MICRO-EPSILON

Operating Instructions

optoCONTROL 2700

ODC2700-10

ODC2700-40

ODC2700-40(002)

Laser micrometer

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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

⚠ CAUTION

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

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

NOTICE

Avoid shocks and impacts to the light source and receiver.

- Damage to or destruction of the light source/receiver

Protect the cables against damage.

- Failure of the measuring device

The supply voltage must not exceed the specified limits.

- Damage to or destruction of the sensor

Avoid damage (scratches) to the protective windows of the light source and receiver through unsuitable cleaning methods or cleaning agents.

- Inaccurate or incorrect measurements

Do not touch the protective windows of the light source and receiver. Immediately wipe off any fingerprints.

- Inaccurate or incorrect measurements

Avoid constant exposure of light source and receiver 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 sensor is designed for use in industrial and laboratory environments.

It is used for

Measuring distance, position, geometry, and thickness

Monitoring Quality and Checking Dimensions

The sensor must only be operated within the limits 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

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

Optical windows are excluded from the protection class. This is because soiling of the windows will cause 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 Functional principle, technical data

2.1 Description

The optoCONTROL 2700 is a high-resolution, two-sided telecentric micrometer for measuring dimensional quantities – such as diameters, gaps, positions, and segments – using a shadow-casting or light section process.

The sensor consists of a light source and a receiver, which are electrically connected via an eight-pin cable. A mounting rail forms the mechanical connection between the light source and receiver.

The sensor offers a high measuring rate with accuracies in the micrometer range. This enables precise measurements to be achieved even in the context of fast processes.

When using the sensor to determine a diameter, tilted targets in the xy direction will lead to distorted measurement results. The active tilt correction feature corrects this error during operation at the full measuring rate.

All evaluation takes places inside the receiver.

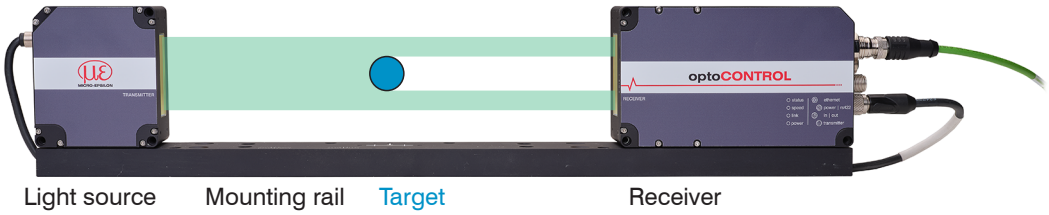


Fig. 2.1: The optoCONTROL 2700 sensor

2.2 Functional Principle

The sensor relies on the shadow-casting principle and contactlessly measures the dimensions of a target or the position of an object's edge.

The light source uses a high-quality telecentric optical system to produce a collimated light beam. The light source is aligned with the receiver, where the transmitted light hits an image matrix after passing through a telecentric lens. If a target is located between the light source and the receiver, part of the light is obstructed and does not hit the image matrix.

Dark patches or shadows are detected on the image matrix. In this way, it is possible to detect edge positions and to evaluate dimensional quantities obtained from the shadow – such as diameters, gaps, and positions – as well as multiple segments.

Neither the light source nor the receiver contain any moving parts, making the sensor virtually wear-free.

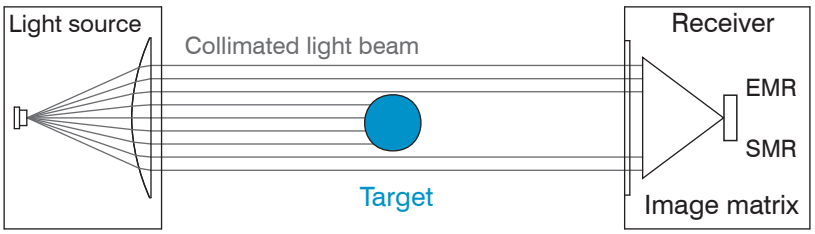


Fig. 2.2: optoCONTROL 2700 measuring principle

The search direction defines the starting point for an edge definition and, in turn, the numbering/order.

- Standard: Search begins at SMR (start of measuring range)
- Inverse: Search begins at EMR (end of measuring range)

Falling edge measuring program: The sensor searches for a light-dark transition.

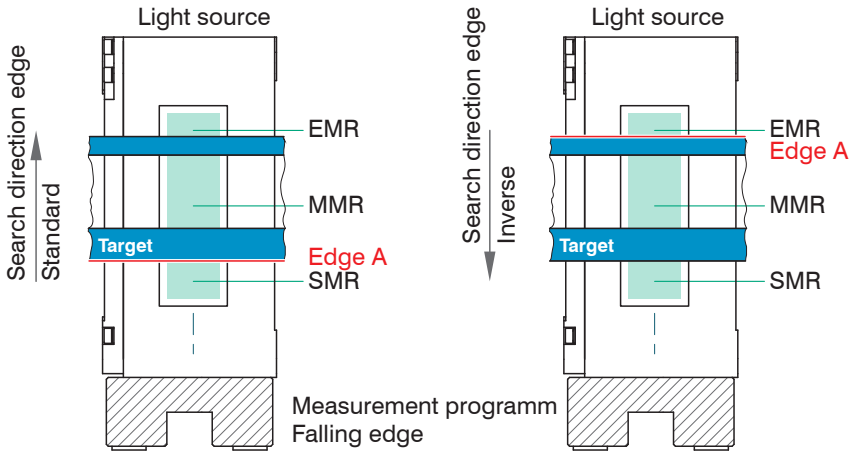


Fig. 2.3: Edge assignment with falling edge measuring program

Rising edge measuring program: The sensor searches for a dark-light transition

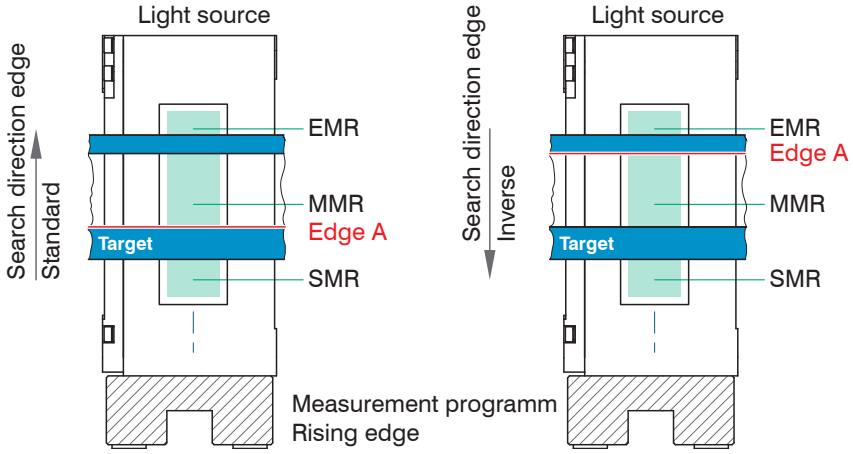


Fig. 2.4: Edge assignment with rising edge neasuring program

i The `search direction` and `measurement direction` parameters in the measuring program (data acquisition) affect the analog and digital outputs by changing the edge assignment.

2.3 Block diagram

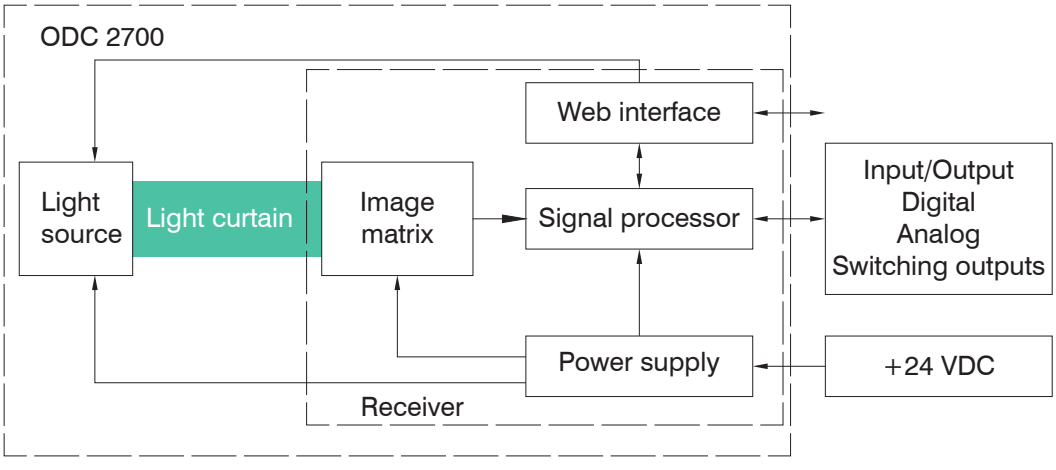


Fig. 2.5: Block diagram of the ODC2700 sensor

The integrated controller evaluates the image matrix and outputs the measured values via analog or digital interfaces.

Various parameterization methods are available, including a web interface (Ethernet) and ASCII commands.

2.4 Functions

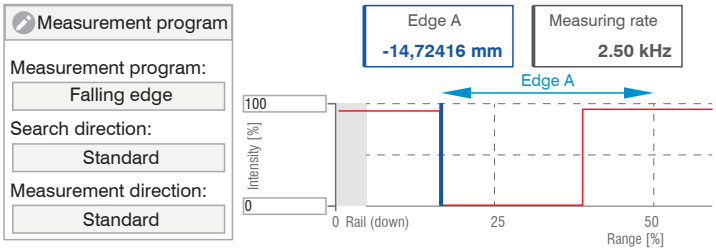
The optoCONTROL 2700 sensor supports the following functions:

- Edge measurements using a shadow-casting process (edge light-dark; edge dark-light)
- Diameter, width, gap width measurement
- Any segment layers or widths
- Freely selectable edges
- Reversible counting direction
- Calculation of center axes between edges
- Counting of edges and segments (pins or gaps)
- Online chart with user levels via web interface
- Ethernet
- Data logger function
- Limitation of the measuring range (for masking out protruding machine parts)
- Triggering and synchronization
- Adjustable switching thresholds
- Statistical values, such as min./max., peak-to-peak, and various types of averaging
- Simultaneous output of up to 8 segments, 16 edge positions, and their center axis
- Setup mode via web interface

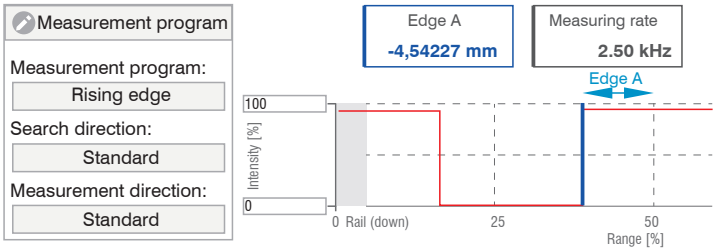
2.5 Operating modes

A preset is a predefined configuration of settings that will produce the best results for the selected measuring task.

Preset
Web edge

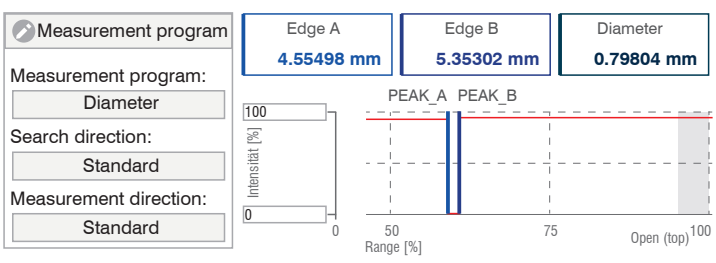


This setting is intended for controlling and measuring web edges, e.g., paper, sheet metal, or film. The signal quality should be adjusted to suit the material (paper webs – high averaging, metal sheets – median, films – low averaging).

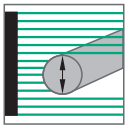


Measurement direction
Determines the reference point of the measured value
standard: Position measured by starting at the MMR (mid of measuring range) and moving toward the mounting rail
inverse: Position measured by starting at the MMR (mid of measuring range) and moving toward the EMR (end of measuring range)

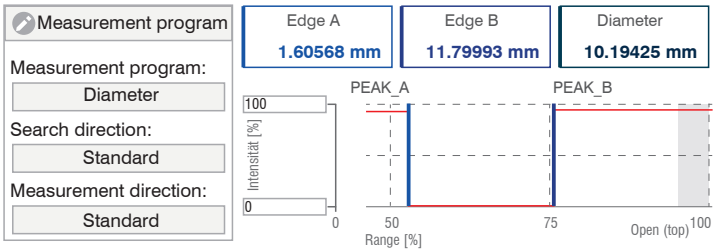
Preset
Wire measurement



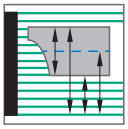
For measuring a thin object that passes through quickly, e.g., wire. Signal and frame averaging are deactivated. The measurement provides the current measured value for each point in time, making it insensitive to vibrations.



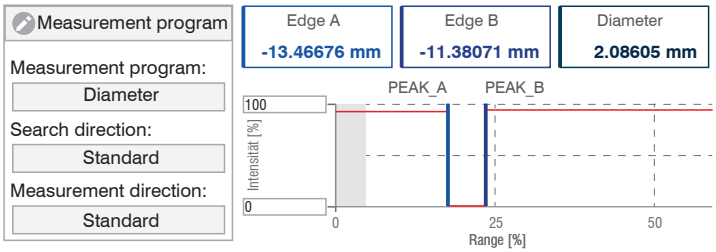
Preset Diameter



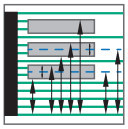
For measuring the diameter of cylindrical objects, e.g., dowel pins, pins, bar stock, pipes, hydraulic lines. If the object is tilted in relation to the measuring plane, the active tilt correction feature compensates for this in real time.



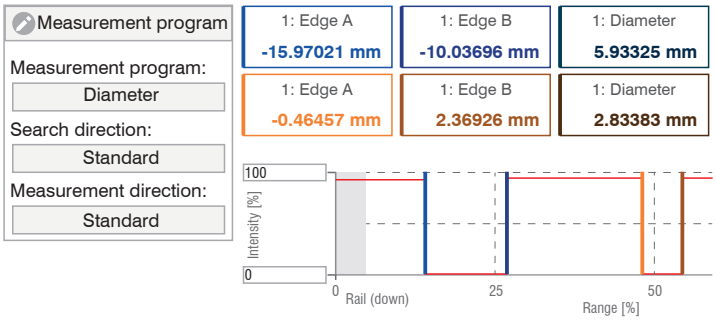
Preset Contour measurement



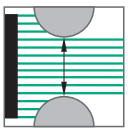
For measuring component contours on a stepped turned part. The following are captured: lower edge (A), upper edge (B), center axis (C), diameter (D), and encoder value.



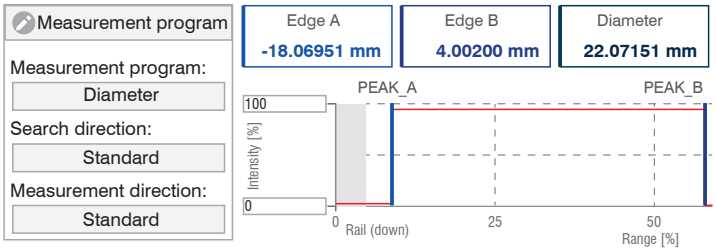
Preset Multi-segment



For the simultaneous measurement of several objects within the beam path – e.g., strips or wires – or for the targeted capture of segments selected by the user. User- and application-specific segments can be custom-defined.
The multi-segment preset allows the edges to be custom-assigned to each other. You can find more details on this in the “Advanced settings” section.



Preset Gap measurement



For measuring the gap between two objects. The width of the gap is output along with the angular deviations of the gap edges (AT and BT). Can be used in roller systems, such as calender rolls.

You can find more information about selection and programming under the measuring programs

2.6 Technical data

Model	ODC 2700-10 Ethernet	ODC 2700-40 Ethernet
Measuring range	10 mm	40 mm
Min. target size [1]	0,05 mm (0,03 mm)	0,3 mm (0,1 mm)
Distance light source - receiver	300 mm	300 mm (Option002 = 400 mm)
Measuring distance target - receiver	150 (±2,5) mm	150 (±10) mm (Option002 = 200 (±10) mm)
Sampling rate [2]	15.0 kHz	
Measuring rate [3]	5.0 kHz	

[1] Value in brackets related to the mid of the measuring range
[2] Number of measurements taken per second
[3] Number of measured values that are output at the sensor interface

Model		ODC 2700-10 Ethernet	ODC 2700-40 Ethernet
Exposure time [4]		8.5 µs	
Resolution [5]		10 nm	
Linearity [6]		≤ 0.5 µm [7]	≤ 1 µm [8]
Repeatability [6]		≤ 0.03 µm	≤ 0.1 µm
Light source		LED turquoise 508 nm (blue-green)	
Laser class		no laser, LED according to DIN EN 62471 risk group 1	no laser, LED according to DIN EN 62471 risk group 0
Permissible ambient light		30,000 lx indirect; 5000 lx direct irradiation	
Supply voltage		11 … 30 VDC	
Max. current consumption		≤ 1 A	
Signal input		3x inputs optionally for encoder, zero point, reset, trigger; light on/off (can be switched off via menu)	
Digital interface [9]		Ethernet, RS422 (up to 8 MBaud) EtherCAT, EtherNet/IP, PROFINET	
Analog output		0 ... 10 VDC / 4 ... 20 mA (16 bit, freely scalable within the measuring range)	
Switching output		3 outputs, optionally for errors and 2x limit values, not electrically separated 24V logic (HTL), high level depends on operating voltage Switchable TTL level	
Digital output		Synchronization	
Connection	Light source	integrated cable 0.8 m, with 8-pin M8 socket for power supply	
	Receiver	8-pin M12 plug for light source supply, 12-pin M12 socket for power supply, sync. and RS422, 4-pin M12x1 socket for Ethernet or fieldbus, 17-pin M12 plug for analog, outputs (errors, limit values) - inputs (trigger/encoder)	
Mounting		integrated mounting rail with mounting holes	
Temperature range [10]	Storage	-20 ... +70 °C	
	Operation	0 ... +50 °C	
Shock (DIN EN 60068-2-27)		15 g / 6 ms in XY axis, 100 shocks each	
Vibration (DIN EN 60068-2-6)		2 g / 20 … 500 Hz in XY axis, 10 cycles each	
Protection class (DIN EN 60529)		IP67	
Material		Aluminum housing	
Weight	Light source	approx. 400 g	approx. 500 g
	Receiver	approx. 900 g	approx. 1400 g
	Mounting rail	approx. 1000 g	approx. 1000 g

[4] With video averaging switched on = 3 x 8.5 µs exposures per measurement

[5] Numerical resolution of the output measured values

[6] The data applies to a 95% confidence interval for diameter measurements with an average of 1024 values over a period of 5 minutes in a temperature-stabilized environment after a warm-up time of 45 minutes.

[7] Measured with 2 mm testing pin at a measurement distance of 150 mm in measuring field 1 (Z=±0.5 mm) linearity ≤ 0,5, in measuring field 2 (Z=±1.5 mm) linearity ≤ 1 µm, in measuring field 3 (Z=±2.5 mm) linearity ≤ 2,5 µm

[8] Measured with 2 mm testing pin at a measurement distance of 150 mm in measuring field 1 (Z=±2.5 mm). In measuring field 2 (Z=±10 mm) linearity ≤ 3 µm - 95% confidence interval

[9] EtherCAT, PROFINET and EtherNet/IP: Connection via interface module (see accessories) directly in the sensor "on board"

[10] Relative humidity % 5 ... 95 (non-condensing)

Model	ODC 2700-10 Ethernet	ODC 2700-40 Ethernet
Measuring programs	Diameter / gap / segment measurement / edge measurement with rising or falling edge / search and measurement direction / additional detection of edge positions and center axes	
Presets	Strip edge / wire measurement / (outer) diameter incl. inclination correction / contour measurement incl. encoder value / Multi-segment as well as roller, gap and angle measurement	
Control and indicator elements	4x LED (power, status, link, speed) Website: Tilt angle correction, contamination display, 6 application-specific presets, freely selectable averaging, data reduction, 8 editable user programs, measured value time diagrams, measured value display in mm / inch, video signal, set-up mode with measuring line and measuring object; menu language German, English an others	
Special features	Including "sensorTOOL" software for data acquisition and processing, "MedaQLib" programming database	

3 Delivery

3.1 Unpacking, included in delivery

- 1 light source with pigtail
- 1 receiver
- 1 mounting rail
- 1 setup guide
- 1 acceptance protocol

The light source and receiver are mounted on the mounting rail as a single unit.

