (red-yellow-green for 1 second each)

t_2 : `Select` key is pressed during the start sequence(t_1... t_3)

t_4 : `Select` key is released while the `State` LED flashes yellow
$\Delta t = t_4 - t_2$; Δt (keystroke duration) must be at least 10 seconds, max. 15 seconds

16 ASCII communication with sensor

16.1 General

The ASCII commands can be sent to the sensor via the RS422 interface. All commands, inputs and error reports are in English. A command always consists of the command name and zero or several parameters that are separated with a space and end in LF. If spaces are used in parameters, the parameter must be placed in quotation marks, e.g. “Password with space”.

Example: Switching on output via RS422

OUTPUT RS422	↵	
Note:	↵	Must contain LF, but can also be CR LF.
Explanation:	LF	Line feed (hex 0A)
	CR	Carriage return (hex 0D)
	↵	Enter (hex 0A or hex 0D0A depending on the system)

The currently set parameter value is reset if a command is invoked without parameters.

The entry formats are:

```
<Command name> <Parameter1> [<Parameter2> […]]
<Command name> <Parameter1> <Parameter2> ... <Parameter...>
```

or a combination thereof.

Parameters in [ ] brackets are optional and require you to enter the preceding parameter. Successive parameters without [ ] brackets are required, i.e. no parameter can be omitted. Alternative entries for parameter values are separated by “|”,

e.g. the values “a”, “b” or “c” can be set for “a|b|c”. Parameter values in **<>** brackets can be selected from a value range.

Explanations on the format:	
“a | b”	Parameter value can be set to the value “a” or “b”.
“ P1 P2”	Both parameters “P1” and “P2” must be set.
“ P1 [P2 [P3]]”	The parameters “P1”, “P2” and “P3” can be set, whereby “P2” can only be set if “P1” is set and “P3” can only be set if “P1” and “P2” are set.
"<a>"	Parameter value is within a value range of “... to ...” , see parameter description.

Parameter values without angle brackets can only be discrete values, see parameter description. Round brackets should be interpreted as a grouping, i.e. for better comprehensibility, “P1 P2|P3” is written as “(P1 P2)|P3”.

Example without [ ]:

"PASSWD <Old password> <New password> <New password>" - All 3 parameters must be entered in order to change the password.

The output format is:

<Command name> <Parameter1> [<Parameter2> […]]

The response can be used again without changes as a command for setting the password. Optional parameters are only returned as well if this is necessary. For example, for the data selection additional values command, only the activated output values are returned.

After a command is processed, a line break and a prompt (“->”) is always returned. In the event of an error, an error message beginning with “Exxx”, where xx stands for a unique error number, comes before the prompt. Moreover, instead of error messages, warning messages (“Wxxx”) may be output. Warnings are structured analogously to error messages. In the case of warning messages, the command has been executed.

For support requests regarding the sensor, the responses to the commands `GETINFO` and `PRINT` are helpful because they contain the sensor settings.

16.2 Commands

16.2.1 Commands overview

Group	Command	Brief information
General		
	HELP	Help on commands
	GETINFO	Request sensor information
	LANGUAGE	Determine language of website
	RESET	Reboot sensor
	ECHO	Switch the command reply, ASCII interface
	PRINT	Output all sensor settings
User level		
	LOGIN	Changing the user level
	LOGOUT	Switch to User level
	GETUSERLEVEL	User level query
	STDUSER	Set the standard user
	PASSWD	Change password
Triggering		
	TRIGGER	Select trigger type
	MFILEVEL	Select level for switching input
	TRIGGERCOUNT	Number of measurement values to be output
Interfaces		
	BAUDRATE	Set transmission rate of RS422
	UNIT	Select measurement unit of web interface
	MFIFUNC	Function selection multifunction input
	ERROROUT1	Activate switching output
	ERRORLEVELOUT1	Output level switching output
	ERRORLIMIT	Threshold value switching output
	ERRORHYSTERESIS	Hysteresis value switching output
	ERROROUTHOLD	Min. switching time of active switching output
Handling of setups		
	IMPORT	Loading parameters
	EXPORT	Export sensor settings
	MEASSETTINGS	Load/save measurement settings
	BASICSETTINGS	Load/save device settings
	SETDEFAULT	Factory settings
Scale analog output		
	ANALOGSCALE	Scale analog output
Key function		
	KEYFUNC	Select key function
	KEYLOCK	Set key lock
Measurement		
	MEASRATE	Select measuring rate
	LASERPOW	Select laser power
	MASTERMV	Mastering / zeroing
Data output		

Group	Command	Brief information
	OUTPUT	Measured value output selection
	OUTHOLD	Set error handling
	GETOUTINFO_RS422	Query data selection
	OUTADD	Data selection of additional values

16.2.2 General commands

16.2.2.1 Help

```
HELP [<Command>]
```

Output help for each command. If no command is given, a general help is output.