► Carefully remove the components of the sensor from the packaging, handling them in such a way that no damage can occur.

i Do not touch the optical windows. Soiling of the optical windows will impair the functionality.

► 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

3.2 Storage

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

4 Installation and assembly

4.1 General

The optoCONTROL sensor is an optical system used to measure in the µm range.

i Ensure careful handling during installation and operation.

NOTICE

Do not touch the optical windows.
> Functionality impaired due to soiling.

No sharp or heavy objects should be allowed to affect the cables. Avoid folding the cables.
> Damage or destruction of the cables, failure of the measuring device.

Observe the minimum bending radii of 60 mm.

Only attach the sensor using the existing holes on a flat surface. Any type of clamping is not permitted.
> Inaccurate or incorrect measurements

The connection cables between the light source and receiver and the Ethernet cable are not drag chain-compatible.

4.2 Light Source and Receiver

4.2.1 Dimensions

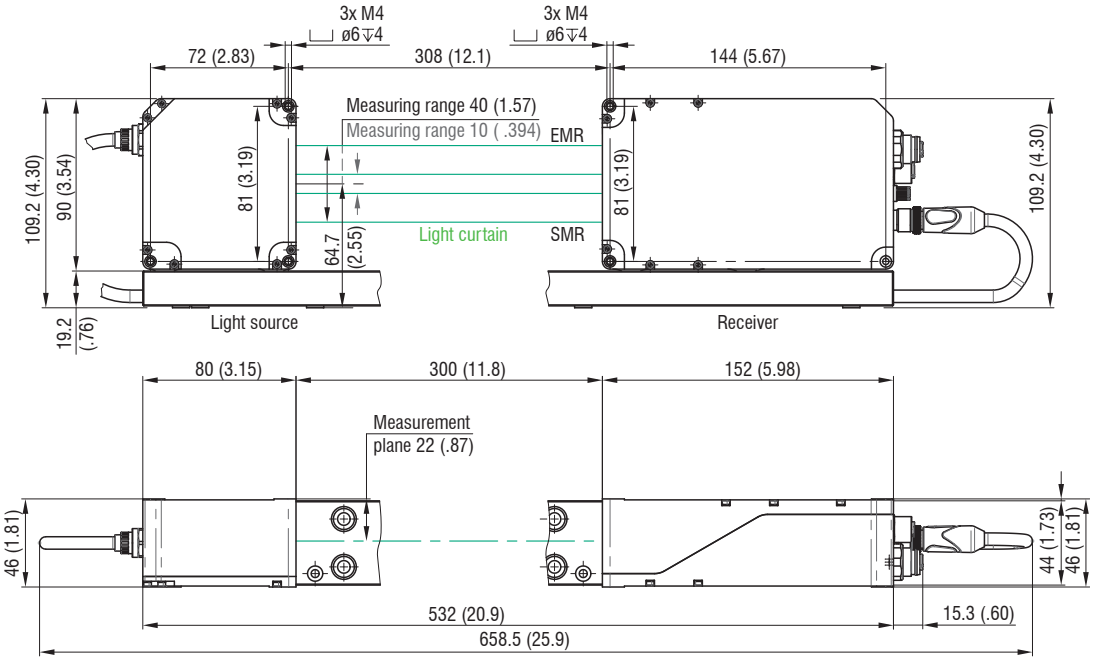


Fig. 4.1: Dimensional drawing light source and receiver ODC2700-10, ODC2700-40, dimension in mm

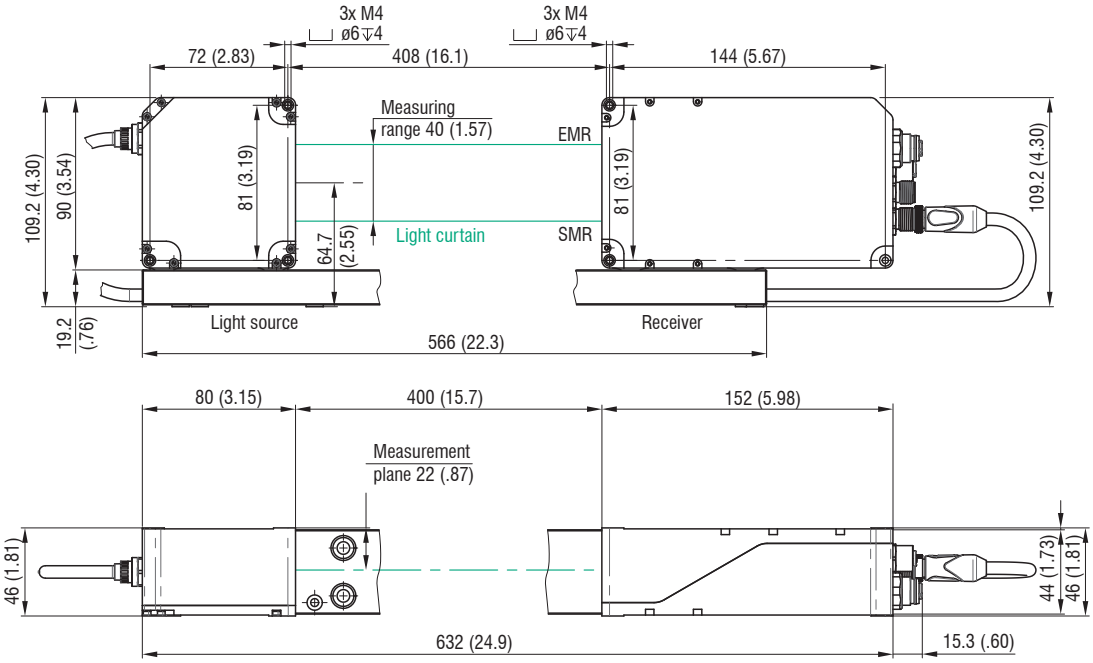


Fig. 4.2: Dimensional drawing light source and receiver ODC2700-40(002), dimensions in mm

4.2.2 Mounting on mounting rail

The sensor unit – comprising the light source, receiver, and mounting rail – is preassembled.

The mounting rail ensures that the components are correctly aligned with one another.

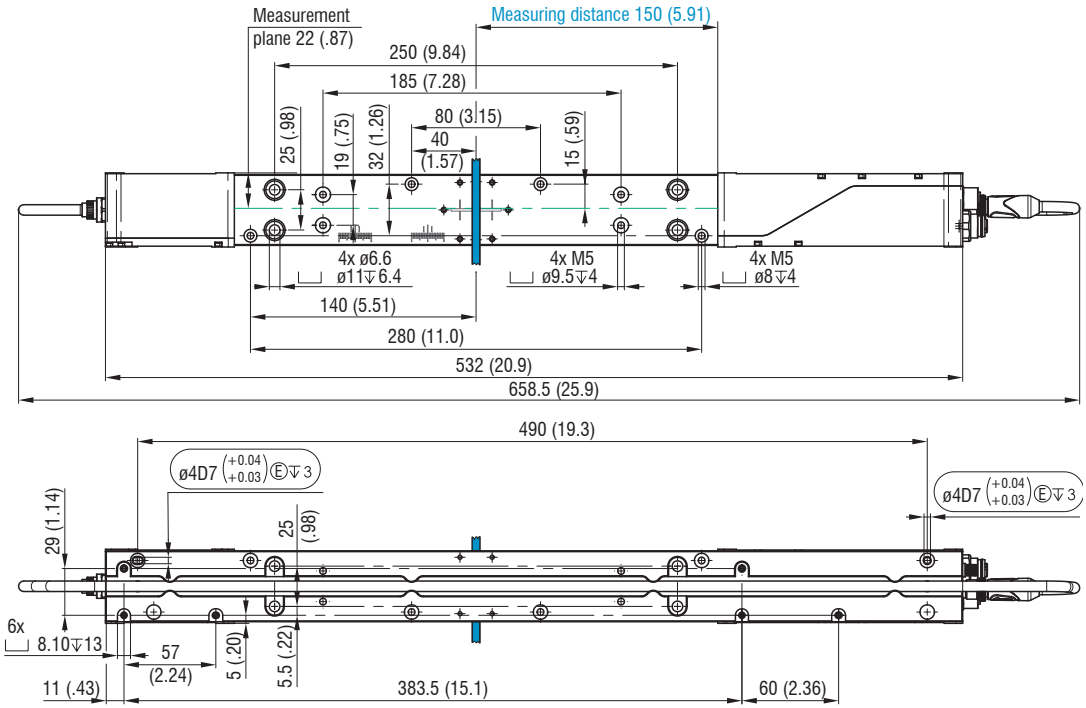


Fig. 4.3: Dimensional drawing of light source and receiver ODC2700-10, ODC2700-40 with mounting rail, dimensions in mm

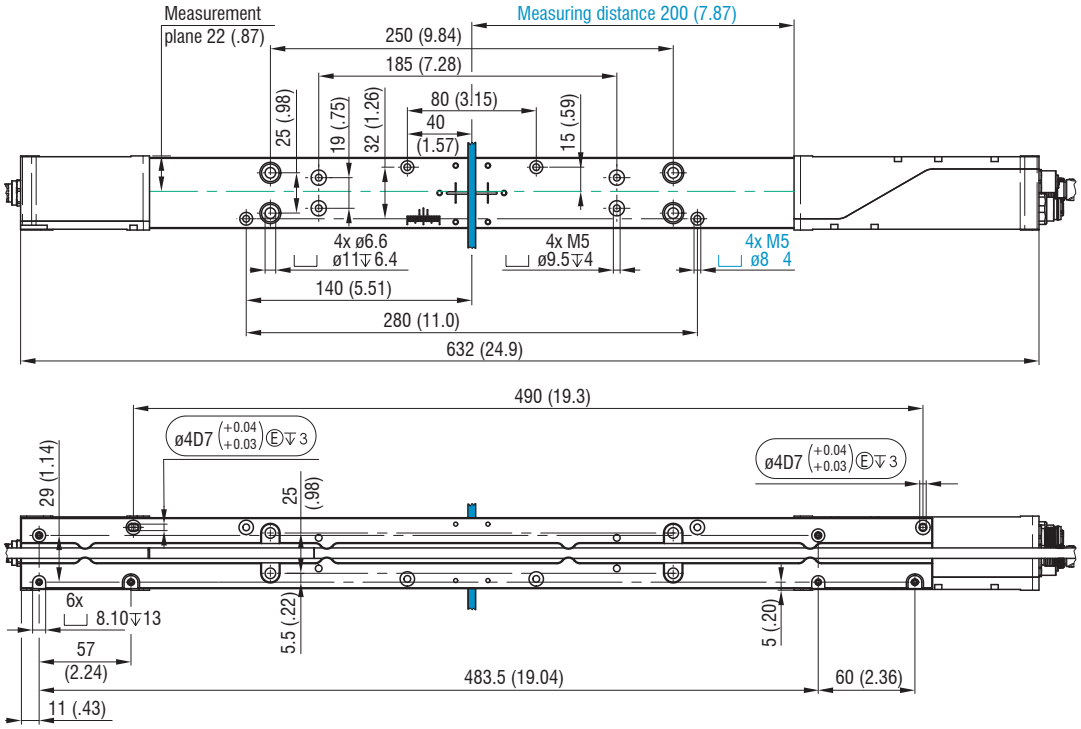


Fig. 4.4: Dimensional drawing of light source and receiver ODC2700-40(002) with mounting rail, dimensions in mm

i The mounting rail must be attached without bending or twisting it.

A horizontal measurement setup is preferable because it results in less soiling of the optical windows.

Mounting rail, standard mounting

- Preferably mount the mounting rail flat on the four M5 mounting holes, colored blue.

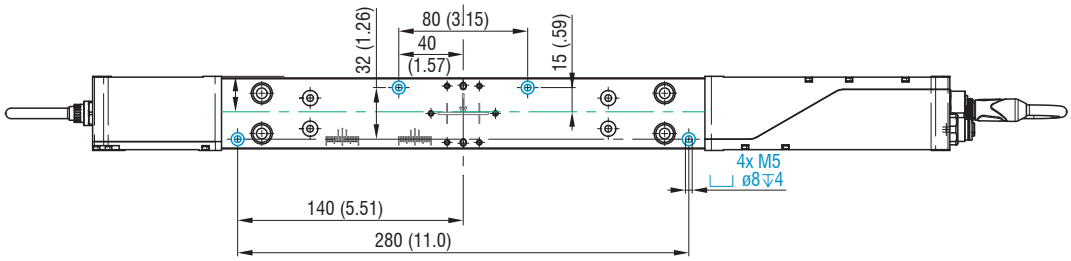


Fig. 4.5: Dimensional drawing of mounting rail ODC2700-10, ODC2700-40, standard mounting

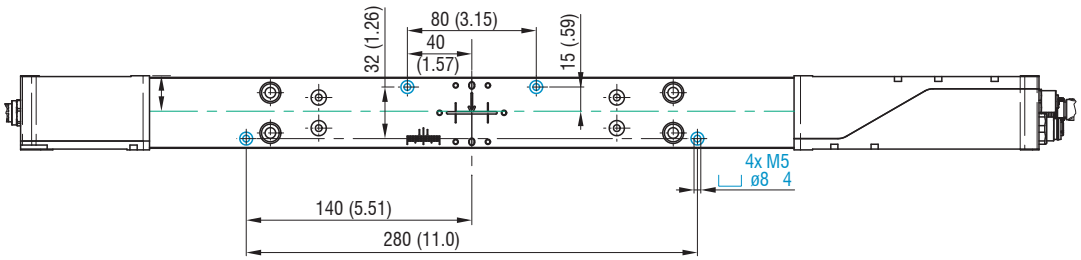


Fig. 4.6: Dimensional drawing of mounting rail ODC2700-40(002), standard mounting

Mounting rail, optional mounting

- Mount the mounting rail flat on the four mounting holes M5, colored blue or
- Mount the mounting rail flat on the four ø6.6 mounting holes, colored blue.

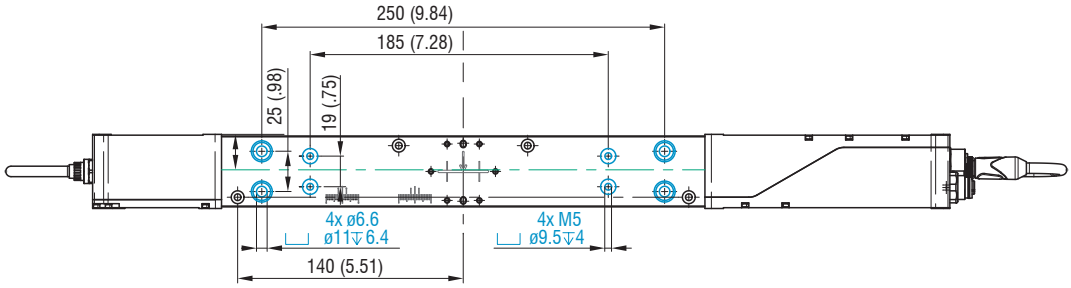


Fig. 4.7: Dimensional drawing of mounting rail ODC2700-10, ODC2700-40, optional mounting

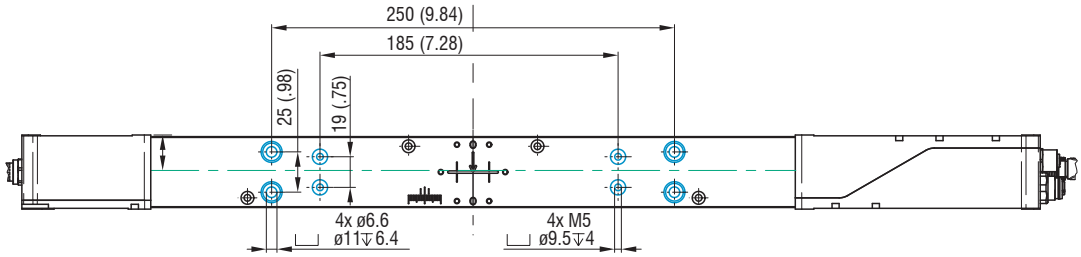


Fig. 4.8: Dimensional drawing of mounting rail ODC2700-40(002), optional mounting

4.2.3 Free mounting

Micro-Epsilon recommends initially mounting the sensor with the mounting rail attached. Once the sensor has been mounted, this rail can be removed.

Only attach the light source and receiver using the existing holes on a flat surface. Any type of clamping is not permitted.

> Inaccurate or incorrect measurements

If light source and receiver must be installed without the supplied mounting rail, you must make sure that the components are exactly aligned with each other.

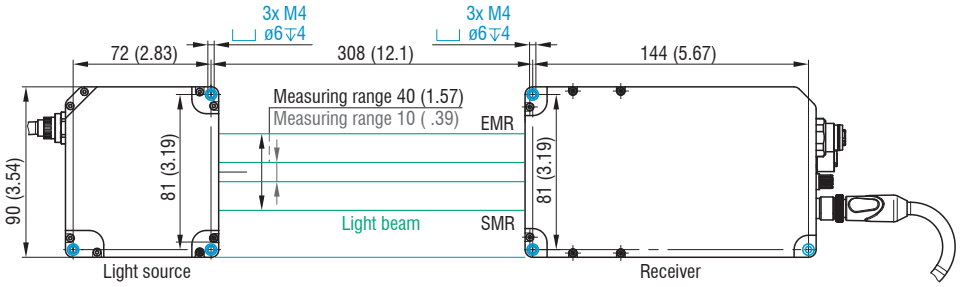


Fig. 4.9: Mounting thread for direct fastening ODC2700-10, ODC2700-40, dimensions in mm

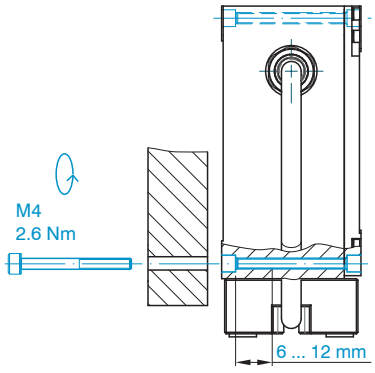


Fig. 4.10: Direct fastening sensor

The distance between the light source and receiver is 300 mm.

i	Light source and receiver must be located on the same plane and must not be tilted in relation to each other.

Use a stop bracket or rails to align the light source and receiver.

Once the light source and receiver have been installed at the correct distance from each other, check that the light band is aligned centered on the receiver, and adjust if necessary.

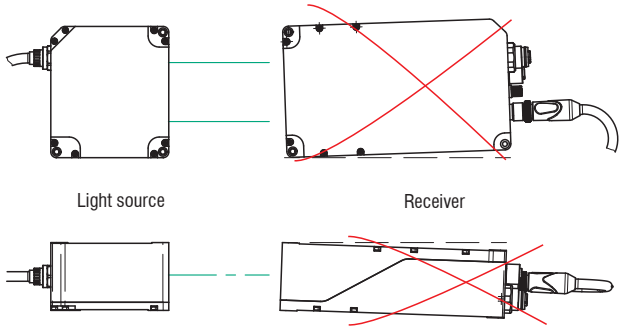


Fig. 4.11: Alignment errors to be avoided with free mounting

If necessary, loosen the light source for exact positioning. Check the central orientation of the continuous light band both horizontally and vertically.

Micro-Epsilon recommends holding a white piece of paper in front of the receiver as a projection screen and covering half of the screen. The strip light must illuminate the glass sheet symmetrically.

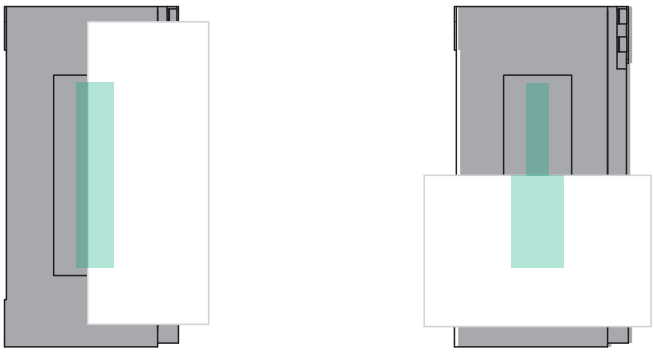


Fig. 4.12: Alignment check with projection screen (paper) in front of the receiver, vertical orientation on the left and horizontal orientation on the right

i	The light band must hit the receiver's inlet window exactly in the center.

4.2.4 Calibrated measuring distance, measuring fields

The sensor delivers the specified technical data at the measuring distance between the target and receiver.

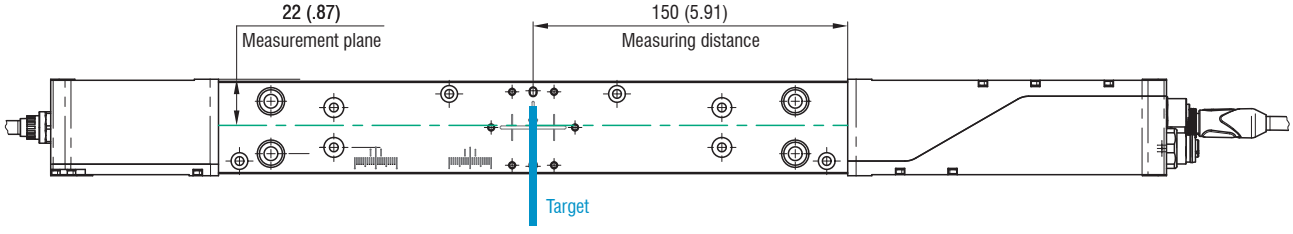


Fig. 4.13: Calibrated measuring distance ODC2700-10, ODC2700-40

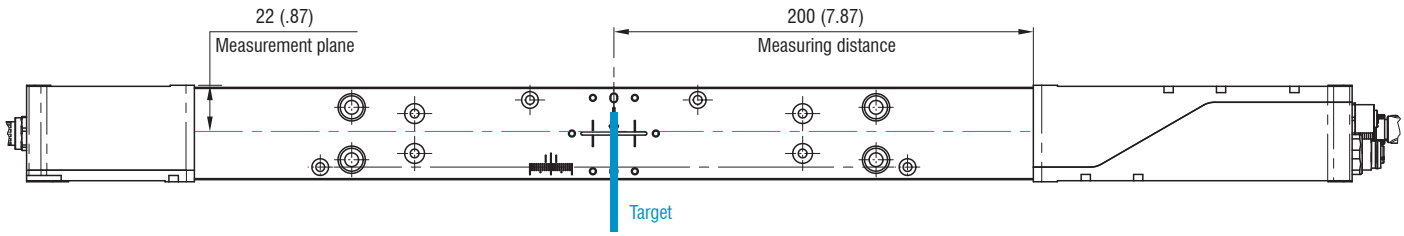


Fig. 4.14: Calibrated measuring distance ODC2700-40(002)

Take account of any lateral guides to avoid transverse movements by the target.

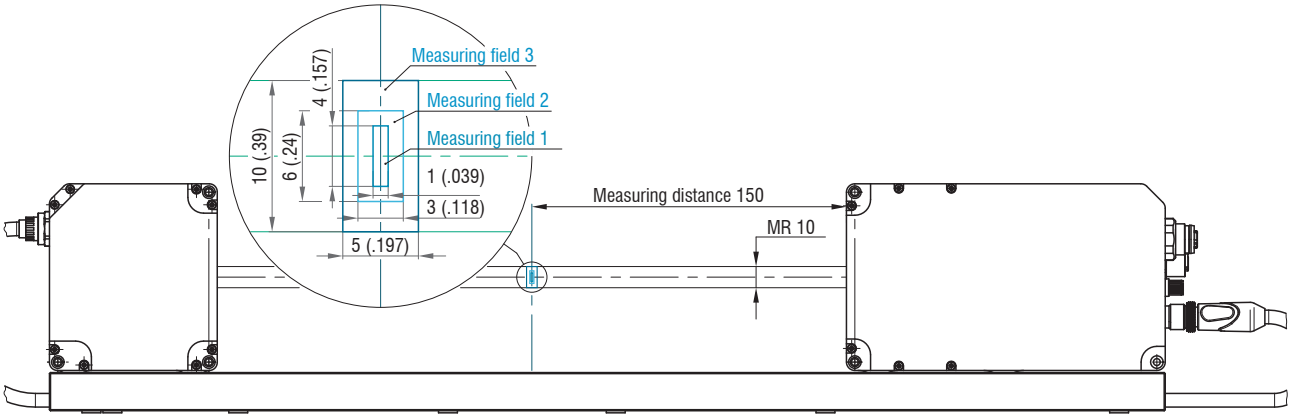


Fig. 4.15: Optimum position of the target within the measuring fields ODC2700-10

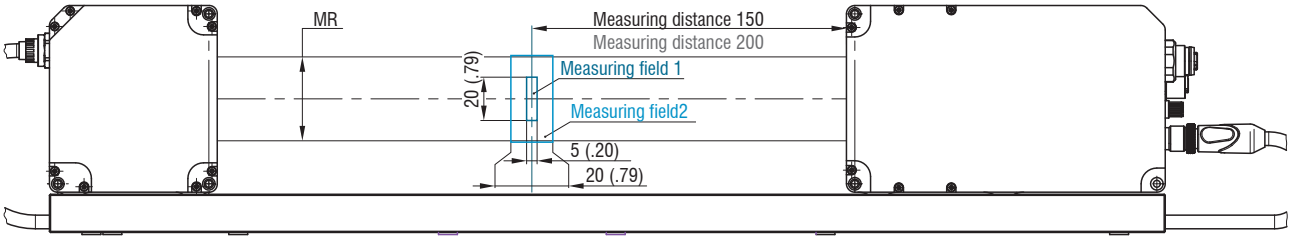


Fig. 4.16: Optimum position of the target within the measuring fields ODC2700-40, ODC2700-40(002)

4.3 Electrical connections

4.3.1 Light source

The light source is supplied with power by the receiver.

Fig. 4.17: Integrated power supply cable on light source

► Connect the integrated cable of the light source to the receiver before switching on the power supply.

4.3.2 Receiver

The connection sockets are labeled on both sides of the receiver housing.

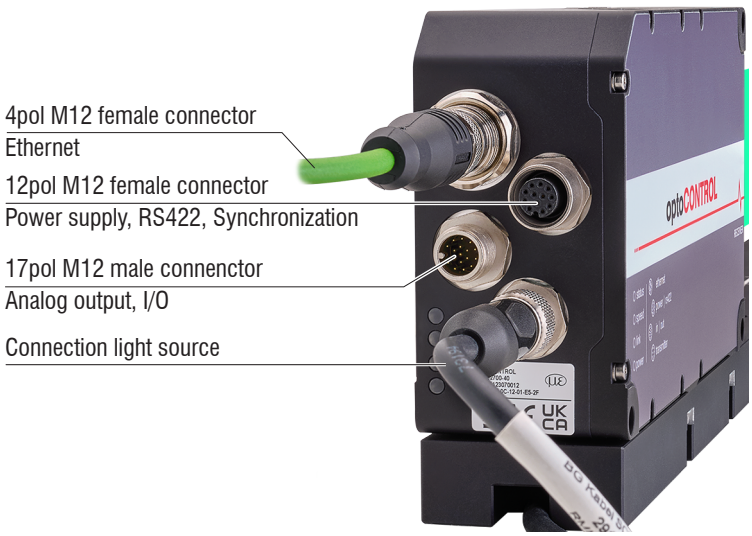


Fig. 4.18: Electrical connections of receiver

Housing screen printing	Signal(s)	Optional cable
ethernet	Ethernet	SCD2700-5 M12
power / rs422	Supply, RS422, Synchronization	PC/SC2700-x
in / out	Analog output, switching outputs, function inputs	SCA2700-x
transmitter	Light source	Included in delivery

Tab. 4.1: Connector assignment

i Unnecessary connections must be fitted with protective caps in order to achieve the possible IP protection class.

4.3.3 Connection possibilities

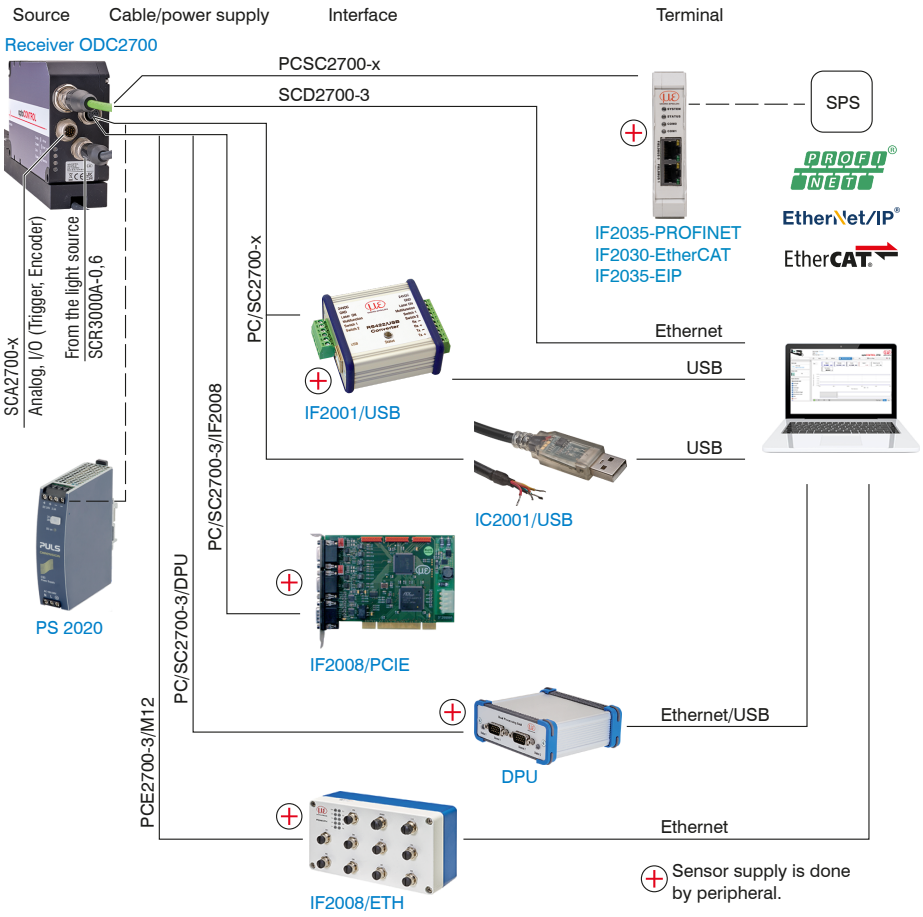


Fig. 4.19: Connection examples on the optoCONTROL 2700

4.3.4 Pin assignment

Signal	Pin	Adernfarbe PC/SC2700-x, explanation		Notes
V_+	9	Red	Supply voltage	11 … 30 VDC, typically 24 VDC, I_{max} 230 mA at 24 VDC
GND	2	Blue	Reference ground	Reference ground for Power, Sync, RS422
Sync +	1	Brown	Synchronization or triggering	Symmetrical, RS422 level, terminating resistor (120 ohms), direction can be switched using software, not electrically separated
Sync -	3	White		
Tx +	5	Pink	RS422, 32 bits	RS422 interface, symmetrical, Rx internally terminated with 100 ohms, max max. 8 MBaud, full duplex, not electrically separated
Tx -	8	Grey		
Rx +	4	Green		
Rx -	6	Yellow		

Tab. 4.2: Pin assignment, 12-pin M12 female connector for power supply, synchronization and RS422

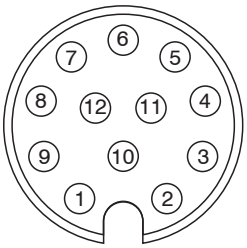


Fig. 4.20: 12-pin cable connector of PC/SC2700-x, view of solder side

The PC/SC2700-x has a 12-pin M12 male connector on one side and open ends on the other.

Signal	Pin	SCA2700-x wire color, explanation		Notes
Analog output	1	White	Not electrically separated, 14-bit D/A	Current 4 ... 20 mA Voltage 0 ... 5 VDC Voltage 0 ... 10 VDC
AGND	2	Black	Ground analog output	
Switching output 1	11	White	Switching behavior: NPN, PNP, push-pull, or push-pull negated; function can be set to either limit value or edge count mode	
Switching output 2	9	Green		
Switching output 3	16	Yellow		
Multifunction input 1	15	Pink	24V logic (HTL): Low ≤ 3 V; High ≥ 8 V (max 30 V) 5V logic (TTL): Low ≤ 0.8 V; High ≥ 2 V Internal pull-up resistor, an open input is detected as High. Connect the input to GND in order to trigger the function. Function can be set to triggering or encoder mode.	
Multifunction input 2	12	Red/blue		
Multifunction input 3	17	Grey/pink		
GND	10	Brown	Reference ground for switching inputs and outputs	
GND	8	Grey		

Tab. 4.3: Pin assignment, 17-pin M12 male connector for analog output, switching inputs and switching outputs

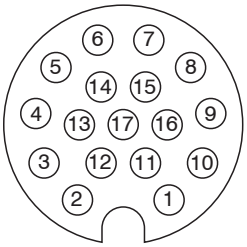


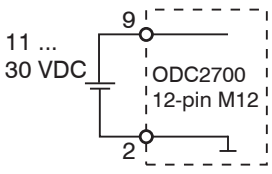
Fig. 4.21: 17-pin female cable connector of SCA2700-x, view of solder side

4.3.5 Supply voltage

Nominal value: 24 V DC (11 ... 30 V, P < 6 W).

- Only turn on the power supply after wiring has been completed.
- Connect inputs “9” and “2” on the 12-pin M12 female connector to a 24 V power supply

power | rs422 12-pin M12 female connector, pin	PC/SC2700-x Wire color	Signal
9	Red	V_+
2	Blue	GND



Tab. 4.4: 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 an optional available power supply unit PS2020 for the sensor.

4.3.6 Analog output

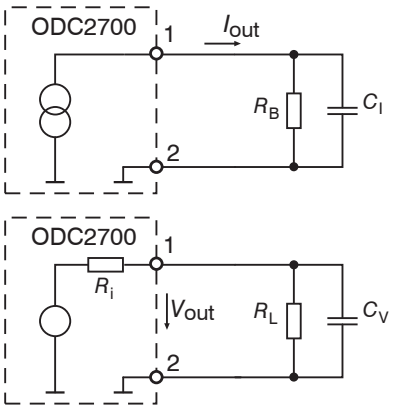
The sensor offers the following alternatives:

- A 4 ... 20 mA current output
- A 0 ... 5 V or 0 ... 10 V voltage output

> 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 outputs 1 (white, inner coaxial conductor) and 2 (black, coaxial shield) on the 12-pin M12 female connector to a measuring device.

in | out 17-pin M12 plug	SCA2700-x Wire color	Signal
1	White	V_{OUT} or I_{OUT}
2	Black	GND

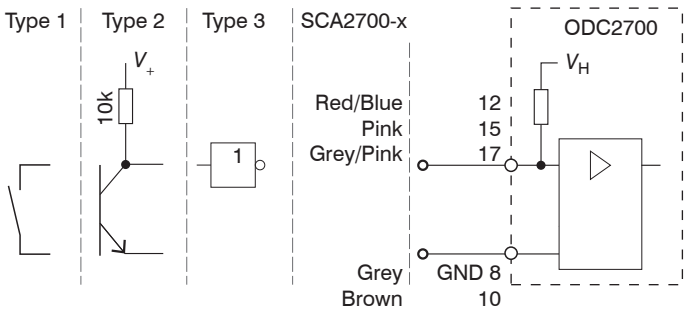


Tab. 4.5: Analog output switching

Current output	Voltage output
R_B max. = 250 ohms at V_+ > 11 V	R_i = 50 ohms
R_B max. = 500 ohms at V_+ > 17 V	R_L > 100 kOhm

4.3.7 Multifunction input

The multifunction inputs support the triggering and encoder functions. The function depends on how the inputs are programmed and on the input signal time response. The inputs are not electrically separated.



5V logic (TTL): Low ≤ 0.8 V; High ≥ 2 V
24 V logic (HTL): Low level ≤ 3 V; High level ≥ 8 V (max 30 V)

Internal pull-up resistor, an open input is detected as High.
Connect the inputs to GND to trigger the function.

Fig. 4.22: Wiring for the multifunction inputs

Signal	Pin
Multifunction input 1	15
Multifunction input 2	12
Multifunction input 3	17

4.3.8 Switching output

The switching outputs Out1/Out2/Out3 are connected as follows:

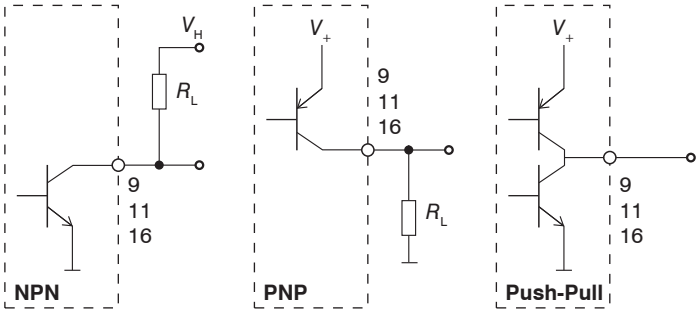


Fig. 4.23: Output configuration (schematic)

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

The NPN output is, for example, suitable for adaptation to a TTL logic circuit with auxiliary voltage of V_H = 5 V. The switching outputs are protected against polarity reversal, overload (< 150 mA), excessive temperature and have an integrated self-induction recuperation diode for inductive loads.

in | out 17-pin M12 plug	SCA2700-x Wire color	Signal	Comments
11	White	Switching output 1	Limit value or number of edges not electrically separated, 24 logic (HTL), I_{max} = 0.1 A, V_{max} = 30 V Saturation voltage at I_{max} = 0.1 A: Low < 2.5 V (output - GND), High < 2.5 V (output - supply voltage)
9	Green	Switching output 2	
16	Yellow	Switching output 3	

Tab. 4.6: Switching outputs characteristics

Name	Output active (e.g. limit value exceeded)	Output passive (e.g. no limit value violation)
NPN (Low side)	GND	V_H
PNP (High side)	V_+	approx. GND
Push-pull	V_+	GND
Push-pull, negated	GND	V_+

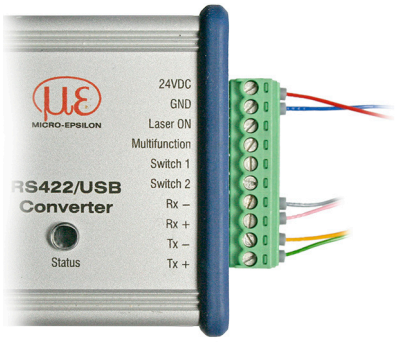
Tab. 4.7: Switching behavior of switching outputs

4.3.9 RS422 Connection with USB converter IF2001/USB

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

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

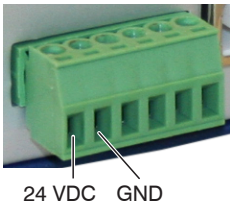
power | rs422 12-pin M12-socket	PC/SC2700-x Wire color	End device (converter) Type IF2001/USB from Micro-Epsilon 10-pin terminal block
V+	Red	24VDC
GND	Blue	GND
Tx - (8)	Gray	Rx -
Tx + (5)	Pink	Rx +
Rx - (6)	Yellow	Tx -
Rx + (4)	Green	Tx +



Tab. 4.8: Connecting sensor to IF2001/USB converter

Symmetrical differential signals according to EIA-422, not electrically separated from the supply voltage.

Use a shielded cable with twisted wires, e.g. PC/SC2700-x/OE.

IF2001/USB 6-pin terminal block	
24 VDC	
GND	
Laser ON	
Multifunction	
Switch 1	
Switch 2	

Tab. 4.9: Connecting the Power Supply to the IF2001/USB Converter

4.3.10 Synchronization

The Sync + and Sync - pins serve as the symmetrical outputs/inputs for synchronization or act as trigger inputs. The function and direction (I/O) are programmable.

All GND conductors are interconnected with one another and to the supply ground.