16.2.2.2 GETINFO, Sensor information

Request sensor information. Output see example below:

```
->GETINFO
Name:               ILD1320-10
Serial:             15030002
Option:             000
Article:            4120209
Cable head:         Wire
Measuring range:    10.00 mm
Version:            001.010
Hardware-rev:       00
Boot version:       001.006
```

Sensor model name, sensor series
Serial number
Option number of the sensor
Article number of the sensor

Measuring range of the sensor
Software version

16.2.2.3 LANGUAGE, Website

```
LANGUAGE DE | EN | CN | JP
```

Determines the language for the web interface

- DE: set language to German
- EN: set language to English
- CN: set language to Chinese
- JP: set language to Japanese

The selected language setting will take effect on the website.

16.2.2.4 RESET, Booting sensor

```
RESET
```

The sensor is restarted.

16.2.2.5 Reset counter

```
RESETCNT [TIMESTAMP] [MEASCNT]
```

The counter is reset after the selected trigger edge occurs.

TIMESTAMP:	resets the time stamp
MEASCNT:	resets the measurement counter

16.2.2.6 ECHO, Switching the Command Reply, ASCII Interface

```
ECHO ON|OFF
```

Setting the command reply with an ASCII command:

- ON: Command response on, e.g. <Kdo> ok (or error message)
  ->
- OFF: command reply off, e.g. ->

16.2.2.7 PRINT, Sensor settings

```
PRINT
```

Print is used to output all sensor settings.

Example of a response:

GETUSERLEVEL PROFESSIONAL	OUTPUT RS422
STDUSER PROFESSIONAL	OUTADD_RS422 NONE
BAUDRATE 921600	GETOUTINFO_RS422 DIST1
UNIT MM	OUTHOLD NONE
LANGUAGE DE	ERROROUT1 DIST
MFIFUNC NONE	ERRORLEVELOUT1 NPN
MFILEVEL HTL_HIGH	ANALOGSCALE STANDARD
KEYFUNC TEACH	ERRORLIMIT DIST1 0.000
KEYLOCK AUTO 5 (IS_ACTIVE)	ERRORHYSTERESIS 0.100
MEASRATE 1.000	ERROROUTHOLD 50
TRIGGER NONE	->
TRIGGERCOUNT 1	

16.3 User level

16.3.1 LOGIN, Change of the User Level

```
LOGIN <Password>
```

Enter the password to access another user level. There are the following user levels:

- USER (standard user): “read-only” access to all elements and graphical display of output values of web interface
- PROFESSIONAL (Expert): Read/write access to all elements

16.3.2 LOGOUT, Change into User Level

```
LOGOUT
```

Sets the user level to USER.

16.3.3 GETUSERLEVEL, User level query

```
GETUSERLEVEL
```

Queries the current user level.

16.3.4 STDUSER, Set Standard User

```
STDUSER USER|PROFESSIONAL
```

Sets the standard user who is logged in after the system starts. Standard user does not change with LOGOUT, i.e. login as standard user is done automatically after the command RESET or power supply of sensor is switched on.

16.3.5 PASSWD, Change Password

```
ASSWD <Old password> <New password> <New password>
```

Changes the password for the PROFESSIONAL level.

The old password must be entered once, and the new password twice. If the new passwords do not match, an error message is displayed. A password may only contain letters (A to Z) and numbers, but no letters with accents or umlauts. Upper and lower case are distinguished. The maximum length is limited to 31 characters.

16.4 Triggering

The multifunction input also serves as a trigger input for the output of measured values.