- Connect the Sync + connections to each other.
- Connect the Sync - connections to each other.

power | rs422 12-pin M12 female connector, pin	PC/SC2700-x Wire color	Signal
1	Brown	Sync +
3	White	Sync -

Tab. 4.10: Synchronization Connection

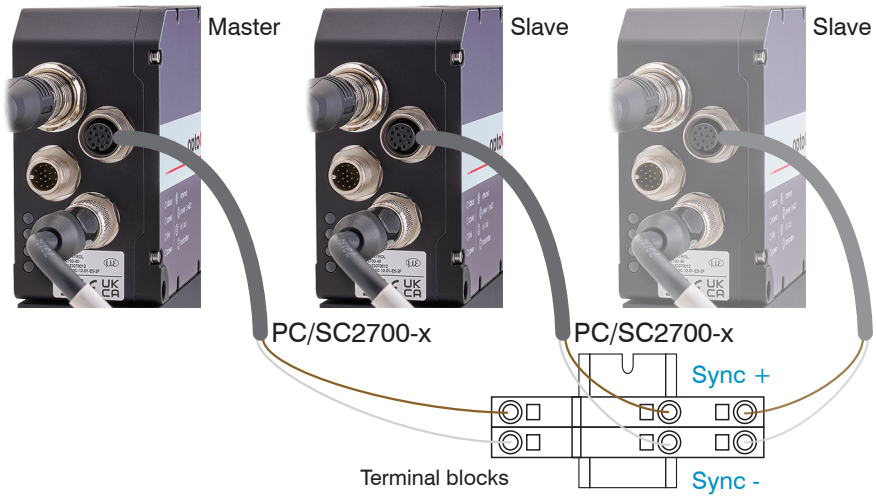


Fig. 4.24: Synchronization of Multiple Sensors

4.4 LEDs on receiver

Speed LED	**Meaning**
Yellow	If baud rate is 100 Mb
Off	If baud rate is 10 Mb
Link LED	**Meaning**
Green	If link active
Off	If link inactive
Flashing	If network activity
Power LED	**Meaning**
Green	Supply voltage ON / operation
Yellow	Booting / bootloader

Tab. 4.11: LEDs on receiver

5 Operation

5.1 Initial operation

- Connect the light source and receiver with the connection cable.
- Connect the sensor to a 24 V DC power supply.
- Turn on the power supply.

After the sensor is switched on, initialization is performed. The sensor is ready for operation after approx. 10 s.

You can configure the software using the web pages or the ASCII commands integrated in the sensor. Parallel operation with web browser and ASCII commands is possible; the last setting applies.

Micro-Epsilon Eltrotec GmbH recommends setting the sensor via the integrated website.

To ensure precise measurements, let the sensor warm up for approx. 30 minutes.

5.2 Control via Ethernet

5.2.1 Requirements

Dynamic web pages containing the current settings for the sensor and peripherals are generated in the sensor. Control is only possible when there is a live Ethernet connection to the sensor. A web browser is required (for example Mozilla Firefox or Internet Explorer) on a PC with a network connection. To facilitate initial operation of the sensor, it is configured ready for direct connection.

If your browser is set to access the Internet via a proxy server, please add the sensor IP address to the IP addresses in the browser settings that are not to be routed through the proxy server. The MAC address of the measuring device is given on the sensor rating plate and in the calibration log.

To allow graphical display of the measurement results, JavaScript must be enabled in the browser.

5.2.2 Direct Connection to PC

5.2.2.1 PC with static IP

- Connect the sensor to a PC using a direct Ethernet connection (LAN). Use the SCD2700-5-M12 cable for this.
- Start the `sensorTOOL` program.

You can find this program online at https://www.micro-epsilon.de/fileadmin/download/software/sensorTool.exe.

- Click the `Sensor` button.
- Select the required sensor from the list.
- Switch to the `Settings` > `Outputs` > `Ethernet` settings menu to change the IP address.
  - IP type: static
  - IP address: 169.254.168.150 [11]
  - Subnet mask: 255.255.0.0
  - Gateway: 169.254.1.1
- Click the `Apply settings` button to transmit the changes to the sensor.
- Click the `Open Website` button to display the website of the sensor in your standard browser. Alternatively, change the IP settings according to the settings on your PC (IP address ranges must match).

Interactive web pages for setting the sensor and peripherals are now shown in the web browser.

[11] This assumes that the LAN connection on the PC uses the following IP address, for example: 169.254.168.1.

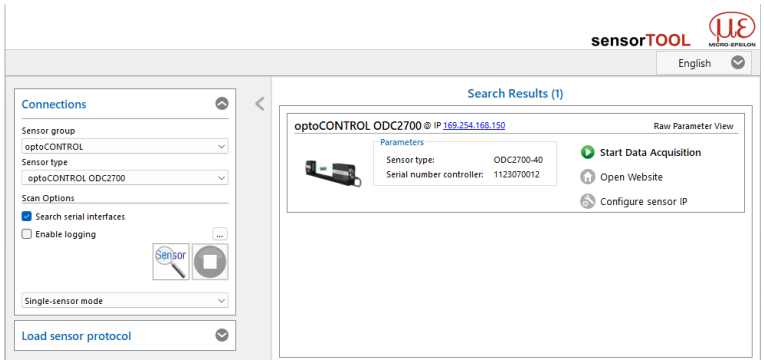


Fig. 5.1: Assistance program `sensorTOOL` for sensor search

5.2.2.2 PC with DHCP

► Connect the sensor to a PC using a direct Ethernet connection (LAN). To do this, use the SCD2700-5-M12 cable.

Wait until Windows has established a network connection (connection with limited connectivity).

► Start the `sensorTOOL` program.
► Click on the `Sensor` button.
► Now select the desired sensor from the list.
► Click on the `Open webpage` button to display the web page of the sensor in your default browser.

5.2.3 Network

Sensor with dynamic IP, PC with DHCP

► Connect the sensor to a switch using a direct Ethernet connection (LAN). To do this, use the SCD2700-5-M12 cable.
► Enter the sensor in the DHCP/register the sensor with your IT department.

IP address assignment by your DHCP server. You can query this IP address with the `sensorTOOL` program.

► Start the `sensorTOOL` program.
► Click on the `Sensor` button.
► Now select the desired sensor from the list.
► Click on the `Open webpage` button to display the web page of the sensor in your default browser.

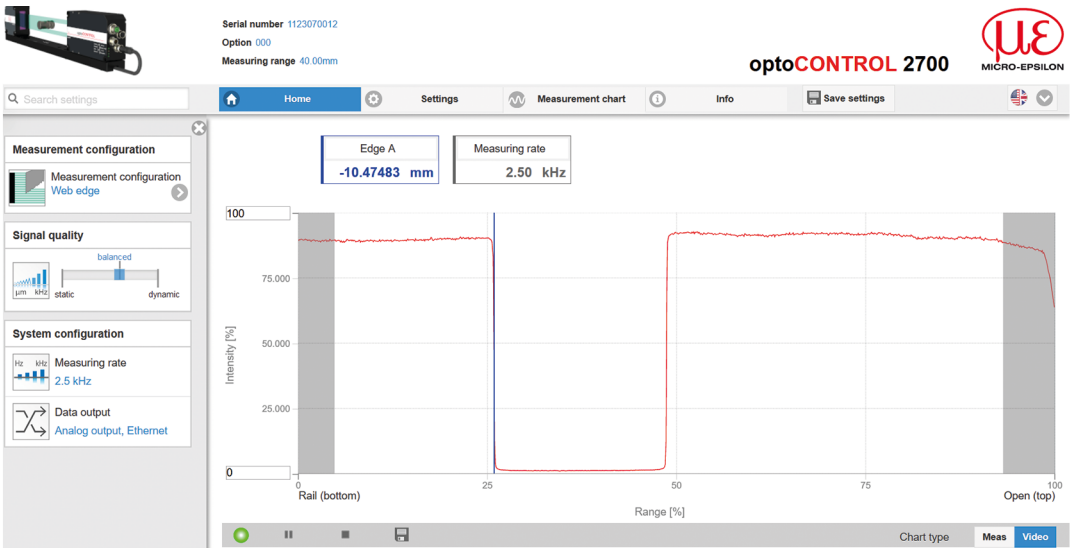
OR: When using DHCP with the DHCP server coupled to the DNS server, access to the sensor is possible using a host name with the structure “ODC2xxx_SN<Serial number>”.

► Start a web browser on your PC. To reach a sensor with serial number “01234567”, type “ODC2xxx_SN01234567” into the address bar of the browser.

5.2.4 Access via Ethernet

► Launch the web interface of the sensor.

Interactive web pages for configuring the sensor now appear in the web browser. The sensor is active and provides measured values.



The horizontal navigation contains the following functions:

- The Find function enables time-saving access to functions and parameters
- `Home`. The web interface automatically starts in this view with measurement chart, measurement configuration, and signal quality.
- `Settings`. This menu contains all sensor parameters.
- `Measurement chart`. Shows a measurement chart with digital display or a video signal.
- `Info`. Contains information about the sensor, including the serial number, software version, and an overview of all sensor parameters.

Tab. 5.1: Start page after accessing the web interface

Parallel operation with web browser and ASCII commands is possible; the last setting applies. Don't forget to save.

The appearance of the web pages can change depending on the functions and the peripherals. Each page contains parameter descriptions and thus tips for configuring the sensor.

5.3 Video Signal

5.3.1 Light Correction

The light correction must be performed once after mounting. If there are any changes in the extraneous light or if a high level of accuracy is required, we recommend repeating the process more frequently. The light correction function ensures effective extraneous light correction as a basis for accurate measurements and a relatively uniform light-corrected signal.

Before it can capture the light signal, the sensor must be allowed to warm up for approx. 30 min.

i	During the light correction, there must not be any objects present between the light source and receiver. If this is not possible, the evaluation range (ROI) must be appropriately masked before the light correction is performed.

► Switch to the menu `Settings` > `Corrections/Referencing`. Press the `Execute` button.

Fig. 5.2: `Light Correction` *Web Page*

The result of the referencing is stored.

5.3.2 Video signal, edge detection

► Under “Chart type”, click on `Video`; see figure.

The chart displayed in the large chart area on the right shows the video signal of the receiver line. The video signal in the chart area shows the intensity distribution over the pixels of the receiver line. Left 0 % (direction: mounting rail or start of measuring range) and right 100 % (direction: end of measuring range).

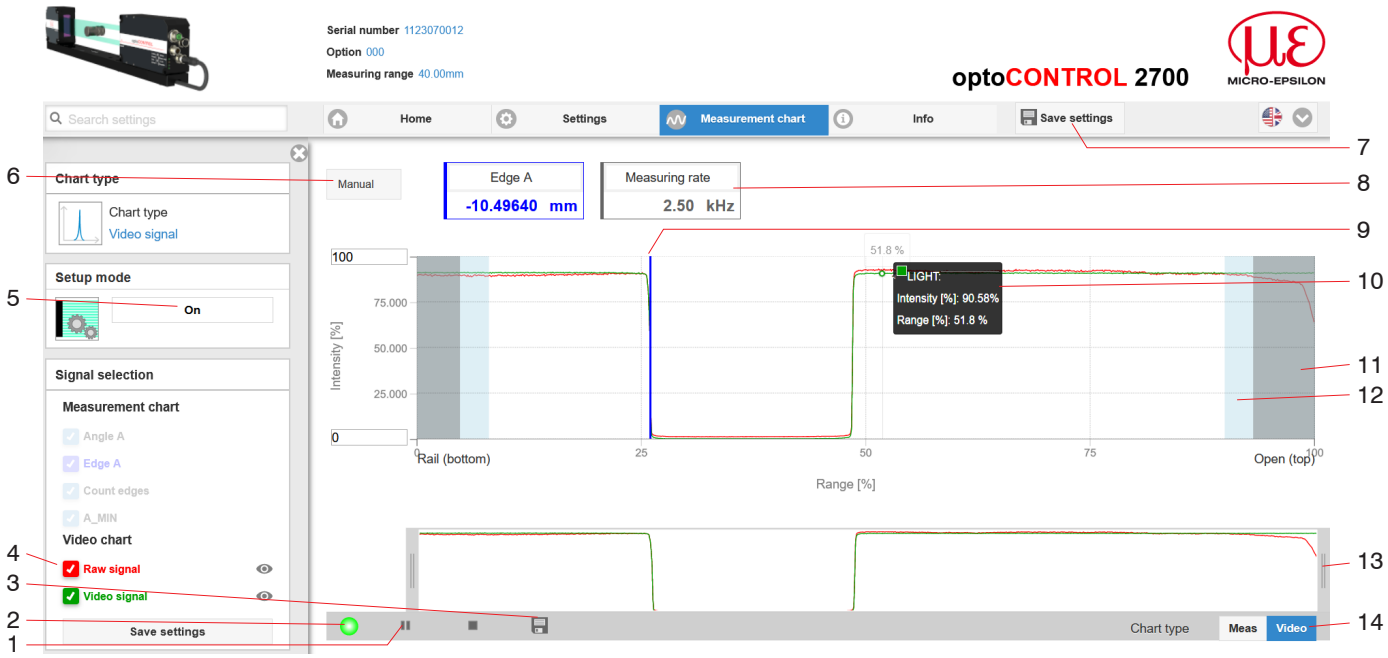


Fig. 5.3: `Video` *Web page*

The video signal web page contains the following functions:

1 `Start`, `Pause`, and `Stop` buttons for controlling a video signal measurement.
`Stop` stops the diagram; you can still continue to use the data selection and zoom functions.
`Start` initiates display of the video signal.
`Pause` pauses the recording.

2 Status indicator:
- Green: OK, data transmission active
- Yellow: Chart stopped
- Red: Faulty sensor connection

3 The Save button can be used to save the displayed measurement curves in CSV format (timestamp and measured values). Pressing it opens the Windows dialog for selecting the file name and save location.

4 The video curves to be displayed can be switched on or off during or after the measurement. Inactive curves are grayed out.

5 Positioning aid in setup mode.

6 Scaling of the intensity axis (Y axis) in the graph
- `Auto` = automatic scaling
- `Manual` = manual scaling

7 All changes only become effective when you click on the `Save settings` button.

8 The current values and selected measuring rate are shown in addition in the text boxes above the graph.

9 The edges of relevance to the selected measuring program are marked with a vertical bar that is color-coded to match the segment. This makes it possible to identify the respective segment edges in the video signal. The search direction determines the edge order.

10 Mouseover function. Moving the mouse over the graph, marks curve points or the peak marking with a circle symbol and displays the corresponding intensity. The corresponding x-position in % appears above the graph field.

11 The linearized range lies between the gray shades in the diagram and cannot be changed. Only peaks whose middles lie within this range can be calculated as a measured value.

12 The evaluation range (ROI) can be restricted if necessary and is then limited by additional light blue shading on the right and left. The peaks remaining in the resulting range are used for the evaluation.

13 X axis scaling: The diagram shown above can be enlarged (zoomed in on) with the two sliders on the right and left in the lower entire signal. It can also be moved sideways with the mouse in the middle of the zoom window (four-sided arrow).

14 Chart type selection: Measurement or video signal display.

The following measurement was performed using the `multi-segment` program. The segment definition can be used to select specific areas of a target for evaluation. Within this context, one segment can span several edges; the color-coded highlighting of the edges enables you to identify them rapidly in the video signal.

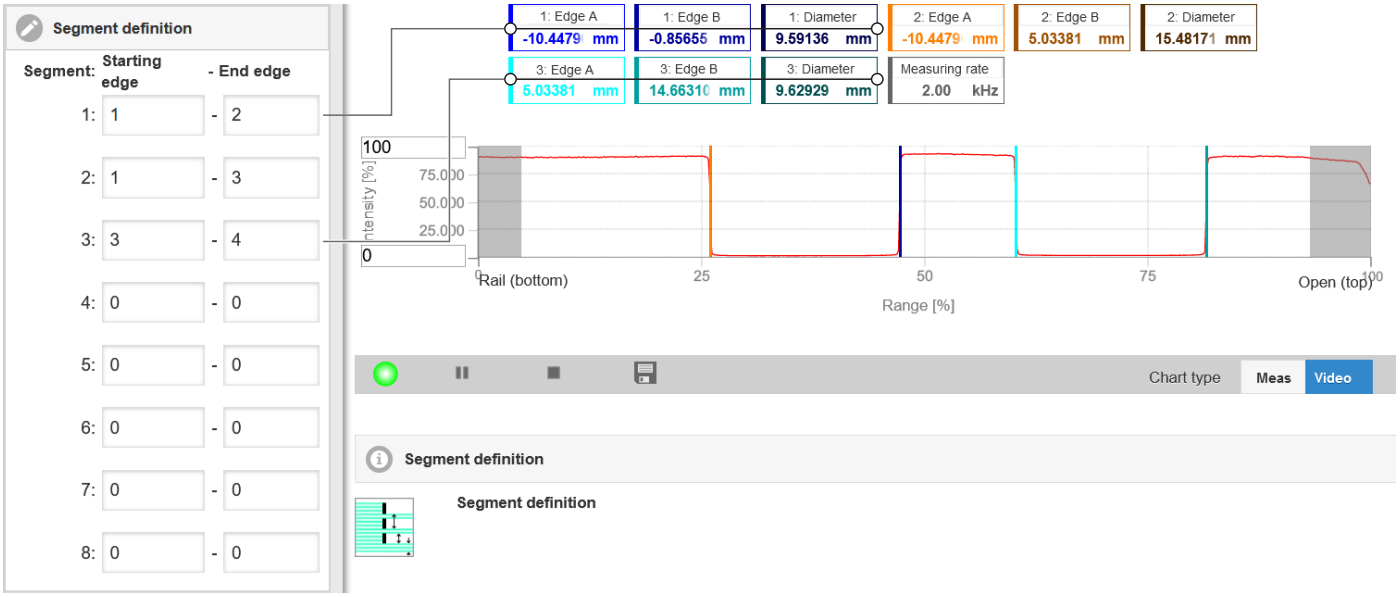


Fig. 5.4: Video signal with defined segments

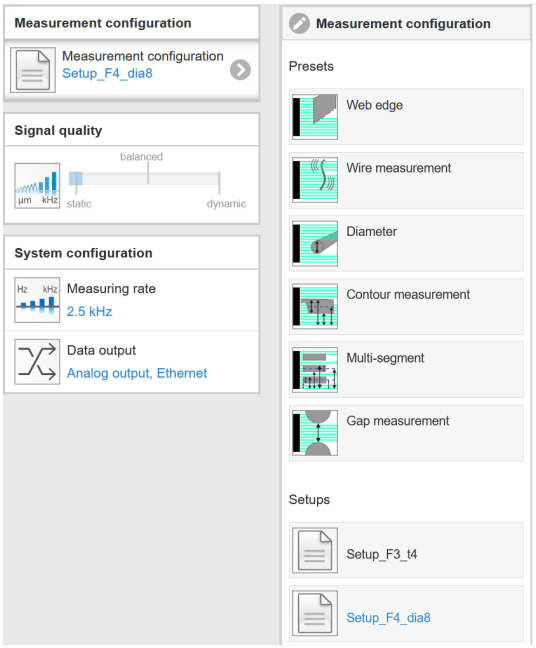
5.4 Presets, setups, measurement configuration selection

Definition

- Preset: Manufacturer-specific program containing settings for common measuring tasks that cannot be overwritten
- Setup: User-specific program containing the relevant settings for a measuring task
- Initial setup on booting (sensor startup): A favorite setting can be selected from the setups for automatic activation on sensor startup. If no favorite has been identified from the setups, the sensor starts with the most recently saved settings/setup or the sensor activates the web edge preset.

Upon delivery of the sensor from the factory:

- the web edge, wire measurement, diameter, contour measurement, multi-segment, and gap measurement presets can be used,
- but 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`
- `Settings` in the menu `System settings > Load & Save` > `Saved measurement settings`

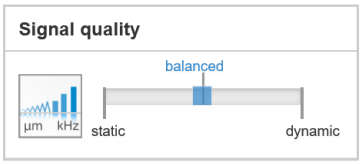
A maximum of 8 setups can be permanently saved in the sensor.

Tab. 5.2: Excerpt from web interface, home tab

For all presets, the averaging function can be customized for the measurement task by moving the `Signal quality` slider control.

In the signal quality section, you can switch between three basic settings (static, balanced, or dynamic). The reaction in the chart and system configuration is immediately visible.

i	If the sensor starts up with a set of user-specific measurement settings (a setup), the signal quality cannot be changed.



Preset	Averaging, measuring rate	
Web edge	Static	Moving with 8 values; 2.5 kHz
	Balanced	Moving with 8 values; 2.5 kHz
	Dynamic	Moving with 8 values; 2.5 kHz
Wire measurement	Static	Moving with 128 values; 5 kHz
	Balanced	Moving with 64 values; 5 kHz
	Dynamic	Median with 9 values; 5 kHz
Diameter	Static	Moving with 128 values; 2.5 kHz
	Balanced	Moving with 64 values; 2.5 kHz
	Dynamic	Median with 9 values; 2.5 kHz
Contour measurement	Static	Moving with 128 values; 2.5 kHz
	Balanced	Moving with 64 values; 2.5 kHz
	Dynamic	Median with 9 values; 2.5 kHz
Multi-segment	Static	No averaging; measuring rate 2 kHz `Thickness` calculation function `Thickness` = center of segment 2 - center of segment 1
	Balanced	
	Dynamic	
Gap measurement	Static	Moving with 128 values; 2 kHz
	Balanced	Moving with 64 values; 2 kHz
	Dynamic	Median with 9 values; 2 kHz

i After parameterization, permanently save all settings in 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.

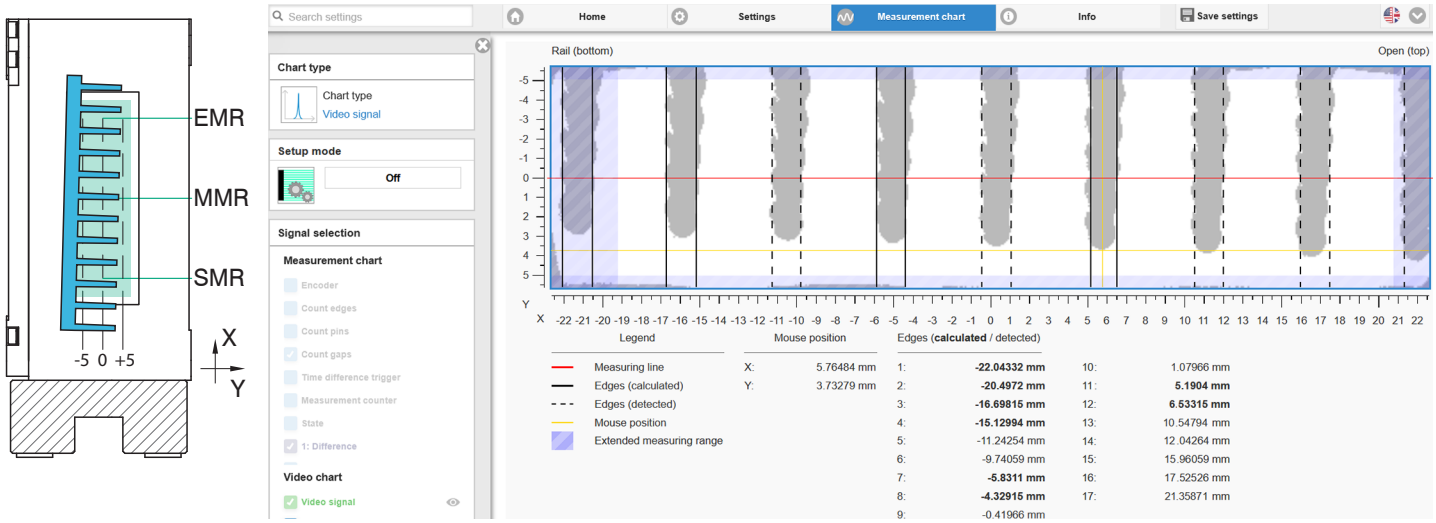
5.5 Setup mode

In setup mode, the two-dimensional video signal of the receiver line is displayed.

Advantages of setup mode:

- Positioning aid for target in measuring range with aiming pattern
- Horizontal and vertical guide lines with a grid spacing of 0.5 mm
- Decision-making aid for assessing edge profiles
- Measuring range in y direction with ±5 mm
- Displays all calculated and detected edges

You can access setup mode via the menu`Measurement Chart`>`Setup Mode`.

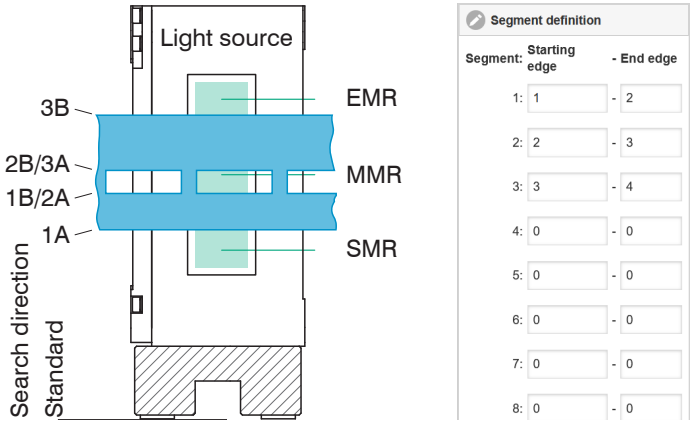


Tab. 5.3: Tilted Fin Profile (Left) and Associated Video Signal (Right), Viewed in Direction of Light Source

Setup mode is optimized for the preset `Multi-segment`. The selection of the calculated edges is linked to the definition of the segments, see Chap. 6.4.3.

5.6 Measurement chart

The following description is based on the `Multi-segment` measuring program.



Tab. 5.4: Punching profile with edge assignment (left) and associated definition of segments (right), viewed in direction of light source

- ► Use the `Measurement chart` tab to start displaying measured values.
- ► Under “Chart type”, click on `Meas`, see figure.

The diagram in the large diagram area on the right shows the desired measurement values as a function of time.

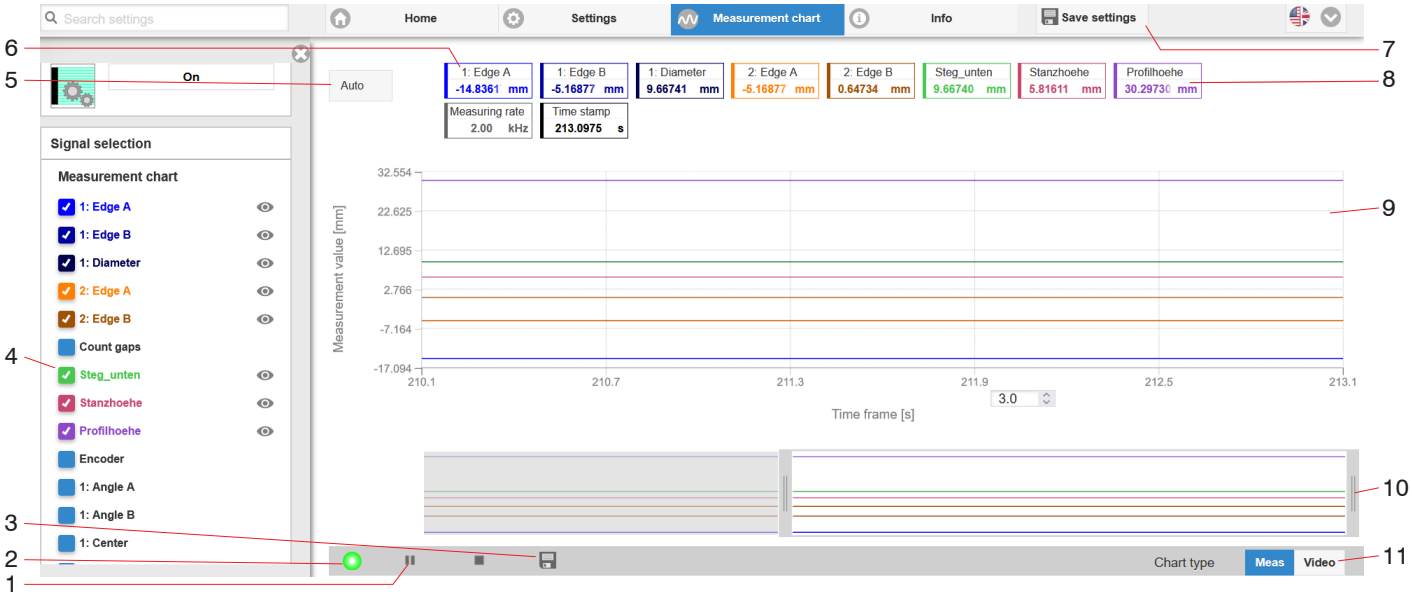


Fig. 5.5: Website `Measurement`

The measurement chart web page contains the following functions:

1 `Start`, `Pause`, and `Stop` buttons for controlling display of the measured values.
`Stop` stops the diagram; you can still continue to use the data selection and zoom functions.
`Start` initiates display of the measured values.
`Pause` pauses the recording.

2 Status display:
- Green: OK; data transmission active
- Yellow: Chart stopped
- Red: Faulty sensor connection

3 The Save button can be used to save the displayed measurement curves in CSV format (timestamp and measured values). It opens the Windows dialog for selecting the file name and save location.

4 The measured values to be displayed can be switched on or off during or after the measurement. Inactive curves are grayed out.
All changes only become effective when you click on the `Save settings` button.

5 Scaling the measurement value axis (y-axis) of the graph
- `Auto` = Auto scaling
- `Manual` = Manual scaling

6 Segment number

7 All changes only become effective when you click on the `Save settings` button.

8 The current values, selected measuring rate, and a timestamp are shown in addition in the text boxes above the graph.

9 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.

10 X axis scaling: The diagram shown above can be enlarged (zoomed in on) with the two sliders on the right and left in the lower entire signal. It can also be moved sideways with the mouse in the middle of the zoom window (four-sided arrow).

11 Select a chart type: measurement values or video signal

5.7 Output of measurement values

The presets and setups differ from one another in terms of the possible output values for the digital interfaces and the analog output. By default, only a few output values are selected for output.

Select output values

► Switch to the tab`Settings`>`Outputs`>`RS422 data output`,`Ethernet`or`Analog output`.

► Select the desired output values, see Chap. 6.7.

By default, the Ethernet interfaces and the analog output are enabled. If you also want to output measured values via the RS422 interface or if you want to use the switching outputs, you must first enable these interfaces, see Chap. 6.7.5.

6 Advanced settings, web interface

6.1 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 and Ethernet

The following sections describe how to make the sensor settings using the web interface.

Legend of the menu structure:

	Fields with gray background require a selection.	Value	Fields with dark border require entry of a value.

6.2 Corrections, referencing

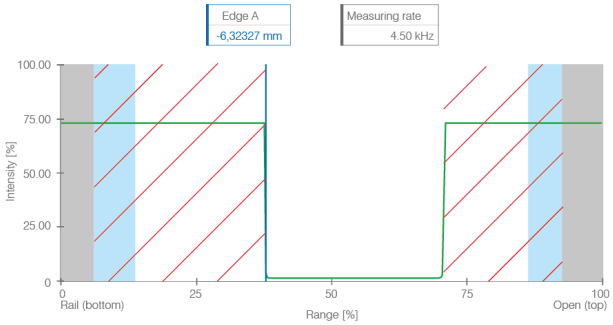
6.2.1 Light correction

You can find more details on this in the “Video Signal” section, see Chap. 5.3.1.

6.2.2 Contamination detection

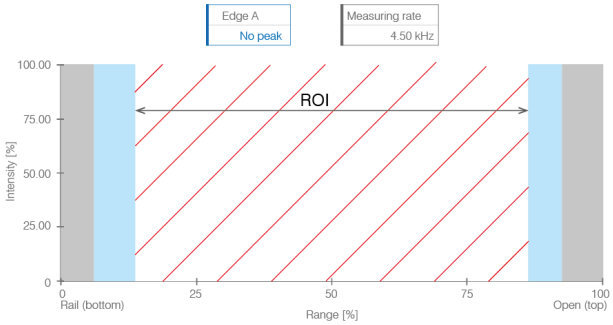
This function detects (possible) deposits on the optical openings of the light source and receiver that could potentially be recognized as edges.

Ignore objects



Contamination detection with targets within the measuring range possible; this area is excluded from detection.

Only in the evaluation area



Contamination detection extends within the evaluation area (ROI).

► Switch to the`Settings > Corrections, Referencing > Contamination detection`menu.
► Select`Ignore objects`or`Only in the evaluation area`.
► Click on the button`Execute`.

More information on cleaning the protective windows can be found here, see Chap. 8.

6.3 Inputs

6.3.1 Synchronization

If two or more sensors are to measure the same target at the same time, the receivers can be synchronized with one another. The synchronization output of the first sensor (= master) is connected to the synchronization inputs of other sensors (= slaves).

The feature for synchronizing multiple sensors is used when measuring the thickness/width of larger targets, for example.

Synchronization	*Master*	*With this setting, the sensor is the master, i.e., it outputs synchronization pulses at the Sync connections.*
	Master alternating *Slave alternating*	*With this setting, the sensor is the master, i.e., it outputs synchronization pulses at the Sync/Trig output. The alternating synchronization requires that the lasers are switched on and off alternately so that the two sensors do not interfere with each other optically. Therefor one sensor is to program as "Master alternating" and one as "Slave alternating". There can be only one master to be connected to a slave.*
	Slave Sync/Trig	*With this setting, the sensor is the slave and waits for synchronization pulses – e.g., from another ODC2700 or a similar pulse source – at the Sync connections.*
	Slave TrigIn	*With this setting, the sensor is the slave. The synchronization signal is received via the Trigger interface. You can select HTL or TTL level.*
	Inactive	*No synchronization. The sensor works autonomously. No synchronizing signal is output via the bidirectional synchronizing line.*

Selecting synchronization

- Switch to the tab `Settings` > `Inputs` > `Synchronization`.
- Make the desired settings and confirm them by pressing `Save settings`.

Notes about electrical connection are available in the "Installation and assembly" section, see Chap. 4.3.10.

6.3.2 Input level

This menu item defines the logic level of the multifunction inputs, see Chap. 4.3.7.

In this way, different output levels of encoders or of a trigger level can be adjusted to match the sensor.

Input level	*TTL*	*Low ≤ 0.8 V, High ≥ 2 V*
	HTL	*Low ≤ 3 V, High ≥ 8 V*

Selecting the input level

- Switch to the tab`Settings`>`Inputs`>`Input level`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.3.3 Encoder

6.3.3.1 Overview

The values of an encoder can be assigned to the measurement data exactly, output, and also used as a triggering condition. This exact assignment to the measured values is ensured by the fact that precisely those encoder values are output that were present in half of the exposure time of the measured value; the exposure time can vary due to the regulation process. Tracks A and B enable direction recognition.

Encoder input	Interpolation (depth)	*single / double / quadruple resolution*	*Track A, B: Interpolation increases the resolution of an encoder. The counter reading is incremented or decremented with each interpolated pulse edge.*
	Maximum Value	*Value*	*When the maximum value is exceeded, the encoder starts again at zero. This could be the pulse count of a rotary encoder without a reference track, for example.* *Value range of 1 ... 4294967295*
	Effect on Reference Track	*No effect / Set to value once for mark / Set to value for all marks*	*No effect: The encoder counter keeps on counting; resetting takes place when the sensor is switched on or when the "Set to value" button is pressed.* *Set to value once for mark: Sets the encoder counter to the defined value when the first reference marker is reached. The applicable mark is the first one after sensor switch-on.* *Set for all marks: Sets the encoder counter to the start value in the case of all marks.*
	Set to Value	*Value*	*Value range of 0 ... 4294967294*
	Set encoder value via software		
	Reset the detection of the first reference mark		

Selecting the encoder setting

- Switch to the tab `Settings` > `Inputs` > `Encoder inputs`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.3.3.2 Interpolation

Interpolation increases the resolution of an encoder. The counter reading is incremented or decremented with each interpolated pulse edge.

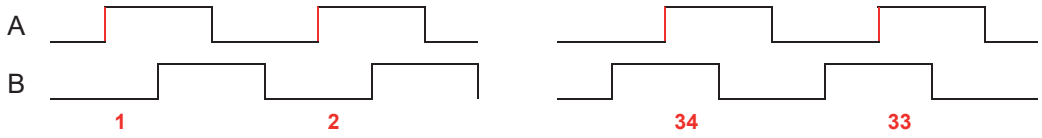


Fig. 6.1: Pulse image encoder signal, simple resolution, add (left), reduce (right)

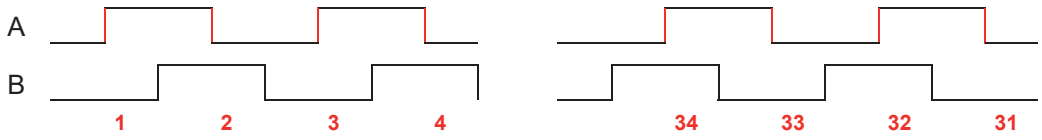


Fig. 6.2: Pulse image encoder signal, double resolution, add (left), reduce (right)

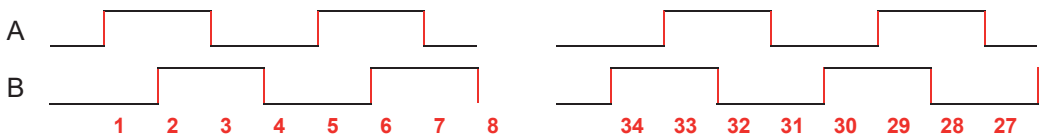


Fig. 6.3: Pulse image encoder signal, quadruple resolution, add (left), reduce (right)

6.3.3.3 Effect of reference track

`No effect`. The encoder counter keeps on counting; the resetting takes place when the sensor/controller is switched on or when the `Set to value` button is pressed.

`Set to value once for mark`. Sets the encoder counter to the defined value when the first reference marker is reached. The applicable mark is the first one after sensor/controller switch-on.

`Set for all marks`. Sets the encoder counter to the start value in the case of all marks.

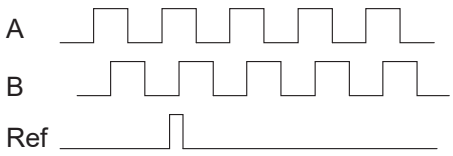


Fig. 6.4: Reference signal of an encoder

6.3.3.4 Set to value

This function sets the encoders to this value

- every time the controller is switched on,
- with the `Set to value` button.

The starting value must be lower than the maximum value and should not exceed 4.294.967.294 (2^32-2).

6.3.3.5 Reset reference marker

Resets the reference marker detection.

6.3.4 Digital input assignment

This menu item assigns the encoder track or a trigger function to the multifunction inputs, see Chap. 4.3.7.

The integrated logic makes the assignment process easier. This ensures that the selection options can be assigned to a multifunction input only once.

- Track A / Track B / Reference track
- Trigger

Digital input assignment	Digital input 1 Digital input 2 Digital input 3	*Encoder Track A / Track B / Reference track / Trigger*

If a reference track is required for the encoder, it is not possible to use the “trigger via multifunction inputs” function.

Selecting digital inputs

► Switch to the tab`Settings`>`Inputs`>`Digital input assignment`.
► Make the desired settings and confirm them by pressing `Save settings`.

6.4 Data recording

6.4.1 Measuring line width

The width of the measuring line can be adapted to the requirements of the measurement task. One pixel corresponds to approx. 22 µm.

- Narrow measuring line: measurements close to steps

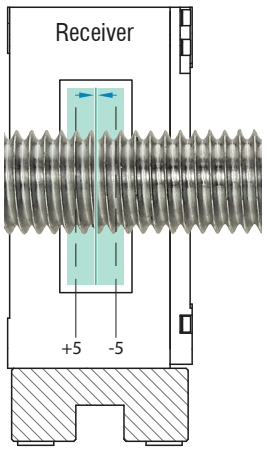


Fig. 6.5: Narrow measuring line for measurements on steep edges and corners, e.g. for measurements on threaded rods

- Wide measuring line: reduces signal noise

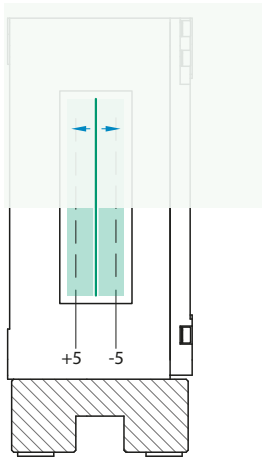


Fig. 6.6: Wide measuring line, e.g. edge tracking on a paper web

Change the width of the measuring line

► Switch to the tab `Settings` > `Data acquisition` > `Measuring line width` and select a suitable width for the measurement task.