16.4.1 TRIGGER, Trigger selection

```
TRIGGER NONE|EDGE|PULSE
```

- NONE: No triggering
- PULSE: Level triggering
- EDGE: Edge triggering
- SOFTWARE: Software triggering

16.4.2 MFILEVEL, Input Level Multi-Function Input

```
MFILEVEL HTL_HIGH|HTL_LOW
```

Selection of switching or trigger level for the multi-function input

- HTL_HIGH: High active (edge triggering: rising edge, level triggering: high active)
- HTL_LOW: Low active (edge triggering: falling edge, level triggering: low active)

16.4.3 TRIGGERCOUNT, Number of Output Measurement Values

```
TRIGGERCOUNT NONE | INFINITE | <n>
<1...16382>
```

Number of Output Measurement Values with Triggering

- NONE: End triggering and start continuous output
- INFINITE: Start of continuous output after first trigger event
- <n>: Number of values to be output after each trigger event n = 1 to 16382.

16.4.4 Software trigger pulse

```
TRIGGERSW
```

Generates a software trigger pulse when the trigger source is set to software.

Command is mapped in the SDO 0x35B0.

16.5 Interfaces

16.5.1 BAUDRATE, RS422

```
BAUDRATE 9600|19200|56000|115200|128000|230400|256000|460800|691200|921600|1000000
```

Sets the baud rate for the RS422 interface.

16.5.2 UNIT, Measurement unit of web interface

```
UNIT MM|INCH
```

Changes the display of measured values on the websites. The command has no influence on the ASCII interface.

- MM Values are displayed in mm
- INCH Values are displayed in inches

16.5.3 MFIFUNC, Function selection multifunction input

```
MFIFUNC NONE | MASTER | TEACH | TRIGGER
```

Select the function of the multifunction input.

- NONE: Multifunction input has no function
- MASTER: Multifunction input is master pulse input
- TEACH: Multifunction input is teach input for analog output
- TRIGGER: Multifunction input is trigger input

16.5.4 ERROROUT1, Activate switching output

```
ERROROUT1 NONE|DIST|TEACH|LI1
```

Choose error signal of the ERROR switching output.

- NONE: Switching output deactivated
- DIST: no peak found or beyond measuring range (out of range)
- TEACH: Distance is out of scaled analog range
- - LI1: Distance is greater than the limit value (ERRORLIMIT)

16.5.5 ERRORLEVELOUT1, Output level switching output

```
ERRORLEVELOUT1 NPN|PNP|PUSHPULL|PUSHPULLNEG
```

Choice of output level for ERROROUT1.

- NPN: Switching output is active in the event of an error.
- PNP: Switching output is active in the event of an error.
- PUSHPULL: Switching output is high in the event of an error.
- PUSHPULLNEG: Switching output is low in the event of an error.

Wiring of the switching output ERROR1, see Chap. 5.4.8

16.5.6 ERRORLIMIT

```
ERRORLIMIT DIST1 <upper threshold>
```

Value which activates switching output when exceeded.

Value range: -2 ... 2 * measuring range [mm].

16.5.7 ERRORHYSTERESIS

```
ERRORHYSTERESIS <hysteresis>
```

Value by which the measured value must fall short of the limit value to deactivate the switching output. Value range: 0 ... 2 * measuring range [mm].

16.5.8 ERROROUTHOLD

```
ERROROUTHOLD [<hold period [ms]>]
```

Specification of the minimum time in ms for which the switching output should remain active if the limit value is exceeded. The time period begins when the limit value is exceeded. Value range: 0 ... 1000 [ms].

16.6 Handling of setups

16.6.1 IMPORT

```
IMPORT [FORCE] [APPLY] <ImportData>
```

Importing data in JSON format [14] into the sensor.

First, the import command returns a prompt (->). Afterwards, data can be sent. After importing a prompt (->) is returned.

- FORCE: Overwriting measurement settings (`= MEASSETTINGS`) with the same name (otherwise an error message is displayed if the names are the same). FORCE must always be specified when importing all measurement settings or the device settings(`= BASICSETTINGS`).
- APPLY : Activates the settings after importing / reading the Initial Settings.
- ImportData: Data in JSON format

16.6.2 EXPORT

```
EXPORT ALL | MEASSETTINGS_ALL | (MEASSETTINGS <SetupName>) | BASICSETTINGS
```

Exporting the sensor settings. In response, the data is transferred in JSON format. Finally, there is another prompt.