6.4.2 Measurement program

6.4.2.1 Presets, search direction

Initial setup on booting (sensor startup): A favorite setting can be selected from the setups for automatic activation on sensor startup. If no favorite has been identified from the setups, the sensor starts with the most recently saved settings/ setup or the sensor activates the web edge preset.

Preset	Active Inclination correction	**Measuring program**	**Search direction**	**Measurement direction**
Strip edge	No	Falling edge	Standard	Standard
Wire measurement Diameter Contour measurement	No Yes No	Diameter		
Multi-segment	No	Segment		
Gap measurement	No	Gap		

Tab. 6.1: Overview of factory settings for the presets and their measurement program

Selecting preset or setup

- Switch to the `Home` > `Measurement configuration` tab and select a preset or individual setup suitable for the measurement task.

Here you can adapt a measurement program.

Measuring program	Search direction Standard	Search direction Reverse
Falling edge	Sensor searches for a light-dark transition, start is SMR	Sensor searches for a light-dark transition, start is EMR
Rising edge	Sensor searches for a dark-light transition, start is SMR	Sensor searches for a dark-light transition, start is EMR
Diameter	Sensor searches for the first light-dark and the last dark-light transition, start is SMR	Sensor searches for the first light-dark and the last dark-light transition, start is EMR
Gap	Sensor searches for the first dark-light and the next light-dark transition, start is SMR	Sensor searches for the first dark-light and the next light-dark transition, start is EMR
Segment	Sensor searches for all dark-light and light-dark transitions, start is SMR	Sensor searches for all dark-light and light-dark transitions, start is EMR

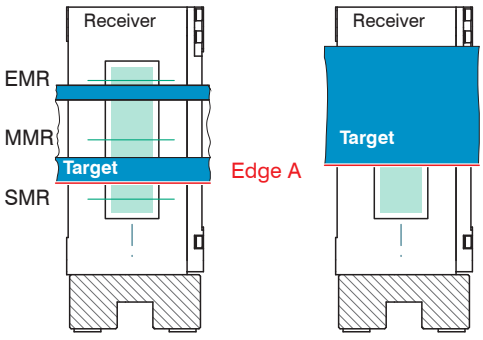
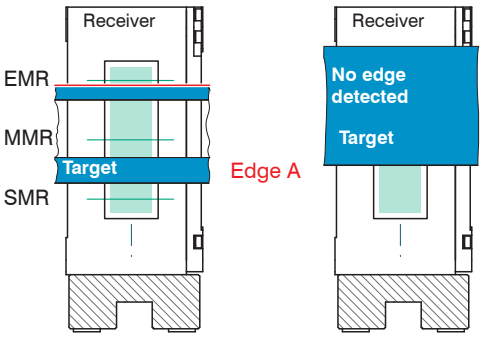
Tab. 6.2: Edge assignment for the measurement programs

Don't forget to save!

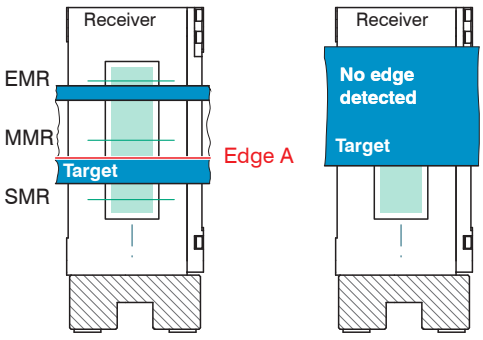
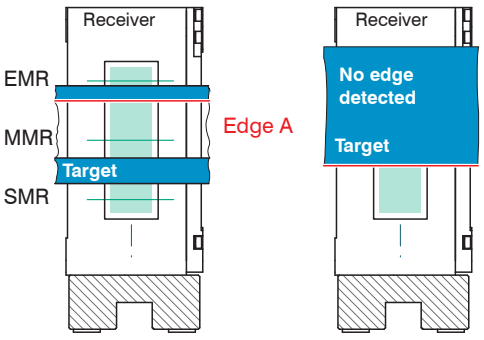
- Save individual adjustments to the measurement programs in a setup, see Chap. 6.8.2.

6.4.2.2 Search direction and sequence of edges, examples

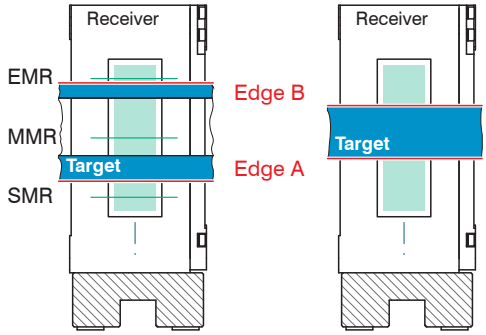
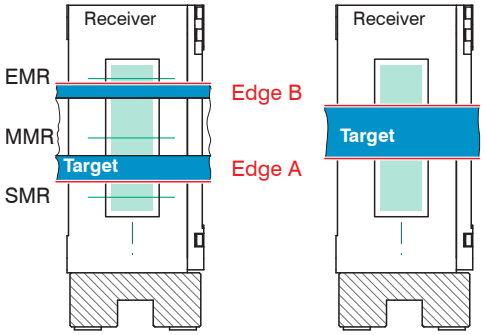
The search direction determines the numbering or sequence of the edges.

Measuring program	Search direction Standard	Search direction Reverse
Falling edge	 Sensor searches for a light-dark transition, start is SMR	 Sensor searches for a light-dark transition, start is EMR

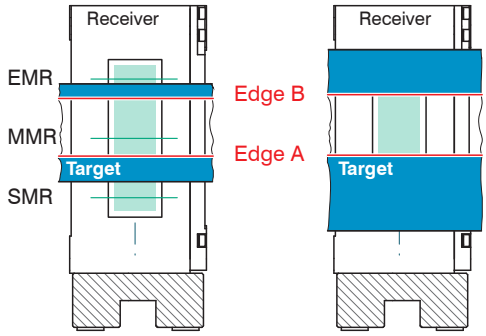
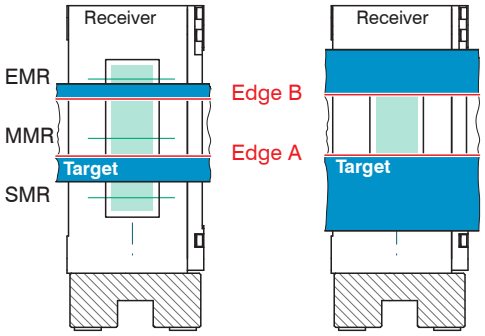
Tab. 6.3: Edge assignment with measurement program Falling edge, example

Measuring program	Search direction Standard	Search direction Reverse
Rising edge	 Sensor searches for a dark-light transition, start is SMR	 Sensor searches for a dark-light transition, start is EMR

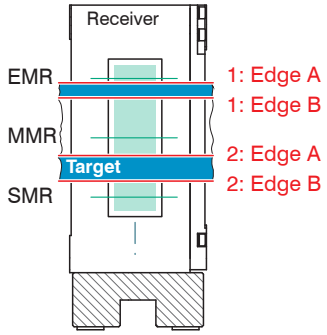
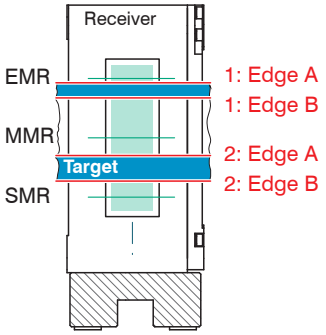
Tab. 6.4: Edge assignment with measurement program Rising edge, examples

Measuring program	Search direction Standard	Search direction Reverse
Diameter	 Sensor searches for the first light-dark and the last dark-light transition, start is SMR	 Sensor searches for the first light-dark and the last dark-light transition, start is EMR

Tab. 6.5: Edge assignment with measurement program Diameter, examples

Measuring program	Search direction Standard	Search direction Reverse
Gap	 Sensor searches for the first dark-light and the next light-dark transition, start is SMR	 Sensor searches for the first dark-light and the next light-dark transition, start is EMR

Tab. 6.6: Edge assignment with measurement program Gap, examples

Measuring program	Search direction Standard	Search direction Reverse
Segment	 Sensor searches for all dark-light and light-dark transitions, start is SMR	 Sensor searches for all dark-light and light-dark transitions, start is EMR

Tab. 6.7: Edge assignment with measurement program Segment, examples

6.4.2.3 Measurement Direction

The measurement direction determines the reference point for the measured value. The reference point is the mid point of the measuring range (MMR).

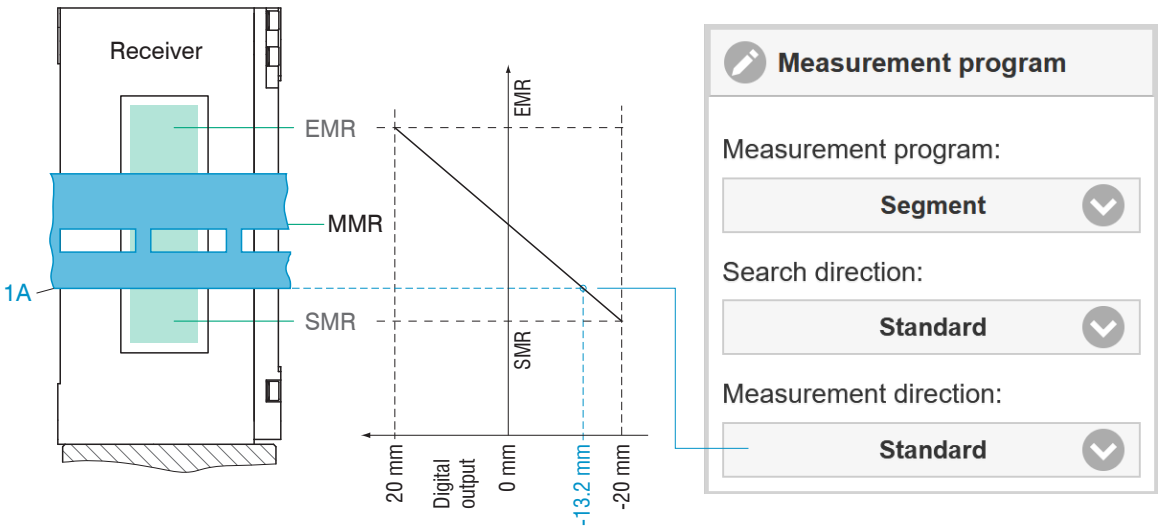


Fig. 6.7: Digital Output with Standard Measurement Direction

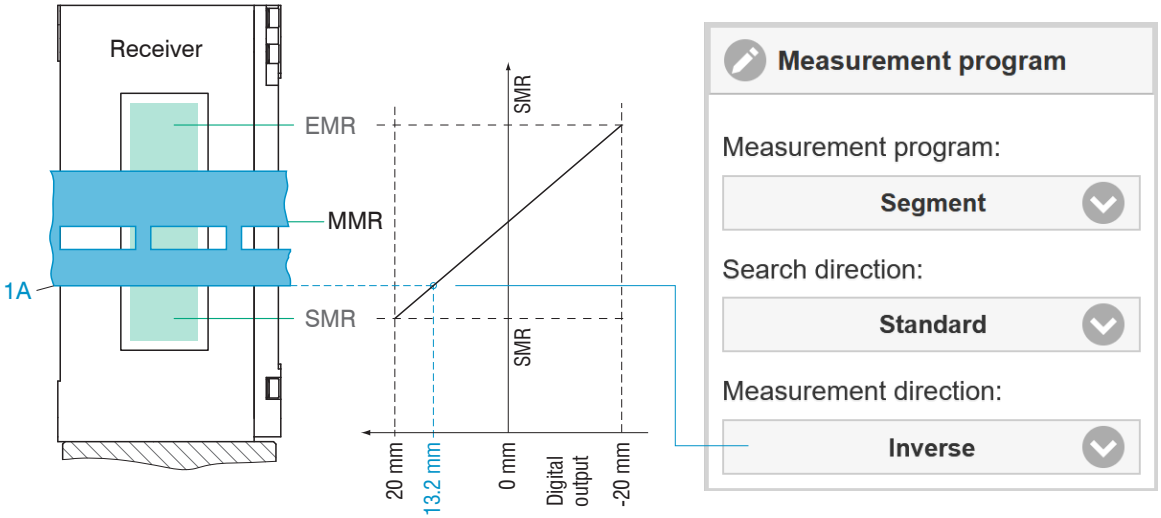


Fig. 6.8: Digital Output with Inverse Measurement Direction

6.4.3 Defining segments

This function is possible in conjunction with the Multi-segment preset and setups derived from it.

The detection of four edges is factory-set, see figure.

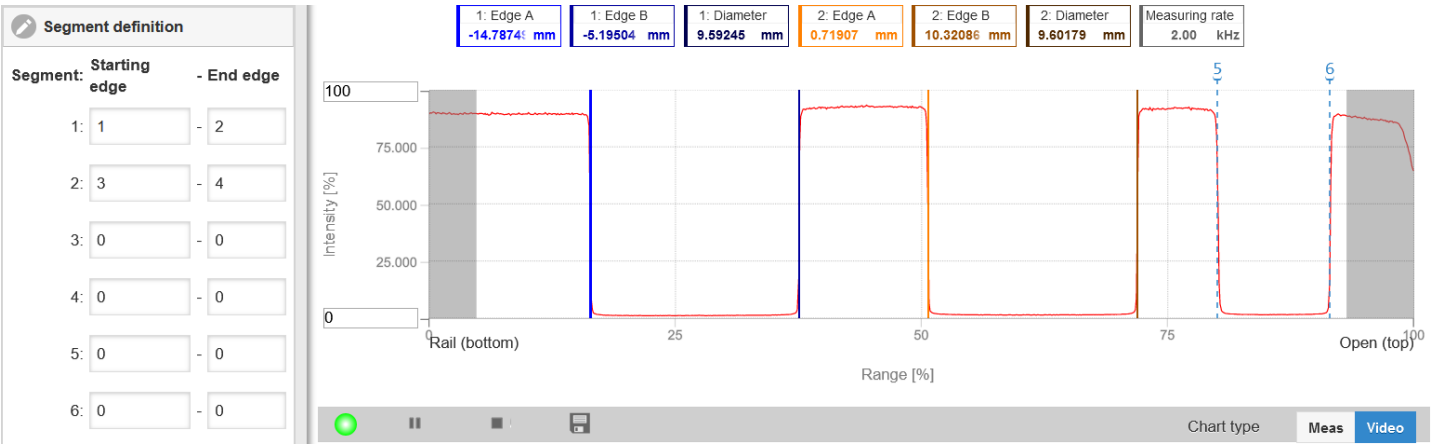


Fig. 6.9: Factory-set segment definition in the multi-segment preset

Measuring object with fewer than four edges: unused text boxes contain "No peak".

Measuring object with more than four edges: additional edges are numbered in the video signal with vertical, blue peak markers.

A maximum of 8 segments or 16 edges can be defined. Edge 1 is the edge that the sensor finds in the standard search direction (from the start of the measuring range). Further edges are numbered in ascending order. Edge 0 is the start of the measuring range. A 0-0 segment is ignored.

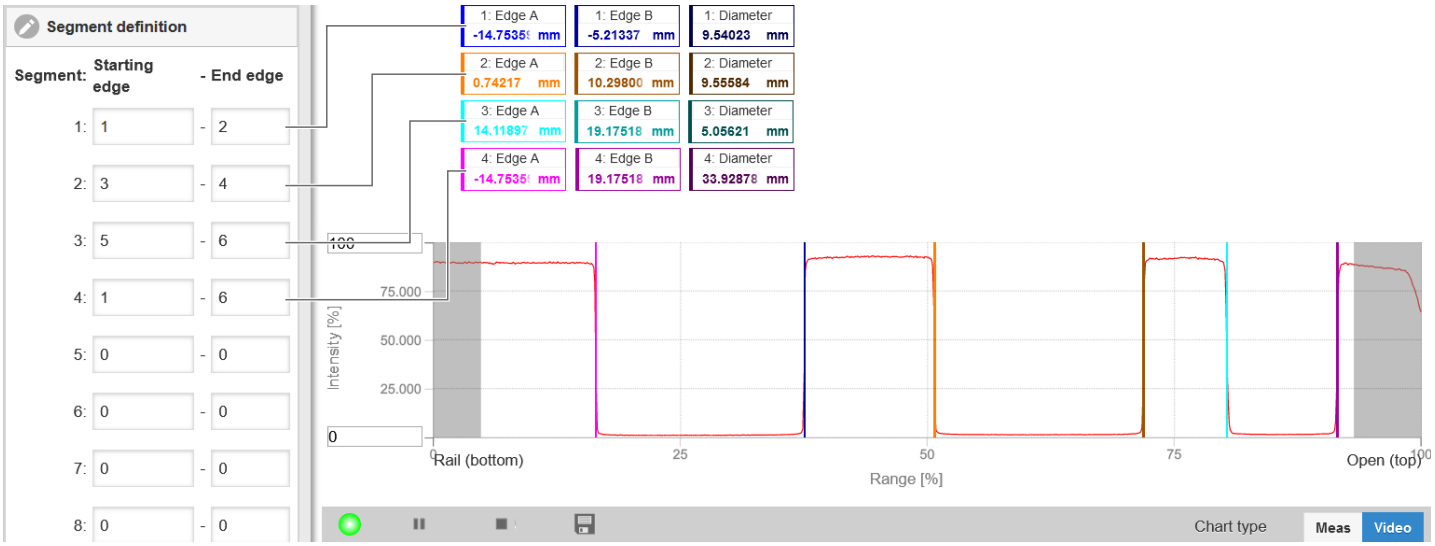


Fig. 6.10: Individual segment definition

Segment definition process

- ► Switch to the tab `Settings` > `Data acquisition` > `Segment definition`.
- ► Define the edge references to suit your measuring object.
- ► Save the resulting setup under a new name.

6.4.4 Measuring rate

The maximum sampling rate is 15 kHz.

The selection of the measuring rate is made in the menu `Settings` > `Data recording` > `Measuring rate`. The measuring rate is continuously adjustable within a range from 0.1 kHz to 5 kHz. The increment is 1 Hz.

Changing the measuring rate

- ► Switch to the tab `Settings` > `Data recording` > `Measuring rate`.
- ► Select the desired measuring rate.

Observing the video signal is useful for selecting the measuring rate.

If the video signal or the setup signal is output via an interface, the measuring rate is reduced to 100 Hz on the used interface only.

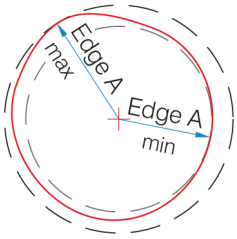
6.4.5 Recording Running Tolerance, View, Data

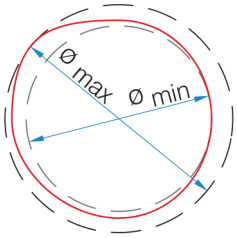
6.4.5.1 Record running tolerancen

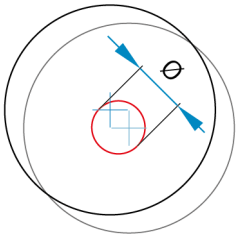
This program option allows for an offline analysis for the geometric characteristics:

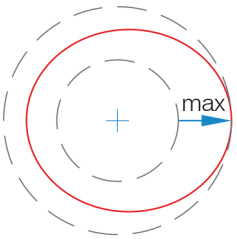
- runout,
- roundness,
- concentricity and
- ovality.