16.6.3 MEASSETTINGS, Load / save measurement settings

```
MEASSETTINGS <Subcommand> [<Name>]
```

Settings for measurement task. Loads manufacturer-defined presets or a user-specific setup from the sensor or saves a user-specific setup in the sensor.

Subcommands:

`CURRENT`	Outputs the name of the current measurement setting.
`PRESETLIST`	Lists all existing presets.
`LIST`	Lists all saved measurement settings.
`READ <Name>`	Loads a preset or a measurement setting from the sensor.
`STORE <Name>`	Saves the current measurement setting in the sensor.
`DELETE <Name>`	Deletes a measurement setting.
`RENAME <NameOld> <NameNew> [FORCE]`	Renames a measurement setting. An existing measurement setting can be overwritten with FORCE.
`INITIAL AUTO:`	Loads the last saved measurement setting when the sensor is started.
`INITIAL <Name>`	Loads a named measurement setting when the sensor is started.
`PRESETMODE`	Returns the set signal quality.
`PRESETMODE <mode>`	Sets the signal quality. The signal quality can only be set if a preset has been loaded.

`<mode>` = BALANCED|DYNAMIC|NOAVERAGING

16.6.4 BASICSETTINGS, Load/save device settings

```
BASICSETTINGS READ | STORE
```

- READ: Loads the saved device settings from the sensor.
- STORE: Saves the current device settings in the sensor.

[14] JSON format, see https://de.wikipedia.org/wiki/JavaScript_Object_Notation

16.6.5 SETDEFAULT, factory settings

```
SETDEFAULT ALL | MEASSETTINGS | BASICSETTINGS
```

Resets the sensor to factory settings.

- ALL: Deletes the measurement and device settings and loads the standard presets for the measurement settings and default parameters for the device settings.
- MEASSETTINGS: Deletes the measurement settings and loads the standard presets.
- BASICSETTINGS: Deletes the device settings and loads the default parameters.

16.7 Key function

16.7.1 KEYFUNC, Select key function

```
KEYFUNC NONE | MASTER | TEACH
```

Selection of key function.

- NONE: Key has no function.
- MASTER: Use key for mastering.
- TEACH: Use key for teaching.

16.7.2 KEYLOCK, Set keylock

```
KEYLOCK NONE | ACTIVE | AUTO <time>
```

Selection of the key lock.

- NONE: Key is activated continuously, no key lock.
- ACTIVE: Key lock is activated immediately after restart.
- AUTO: Key lock is only activated <time> minutes after a restart.

16.7.3 ANALOGSCALE, Scaling the analog output

```
ANALOGSCALE STANDARD|(TWOPOINT <minimum value> <maximum value>)
```

Set the two-point scaling of the analog output.

- STANDARD: Utilize the measuring range of the sensor.
- TWOPOINT: Two-point scaling within the analog range (4 - 20 mA).
  - Minimum value: Measured value in mm that is assigned to the lower analog value (4 mA).
  - Maximum value: Measured value in mm that is assigned to the upper analog value (20 mA).

i The minimum value (in mm) can be greater than the maximum value (in mm), see Chap. 7.5.3.

16.8 Measurement

16.8.1 MEASRATE, Measuring rate

```
MEASRATE 0.25|0.5|1|2|4
```

Selection of the measuring rate in kHz.

16.8.2 LASERPOW, Laser Power

```
LASERPOW FULL | OFF
```

- FULL: Laser power is switched to 100 %.
- OFF: Laser is switched off.

16.8.3 MASTERMV, Mastering / zeroing

```
MASTERMV NONE|MASTER <MV>
```

- NONE: Ends the mastering.
- MASTER: Setting the current measured value as the master value.
- MV: Master value in millimeters; MV = (0 ... 2) * Measuring range, i.e. the master value must be within the measuring range.

If the master value is 0, the mastering function has the same functionality as the zero setting. When mastering the analog output, the parameter MV always acts as 0 (zero setting) regardless of the input.

The master command waits for a maximum of 2 seconds for the next measurement value and uses this as master value. If no value is measured within this time, e.g. in case of external triggering, the command returns with the error „E220 Timeout“.

The master value is processed with six decimal places.

Please note that the output value is limited to 18 bits.

16.8.4 Measurement value processing

16.8.4.1 MASTERMV, Mastering / zeroing

```
MASTERMV NONE|MASTER <MV>
```

- NONE: Ends the mastering.
- MASTER: Setting the current measured value as the master value.
- MV: Master value in millimeters; MV = (0 ... 2) * Measuring range, i.e. the master value must be within the measuring range.

If the master value is 0, the mastering function has the same functionality as the zero setting. When mastering the analog output, the parameter MV always acts as 0 (zero setting) regardless of the input.

The master command waits for a maximum of 2 seconds for the next measurement value and uses this as master value. If no value is measured within this time, e.g. in case of external triggering, the command returns with the error „E220 Timeout“.

The master value is processed with six decimal places.

Please note that the output value is limited to 18 bits.

16.8.5 Data output

16.8.5.1 OUTPUT, Selection of Measurement Value Output

```
OUTPUT NONE|RS422|ANALOG
```

- NONE: No output of measured values
- RS422: Output of measured values via RS422
- ANALOG: Output of measurement values via analog output

16.8.5.2 OUTHOLD, Error Handling

```
OUTHOLD NONE|INFINITE|<n>
```

Sets the measured value output behavior in the event of an error.

- NONE: Last measured value not held; error value output.
- INFINITE: Infinite holding of the last measurement value.
- <n>: Holding the last measured value over n measuring cycles; then an error value is output. n = (1 ... 1024).

16.8.6 Selection of the measurement values to be output

16.8.6.1 GETOUTINFO_RS422, Data Selection Query

```
GETOUTINFO_RS422
```

The command lists all output data selected for the RS422 interface. The order shown corresponds to the output order.

16.8.6.2 OUTADD_RS422, Data selection of additional values

```
OUTADD_RS422 NONE|([SHUTTER] [COUNTER] [TIMESTAMP] [INTENSITY] [STATE] [DIST_RAW])
```

Selection of additional values to be transmitted.

- NONE: No output of any further values
- SHUTTER: Outputs the exposure time
- COUNTER: Outputs the measured value counter
- TIMESTAMP: Outputs the time stamp
- INTENSITY: Outputs the intensity parallel to each distance value
- STATE: Outputs the status word
- DIST_RAW: Outputs the uncalibrated distance value (raw value)

16.8.7 Example command sequence during selection of measurement value

Command	Contents
MEASPEAK	Peak selection with distance measurement
MEASRATE	Measuring rate (by taking into consideration reflectivity and movement of the target)
OUTPUT	Selection of the output channel
OUTHOLD	Output behavior in the event of measuring errors
OUTADD_RS422	Selection of the additional values to be output for RS422 interface
BAUDRATE	Baud rate setting RS422 interface

16.8.8 Error messages

If an error occurs with a command, the error message is listed.

Error message		Description
E100	Internal error	Internal error code
E104	Timeout	Timeout during mastering
E200	I/O operation failed	Cannot write data on output channel.
E202	Access denied	Access denied; requires login as expert.
E204	Received unsupported character	An unsupported character has been received.
E210	Unknown command	Unknown command (insufficient rights for reading)
E214	Entered command is too long to be processed	The specified command with the parameters is too long (greater than 255 bytes).
E220	Timeout, command aborted	Timeout during mastering
E232	Wrong parameter count	Number of parameters too high or too low
E234	Wrong or unknown parameter type	A transmitted parameter has the wrong type or the wrong number of parameters has been passed.
E236	Value is out of range or the format is invalid	The parameter value is outside the range of values.
E262	Active signal transfer, please stop before	One measurement data output is active. End the measurement data output in order to execute the command.
E320	Wrong info-data of the update	Only when updating: the header of the update data contains an error
E321	Update file is too large	Only with update: The update is too large.

Error message		Description
E322	Error during data transmission of the update	Only when updating: Error when transferring the update data
E323	Timeout during the update	Only when updating: Timeout when transferring update data
E331	Validation of import file failed	Import file is invalid.
E332	Error during import	Error with processing import data.
E333	No overwrite during import allowed	No overwrite of measurement and device settings allowed through import. Setting checkbox.
E350	The new passwords are not identical	Error when repeatedly entering the new password
E360	Name already exists or not allowed	Name for the measurement setting already exists or is not permitted.
E361	Name begins or ends with spaces or is empty	Name for the measurement setting begins or ends with a space or is empty.
E362	Storage region is full	Number of storable measurement settings is reached.
E363	Setting name not found	Name of the measurement setting to be loaded not found.
E364	Setting is invalid	Measurement setting or device setting is invalid.
E602	Master value is out of range	The master value is outside the valid range.
E616	Software triggering is not active	Software trigger is not active.