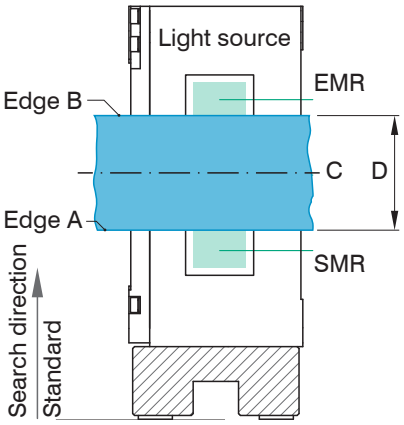
This program option requires the `Diameter` preset, see Chap. 6.4.2.1. A typical application for tolerance measurement is setup mode. During operation/production, Micro-Epsilon recommends the switching outputs for error or limit value monitoring, see Chap. 6.7.4.1.

Runout		
	Runout is defined as the distance between two coaxial circumferential lines, which is calculated from the difference between the maximum and minimum position of edge A. This gives the runout as the deviation tolerance for the circumferential line of a cylindrical target from a reference circle with respect to a global center axis. Reference for edge A is the start of the measuring range (SMR).	Data from offline file: A [mm]
Runout = EdgeA_{max} - EdgeA_{min}		

Roundness		
	Roundness is defined as the tolerance range for the circumferential diameter. In contrast to runout, the center axis specific to the target is also taken into account here.	Data from offline file: D [mm]
ROUNDNESS = Diameter_max – Diameter_min		

Concentricity		
	Concentricity is defined as the diameter of a circle in which the center moves; i.e. the radius around the center axis positions.	Data from offline file: C [mm]
CONCENTRICITY = Center axis_max – Center axis_min		

Ovality		
	Ovality is defined as the deviation from a circular shape (out-of-roundness) or the difference between the maximum and minimum dimensions of the outer diameter. It can be determined by measuring the highest and lowest points at any location on a cylindrical object.	Data from offline file: D [mm]
Ovality = (Diameter_max - Diameter_min) * 100 % / Diameter_mean		



In order for the controller to calculate geometric signals, two conditions must be met:
- Sources of the start and stop events are configured,
- At least one geometric signal is set for output via website, analog / switching output, Ethernet or RS422.

If these conditions are met, the setting takes effect in `Output mode`. Depending on the circumstance, this mode result in the data output being stopped completely. For the option `Always` the data output remains active and the controller behaves as usual.

It is only with a start event that the controller starts to internally calculate the measurement data for the geometric signals. With a stop signal, the results of the geometric signals are output once.

Tab. 6.8: Assignment of edge A/B for running tolerance measurement

Output mode	*always / only during calculation* *only 1x after calculation*			*Always: The calculated values for runout, roundness, concentricity and ovality can be output in parallel with all output values via the RS422 and Ethernet interfaces. The measurement and result values are displayed in the web interface. A CSV file for offline analysis is created when the start/stop condition is met; the file contains all measured values including time information within the start and stop events.* *roundness, concentricity and ovality can be output in parallel with all output values via the RS422 and Ethernet interfaces if the stop condition is met. The result is displayed in the web interface. A CSV file for offline analysis is also created when the start/stop condition is met; the file contains all measured values including time information within the start and stop events.* *Only 1x after calculation: The measured values are gathered when the start/stop condition is met. The calculated values for runout, roundness, concentricity and ovality, including time information, are written to a CSV file, i.e. one value each for edge A and B, center and diameter. Offline analysis is not possible. The result values can be output via the RS422 and Ethernet interfaces. The web interface only shows the result values.*
Source Start pulse	*TrigIn / Sync/Trig*	Mode	*Edge / level*	*Determines the signal source/input for the start of a measurement.*
		Level	*Low falling edge / High rising edge*	
	Encoder	Lower limit	*Value*	*Value range between 0 ... 4294967294*
		Upper limit	*Value*	*Value range between 1 ... 4294967295*
		Increment	*Value*	*Value range between 0 ... 4294967295*
	Software	Start		
	Inactive			*The geometric data for runout, roundness, concentricity and ovality can be continuously output via the interfaces.*

Source Stop pulse	*TrigIn / Sync/Trig*	Mode	*Edge / level*	*Determines the signal source/input or condition for the end of a measurement.*
		Level	*Low falling edge / High rising edge*	
	Encoder	Lower limit	*Value*	*Value range between 0 ... 4294967294*
		Upper limit	*Value*	*Value range between 1 ... 4294967295*
		Increment	*Value*	*Value range between 0 ... 4294967295*
	Software	Stop		
	Expiration time		*Value*	*Value range between 0 ... 10 sec*
	Number of measured values		*Value*	*Value range between 1 ... 4294967295*
Start website recording				*The buttons initiate or close local storage of the geometric data relating to runout, roundness, concentricity and ovality. By clicking the* `Start website recording` *button, multiple measurements can be carried out one after the other if the start condition is met. A corresponding data file is created for each measurement.*
Stop website recording				

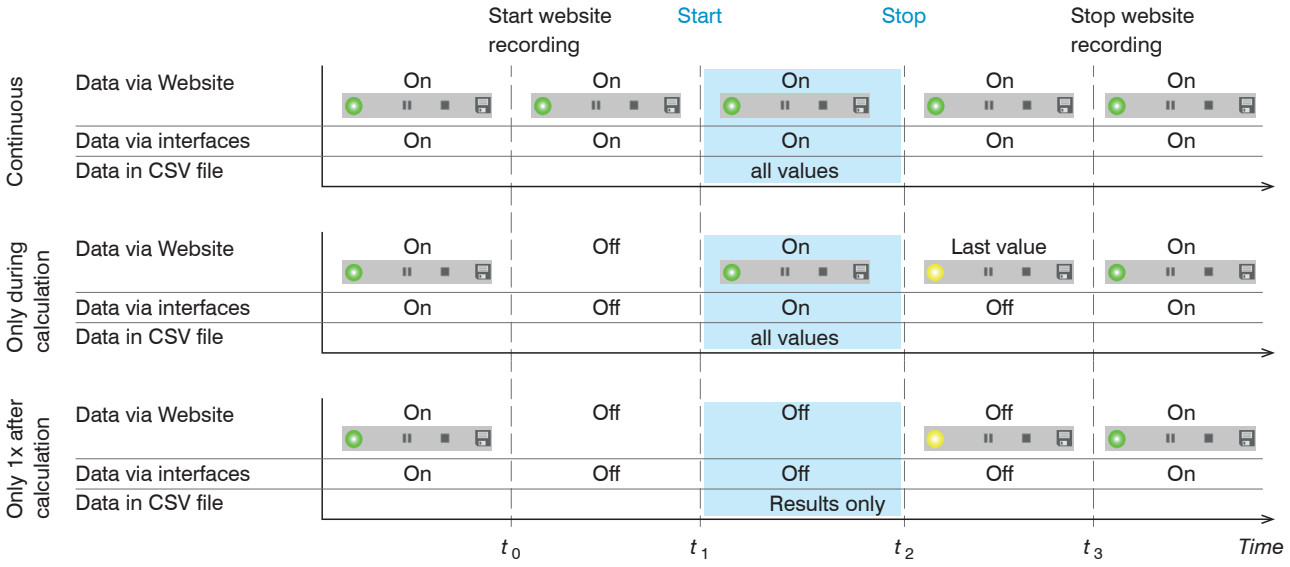
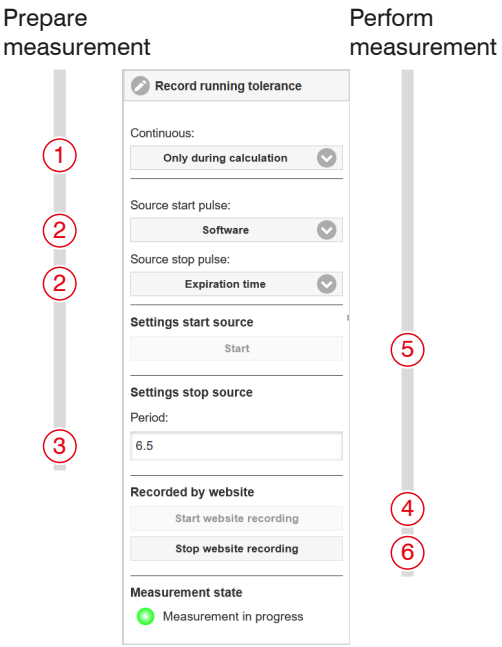


Fig. 6.11: Data flow control by running tolerance measurement, website, interfaces

Example sequence for a measurement/data recording via software, with csv file:

- Select a program (1) from, e.g. `Only during calculation`.
- Define the start and stop conditions (2).
- Define the signal source/input (3)..
- Click on the button `Start website recording` (4).
- Click on the button `Start` (5).
- Click on the button `Stop website recording` (6).

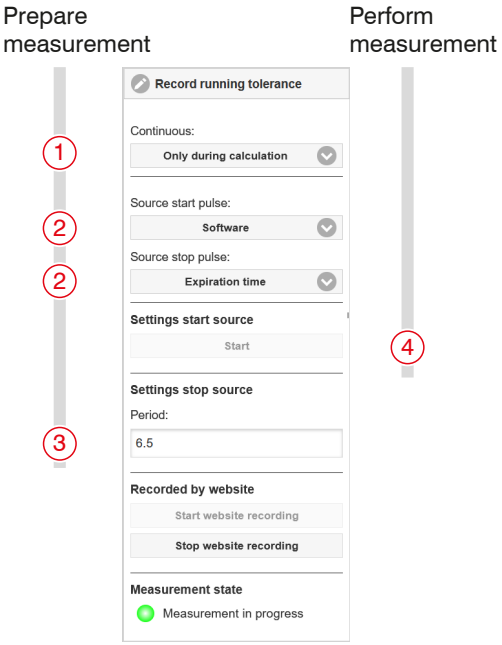


Tab. 6.9: Sequence for a measurement, with CSV file

Example sequence for a measurement/data recording via software, without csv file:

- Select a program (1) from, e.g. `Only during calculation`.
- Define the start and stop conditions (2).
- Define the signal source/input (3).
- Click on the button `Start` (4).

Data is recorded here, for example, by customer software from the output values via Ethernet, RS422 or the analog output.



Tab. 6.10: Sequence for a measurement, without CSV file

6.4.5.2 Running tolerance view

Start evaluation

► Switch to the tab `Settings` > `Data acquisition` > `Running tolerance view`.

► Select the desired dataset (1) and the view (2); see figure.

The angle specifications in the `Overview` and `Recording` views are scaled to the total measured values. Use an encoder for the start/stop condition if you want to restrict the measurement series to one revolution of the target.

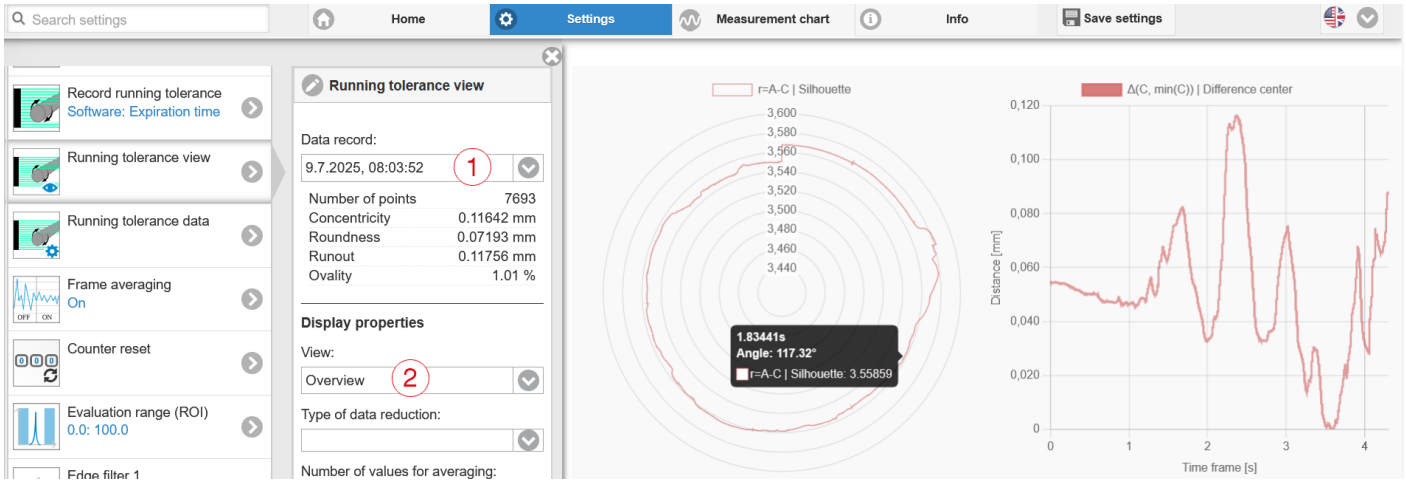


Fig. 6.12: View `Overview`

The start value for the delta information in the `Overview` and `Change` views is in each case the first measured value, not a calculated minimum value, for example.

Use the mouse wheel to enlarge/reduce (image excerpt) the time axis.

In the `Recording` and `Change` views, you can hide individual measurement series. To do this, click on the legends in the upper edge of the image.

PROTOCOL VERSION	1			
DECIMAL SEPARATOR	,			
UNIT	MM			
name	data	unit		
RUNOUT	0,29744	mm		
ROUNDNESS	0,57772	mm		
CONCENTRICITY	0,55961	mm		
OVALITY	7,35	%		
TIMESTAMP [s]	EDGE A [mm]	EDGE B [mm]	CENTERPOS C [mm]	DIFFERENCE D [mm]
0.000000	2,07406	9,80987	5,94197	7,72907
0.010000	2,12952	9,85591	5,99272	7,72919
0.020000	2,19805	9,91173	6,05489	7,72911
0.030000	2,25766	9,9634	6,11053	7,72889
0.040000	2,2557	9,95967	6,10768	7,7286

Runout = EdgeA_{max} - EdgeA_{min}
ROUNDNESS = Diameter_max – Diameter_min
CONCENTRICITY = Center axis_max – Center axis_min
Ovality = Diameter_{max} - Diameter_{min}

Tab. 6.11: CSV file excerpt for offline analysis

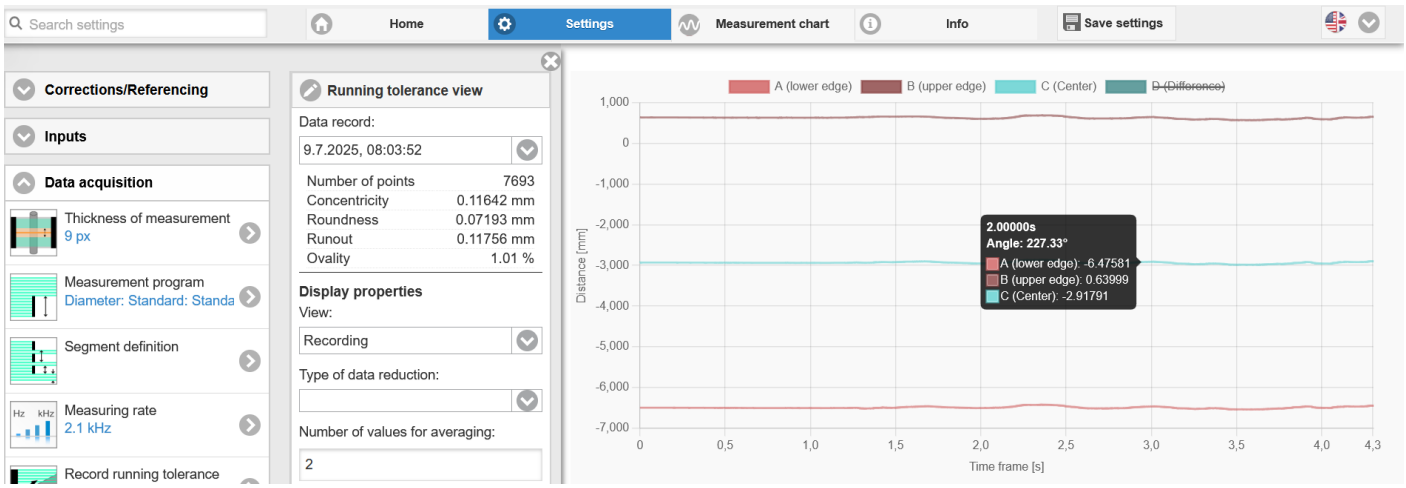


Fig. 6.13: View `Recording`

> i If the output mode `1x after calculation` is active, a graphical representation of the geometric data is not possible.

6.4.5.3 Running Tolerance Data

File management for offline analysis

► Switch to the tab `Settings` > `Data acquisition` > `Running tolerance data`.

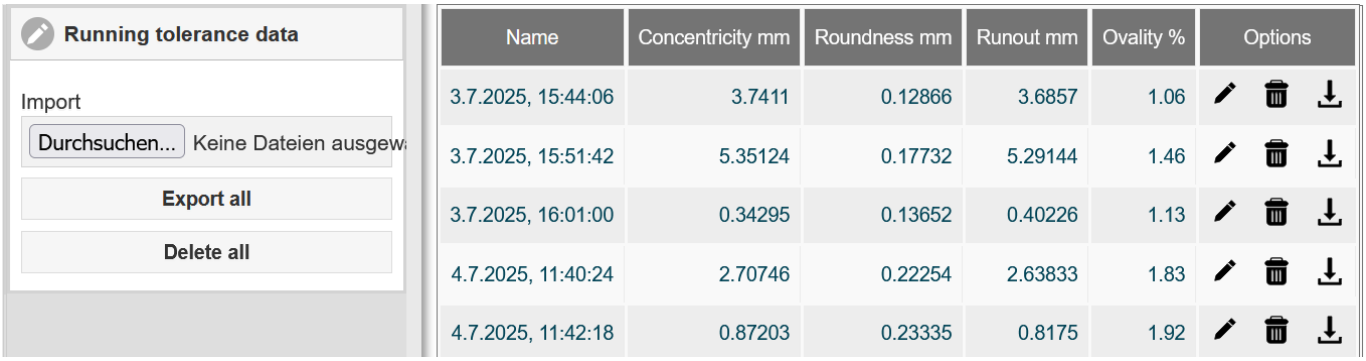


Fig. 6.14: Manage files for offline analysis

The overview allows for file manipulation

- Edit file name,
- Delete file, and
- Save file locally (download).

Click on the button `Export all` to combine the existing files in a ZIP folder and save locally.

Click on the button `Browse` to load a locally saved file into the sensor. A graphical evaluation is then possible in the web interface.

6.4.6 Frame averaging

Frame averaging is enabled by default (= `On`). It provides an optimal signal-to-noise ratio.

ON: Several frame recordings are created, averaged and further processed.

OFF: A frame recording is created and further processed. This is required for fast moving measuring objects.

Deactivate frame averaging

► Go to the tab `Settings` > `Data acquisition` > `Frame averaging`.

► Switch off frame averaging for fast-moving objects (= `Off`).

Without frame averaging, the exposure time for the line scan camera remains constant.

6.4.7 Counter reset

You can reset the measured value counter or the timestamp by pressing the relevant button.

Counter reset procedure

► Switch to the menu `Settings` > `Data acquisition` > `Counter reset` and click on the relevant button.

6.4.8 Region of interest

The region of interest can be set individually in the sensor. Masking limits the evaluating range (ROI - Region of Interest) for the edge detection and thus the distance calculation in the video signal. This function is used, for example, to suppress interfering edges. Masking (start and end) is entered into the two boxes on the left (in %). The factory settings are 0 % (start) and 100 % (end).