Warning		Description
W320	The measuring output has been adapted automatically.	The measurement value output has been adapted automatically.

17 Operating menu

17.1 Home tab

Measurement task	Preset	*Standard*	*Suitable for materials made of ceramic, metal or filled plastics*
		Changing surfaces[9]	*Suitable for circuit boards (PCB) or hybrid materials*
		Material with penetration[9]	*Suitable for plastics (POM, Teflon), materials with strong penetration depth of the laser*
	Setup	*Setup 1*	*A setup contains the user-specific measurement settings. Unlike presets, it can be changed at any time.*
Signal quality		*static / balanced / dynamic / off*	*The signal quality affects the averaging of measurement values.*

17.2 Settings tab

17.2.1 Inputs

Laserpower	*On / Off*		*Laser on/off is only effective when Pin 8 is connected to GND.*
Multifunction input	*Zeroing (mastering)*	*High / Low*	*Defines the function of the switching input. The trigger influences the recording and output of a measured value. Zeroing/mastering sets the current measurement value to the entered master value. Teaching scales the analog output. HTL is defined as the active input level.*
	Trigger In	*High / Low*	
	Teaching		
	Inactive		
Key function	*Zeroing (mastering)*		*Defines the function of the sensor button. Inactive means key lock.*
	Teaching		
	Inactive		

17.2.2 Signal processing

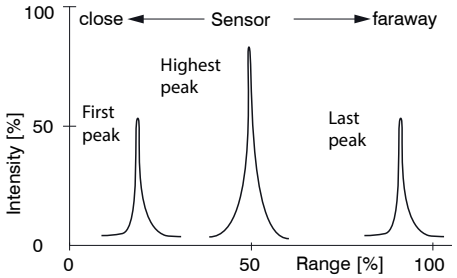
Measuring task	*Standard*	*Suitable for materials made of ceramic, metal or filled plastics*
	Changing surfaces[9]	*Suitable for circuit boards (PCB) or hybrid materials*
	Material with penetration[9]	*Suitable for plastics (POM, Teflon), materials with strong penetration depth of the laser*

Measuring rate	*250 Hz / 500 Hz / 1 kHz / 2 kHz / 4 kHz*	*Use a high measuring rate for bright and mat measuring objects. Use a low measuring rate for dark or shiny measuring objects (e.g. black painted surfaces) to improve the measurement result.*

[9] Available for the ILD1320-10/25/50 sensor models.

Triggering (data output)	*Level*			*Measurement values are output continuously as long as the selected level applies. Level selection, see Chap. 7.3. The pulse duration must be at least as long as one cycle. The subsequent pause must be at least as long as one cycle.*
	Edge	*Infinite*		*Edge selection, see Chap. 7.3. "0" Stop triggering, "1 ... 16382" values per trigger, "16383" End lot trigger*
		Manual selection	Number value	
	Software	*Infinite*		*A software trigger is started by pressing the Trigger button. "0" Stop triggering, "1 ... 16382" values per trigger, "16383" End lot trigger*
		Manual selection	Number value	
	Inactive			Stop triggering

Peak selection		*Defines which signal in the array signal is used for the evaluation.*
	First peak	*First peak: Nearest peak to sensor.*
	Highest peak	*Highest peak: Standard, peak with the highest intensity.*
	Last peak	*Last peak: Peak furthest away from sensor.*



Error handling	*Error output, no measurement value*		*The analog output provides 3 mA instead of the measured value. The RS422 interface outputs an error value.*
	Hold last value infinitely		*The analog output and RS422 interface remain on the last valid value.*
	Hold last value	*1... 1024*	value

Zeroing/mastering	*Inactive*		*Normal measurement value or zeroing/mastering is reversed.*
	Active	value	*Specification, e.g. of the thickness of a master piece. Value range 0 to max. +2x measuring range*

17.2.3 Outputs

RS422	*Baud rate*	*9.6 / 19.2 / 56.0 / 115.2 / 230.4 ... / 1000 kBps*		*Transmission speed, binary data format*
	Output data	*Distance* *Exposure time* *Intensity* *Sensor status* *Measurement counter* *Non-linearized focal point* *Timestamp*		*The data intended for transmission must be activated with the checkbox.*
Analog output	*Standard scaling*			*Start of measuring range 4 mA, at the end of measuring range 20 mA*
	Two-point scaling	Start of range	value	In every case, 2 points are taught which characterize the start and the end of the new measuring range. Two-point scaling allows the output signal to be reversed.
		End of range	value	

Error output (switching output)	*Inactive*			
	Analog range / measuring range	*NPN / PNP / PushPull / PushPullNeg*		*Controls the switching behavior of the switching output (error),, see Chap. 5.4.8 (error), see Chap. 5.4.8. Analog range: The switching output switches when the scaled analog range is exceeded. Measuring range: The switching output switches when the peak is not (completely) within the region of interest (ROI). Limit value: The switching output switches when the limit value is exceeded.*
	Limit value	*NPN / PNP / PushPull / PushPullNeg*		
		Limit value	value	
		Hysteresis	value	
		Minimum hold time	value	
Data output	*Web interface / Analog / RS422*			*Decides on the interface used for outputting the measured value. Parallel physical output of measurement values via RS422 and analog is not possible. If Web interface is selected, no measurement values are output via RS422 or the current output.*

		LED output	Web interface		RS422	Current output
			Parameter setting	Measurement chart		
Selected data output	Web interface	yellow	x	x		
	RS422	green	x		x	
	Analog	red	x	x		x

17.2.4 System settings

Unit on the web interface	*mm / inches*	*Unit on the web interface*

Key lock	*Automatic*	Range from 1 ... 60 [min]	value	*The key lock is activated after the defined time has elapsed. Click on the `refresh` button to extend the time until the key lock is activated.*
		refresh		
	active			*The `Select` button does not respond to inputs, regardless of the user level.*
	inactive			*The `Select` button is active, regardless of the user level.*

Load & Save	Measurement settings	*Creating a setup / Setup*	*Load*	*Activates a saved measurement setup.*
			Save	*Saves changed measurement settings to an existing setup.*
			Favorite	*Select a setup to be used after restarting the sensor.*
			Delete	*Deletes a setup.*
			Browse	*Both buttons load an existing setup from a PC or similar device into the ILD1320.*
			Import	
			Export	*Saves the setup on a connected PC or similar device.*
	Device settings	Create setup	*Load*	*Activates the saved device settings.*
			Save	*Saves changed device settings*
			Browse	*Use both buttons to load the device settings from a PC or similar device into the ILD1320.*
			Import	
			Export	*Saves the device settings on a connected PC or similar device.*

Import & Export	Create file	*Measurement settings*	*The measurement settings, the file containing the device settings, and the boot file can be combined in a parameter set and exchanged with a PC or similar device.*
		Boot setup	
		Device settings	
	Browse		*Button launches the file manager for selecting a parameter set.*
	Check parameter set	*Overwrite existing setups (with the same name)*	*Dialogue helps prevent unintentional overwriting of existing settings.*
		Apply settings from the imported boot setup	
		Transmit file	

Access authorization	Current access permissions	value		*read only*
	Logout / Login			*Button starts the change of access authorization.*
	User level when restarting	*Professional / User*		*Defines the user level that is enabled when the sensor starts the next time. MICRO-EPSILON recommends to select User level*
	Change password	Old password	value	*All passwords are case-sensitive; numbers are allowed. Special characters are not permitted. The maximum length is limited to 31 characters.*
		New password	value	
		Repeat new password	value	
		Change password		*Button triggers a change of password.*

Reset sensor	*Measurement settings*	*Deletes the settings for measuring rate, trigger, region of interest, peak selection, error handling, averaging, zeroing/mastering, data reduction and the setups. Loads the 1st preset.*
	Device settings	*Deletes the baud rate, language, unit, key lock and echo mode settings and loads the default parameters.*
	Reset all	*Deletes the settings for the sensor, the measurement settings, the access authorization, password and the setups. Loads the 1st preset.*
	Reboot sensor	*Reboots the sensor with the settings from the favorites setup*, see Chap. 7.6.4.

i The settings take effect when you click the "Apply" button. i After programming, save all settings permanently to a parameter set so that they will be available again the next time you switch on the sensor.

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