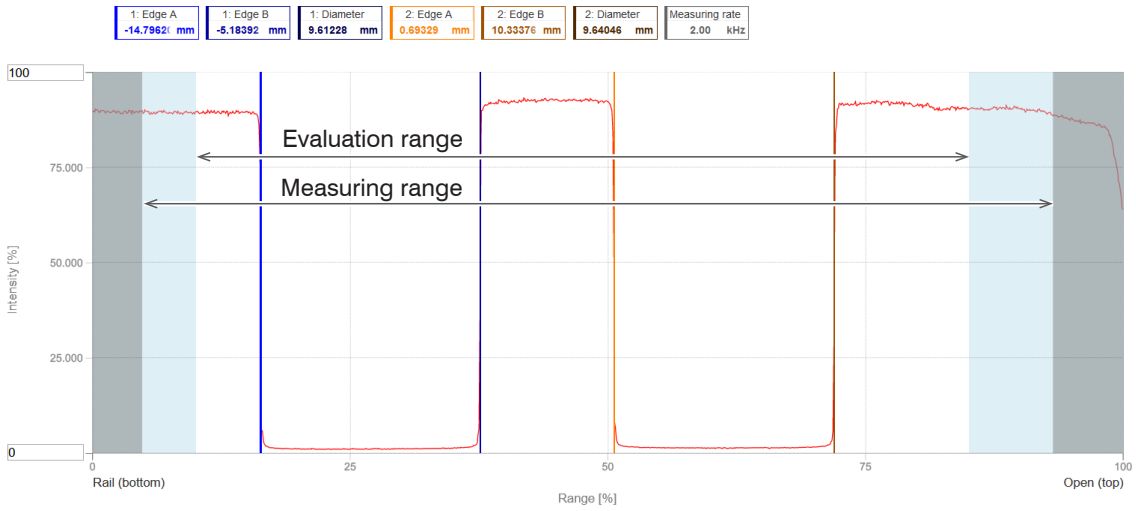


Fig. 6.15: Limiting the video signal used

Help text: Region of interest (ROI). The range of interest can be restricted if, for example, ambient light of a certain wavelength (blue, red, IR) causes interference in the video signal. The value for the "Start of range" must be smaller than the value for the "End of range". Value range from 0 ... 100 %.

Region of interest (ROI)	Start of range	*Value*	*Value range from 0 ... 100 %.* *The value for the "Start of range" must be smaller than the value for the "End of range".*
	End of range	*Value*	

Defining the region of interest

- ► Go to the tab `Settings` > `Data acquisition` > `Evaluation range`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

6.4.9 Edge filter

The purpose of an edge filter is to suppress the overshooting of measured values in the context of rising edge transitions. The upper threshold activates the edge filter once. The lower threshold deactivates the filter and resets it so that it can be reactivated again the next time the upper threshold is exceeded. This filter should be applied with care because it can distort the measurement if used incorrectly.

The edge filter outputs the last value that was below the upper limit.

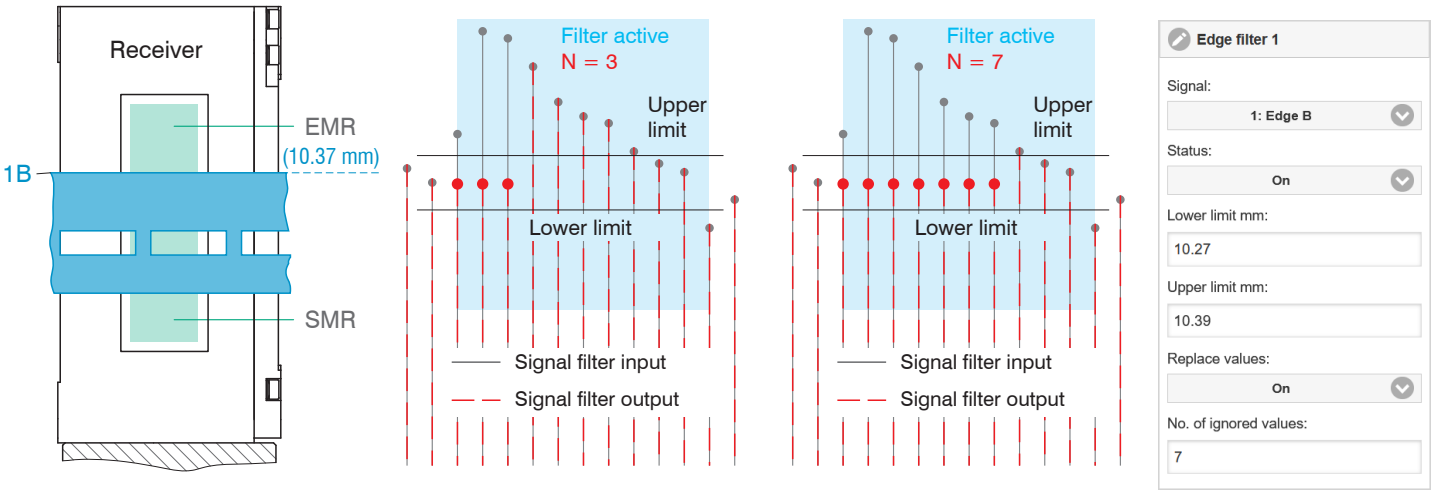


Fig. 6.16: Number of ignored values N is too small, minor overshoot remains (Left), N set to the ideal value (Right)

Defining the edge filter

- ► Switch to the tab `Settings` > `Data acquisition` > `Edge filter`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

6.4.10 Error handling

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.

Error handling	*Error output, no measured value*	*Interfaces output an error instead of a value.*	
	Hold last value infinitely	*Interfaces output the last valid value until a new, valid measured value is available.*	
	Hold last value	*Value*	*Possible number of values to be maintained between 1 and 1024. When number = 0, the last value is maintained until a new, valid reading becomes available.*

Error handling

- Switch to the tab `Settings` > `Data acquisition` > `Error handling`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.4.11 Triggering for Data Acquisition

6.4.11.1 General

The acquisition and output of measured values by the sensor can be controlled using an external electrical trigger signal or commands.

- The triggering does not affect the preselected measuring rate.
- The Sync/Trig inputs or multifunction inputs (TrigIn) are used as external trigger inputs, see Chap. 4.3.4.
- Factory setting: No triggering, the sensor starts transmitting data immediately after being switched on.
- The pulse duration of the trigger signal is at least 5 µs.

Sync/Trig / TrigIn	Trigger type	*Level*	Trigger level	*High / Low*	
		Edge	Trigger level	*Falling edge / rising edge*	
			Number of measured values	*Manual selection*	*value*
				Infinite	
Software			Number of measured values	*Manual selection*	*value*
				Infinite	
Encoder			Lower limit		*value*
			Upper limit		*value*
			Increment		*value*
Inactive					

Selecting `Inactive` causes continuous acquisition or output of measurement values.

Notes on triggering

`Level triggering`. Continuous measured value acquisition/output as long as the selected level is present. After that, the controller stops the data acquisition/output. 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.
S = displacement signal

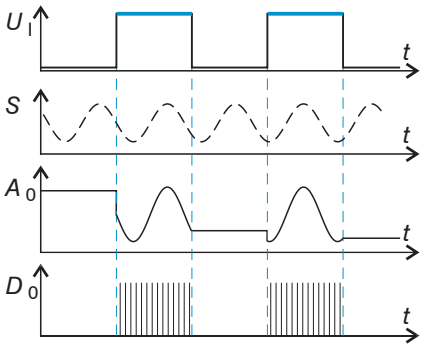


Fig. 6.17: Triggering with active high level (U I), associated analog signal (A O) and digital signal (D O)

`Edge triggering`. Starts measured value input/output as soon as the selected edge is active to the trigger input. The pulse must be at least 5 µs.
S = displacement signal

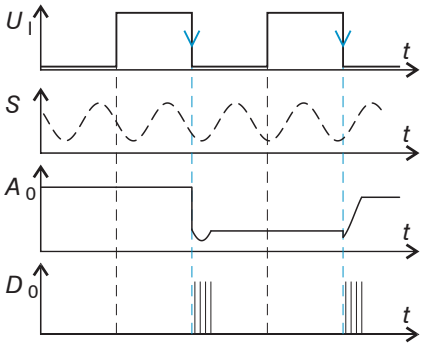


Fig. 6.18: Triggering with falling edge (U I), associated analog signal (A O) and digital signal (D O)

`Software triggering`. Starts data acquisition as soon as a software command is issued (instead of using the trigger input) or the`Initiate trigger`button is clicked.

`Encoder triggering`. Starts data acquisition/output via the encoder input.

Defining triggering

- Go to the tab `Settings` > `Data acquisition` > `Triggering`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.4.11.2 Triggering for measured value acquisition

The current array signal is only processed and measured values are calculated from it after a valid trigger event. The measured value data are then transferred for further calculation (e.g., averaging, statistics), as well as for output via a digital or analog interface.

When calculating averages or statistics, measured values immediately before the trigger event cannot be included; instead, the calculation incorporates older measured values that were captured during previous trigger events.

6.4.11.3 Example

The multifunction inputs for synchronization or triggering on the sensor expect the set TTL or HTL level. The sync inputs for synchronization or triggering expect an RS422 level. The following example shows the adaptation of a 24V trigger source with the SU4-1 level converter from the optional accessories.

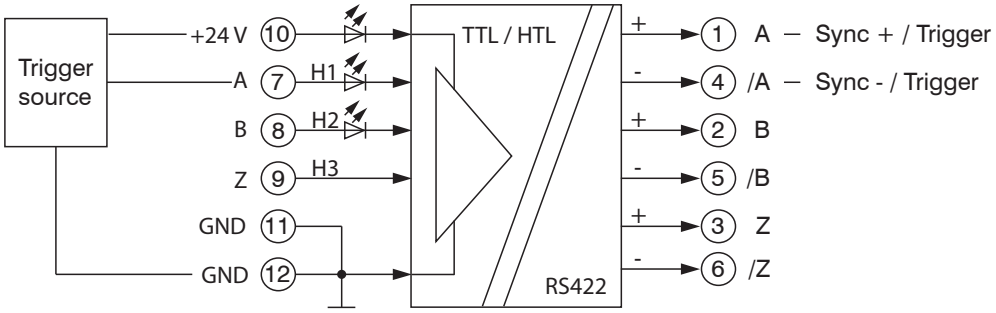
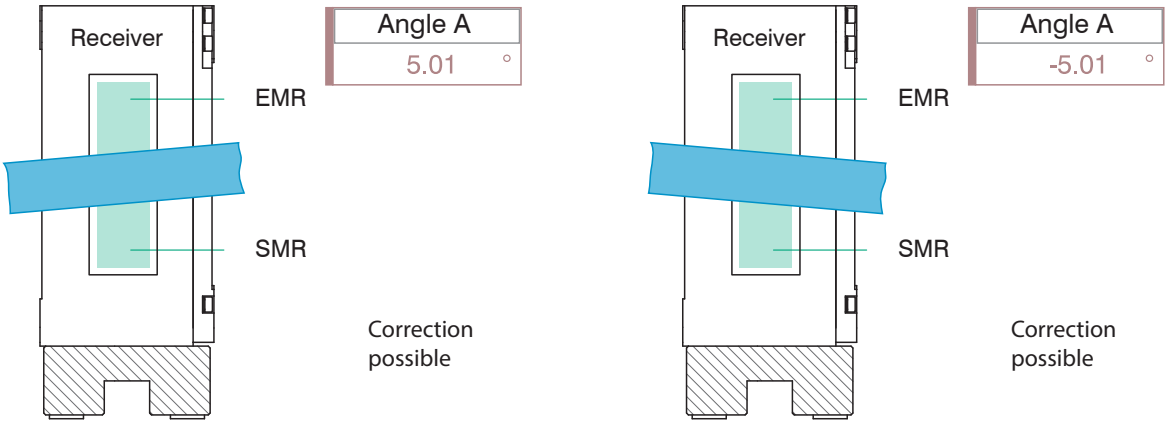


Fig. 6.19: Level adjustment from HTL to RS422 with the SU4-1 level converter

6.5 Signal Processing

6.5.1 Inclination correction

The sensor detects tilted measuring objects. The two-dimensional video signal is used to compensate for the resulting measurement errors.



Tab. 6.12: Display of measured values for counterclockwise tilted measuring objects (left) and clockwise (right)

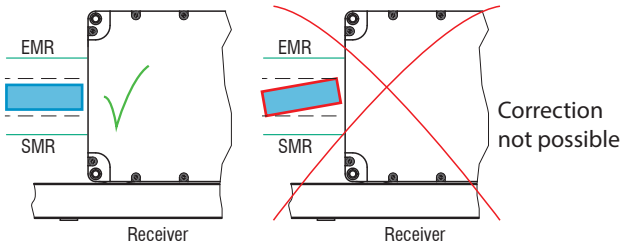


Fig. 6.20: Correct: edges of measuring object parallel with light curtain (left), incorrect measurement result due to rotated measuring object (right)

Upon delivery of the sensor, inclination correction is deactivated (off) by default.

Inclination correction is possible with the following presets `wire measurement`, `diameter`, `contour measurement`, `multi-segment` and `gap measurement`. Inclination correction is also possible in setups derived from this.

Activate inclination correction

► Switch to the tab `Settings > Signal processing > Inclination correction` and select `On`.

Inclination correction is possible for measuring objects tilted by up to ±63°.

6.5.2 Calculation

6.5.2.1 Data source, parameters, calculation programs

One calculation operation can be performed in each calculation block. The calculation program, the data sources and the parameters of the calculation program must be set for this.

Median		Signal or result Number of values
Moving averaging		Signal or result Number of values
Recursive averaging		Signal or result Number of values
Thickness	Calculating the difference	Signal or result Signal distance A < Signal distance B
Formula	Distance B - Distance A	
Calculation	Summation	Signal or result
Formula	Factor 1 * Distance A + Factor 2 * Distance B + Offset	
Duplicate		Signal or result

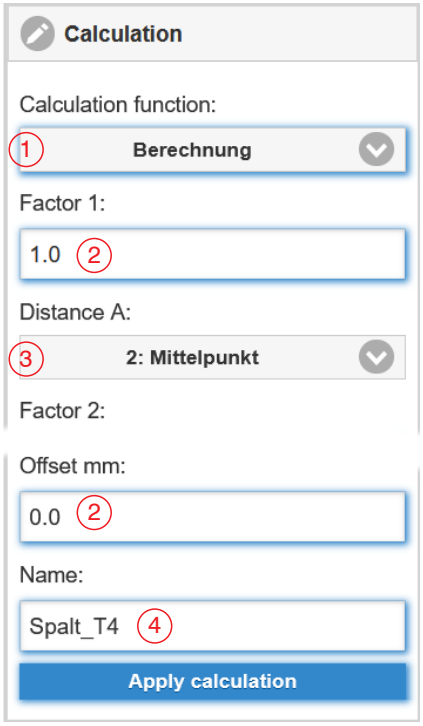
Tab. 6.13: Available calculation programs

Add calculation function

► Switch to the tab Settings > Signal processing > Calculation .

Sequence for creating a calculation block:

- Select a program (1), e.g. average.
- Define the parameters (2).
- Define the data source(s) (3).
- Enter a block name (4).
- Click on the Apply calculation button.



Tab. 6.14: Sequence for the program selection

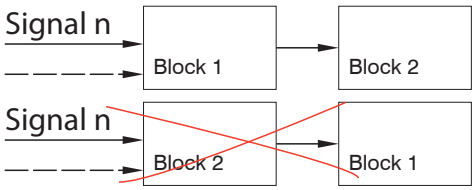
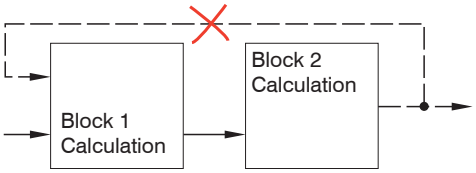
The programs calculation and thickness have two data sources. Averaging programs each have one data source.

Calculation / thickness	Factor 1 / 2	*Value*	*-32768.0 ... 32767.0*
	Offset	*Value*	*-2147.0 mm ... 2147.0 mm*
Moving average / recursive average / median	Number of values	*Value*	*Moving: 2 / 4 / 8 / ... / 4096*
			Recursive: 2 ... 32767
			Median: 3/5/7/9
Duplicate		*Value*	*Name of the duplicated signals*

Tab. 6.15: Value range of computing program parameters

6.5.2.2 Definitions

Observe the following instructions when using calculation functions.

Signal(s)	n Edge A / n Edge B / ...
A maximum of 10 calculation blocks are possible in the sensor. The calculation blocks are processed sequentially.	
Feedback couplings (algebraic loops) over one or several blocks are not possible. Only the signals or the calculated results from the previous calculation blocks can be used as data source.	
Processing sequence: 1. Edge determination 2. Calculation of differences (diameter, gap, segments) and center axes 3. Error handling in the event of no valid measurement value 4. Spike correction of the measured values 5. Calculation functions (blocks) 6. Statistics	

6.5.3 Averaging

6.5.3.1 General

Measurement averaging is performed after measured values have been calculated, and before they are issued or processed through the relevant interfaces.

Measurement averaging

- improves the resolution,
- allows the masking of individual interference points, or
- “smooths” the measurement result.

> i Linearity is not affected by averaging. Averaging has no effect on measuring rate and output rate. The defined type of average value and the number of values must be saved in the sensor to ensure they are maintained after it has been switched off.

Averaging is disabled by default on the sensor.

Defining measurement averaging

► Switch to the tab `Settings` > `Signal processing` > `Calculation`.
► Make the desired settings and confirm them by pressing `Save settings`.

6.5.3.2 Moving mean

Moving Average

The arithmetic average M_{mov} is calculated and output for a series of consecutive measured values according to the selectable filter width *N*. Each new measured value is added, and the first (oldest) value is removed from the averaging (from the window).

$M_{mov} = \frac{\sum_{k=1}^{N} MV(k)}{N}$	*MW* = measured value
	N = averaging value
	k = continuous index (in the window)
	M_{mov} = average value or output value

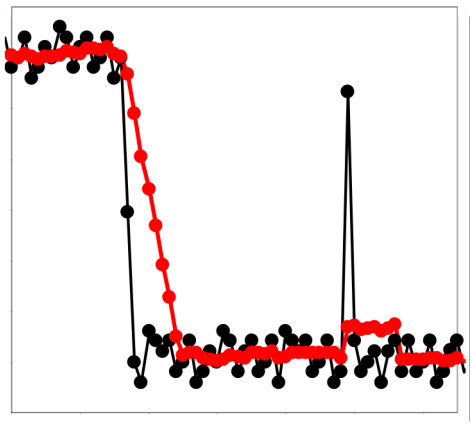
This produces short settling times in case of measurement jumps.

Example: N = 4

... 0, 1, 2, 2, 1, 3 ... 1, 2, 2, 1, 3, 4 Measured values

$\frac{2, 2, 1, 3}{4} = M_{mov}(n)$ $\frac{2, 1, 3, 4}{4} = M_{mov}(n+1)$ Output value

Note	For the moving average, only powers of 2 are permitted for the averaging number *N*. The highest averaging value is 4096.



Application tips

- Smoothing of measured values
- In contrast to recursive averaging, the effect can be finely controlled.
- With uniform noise of the measured values without spikes
- In the case of a slightly rough surface whose roughness is to be eliminated.
- Also suitable for measured value jumps with relatively short settling times

Signal without averaging

Signal with averaging

Tab. 6.16: Moving average, N = 8

6.5.3.3 Recursive average

Recursive average

Each new measured value *MW*(n) is weighted and added to (n-1) times the previous average value.

Formel:

$M_{rec}(n) = \frac{MW_{(n)} + (N\text{-}1) \times M_{rec\,(n-1)}}{N}$

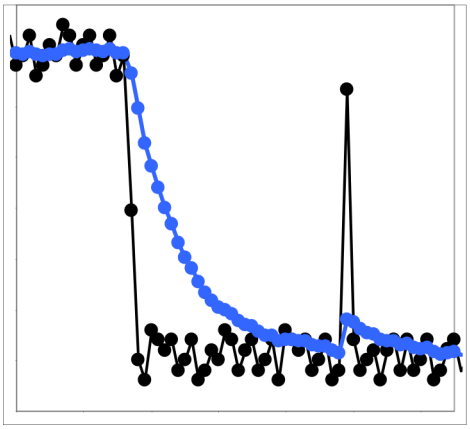
N = Mittelungszahl, *N* = 1 ... 32767

n = Messwertindex

MW = Messwert

M_{rek} = Mittelwert bzw. Ausgabewert

Recursive averaging allows for very strong smoothing of the measurements, however it requires long response times for measurement jumps. The recursive average value shows low-pass behavior.



Application tips

- Permits a high degree of smoothing of the measured values. Long settling times in the case of measured value jumps (low-pass behavior).
- High degree of smoothing for noise without strong spikes
- To especially smooth signal noise for static measurements
- To eliminate the roughness when performing dynamic measurements on rough target surfaces, e.g., roughness of paper.
- To eliminate structures, e.g., parts with uniform groove structures, knurled turned parts or coarsely milled parts
- Unsuitable for highly dynamic measurements

—— Signal without averaging
—— Signal with averaging

Tab. 6.17: Recursive average, N = 8

6.5.3.4 Median

Median

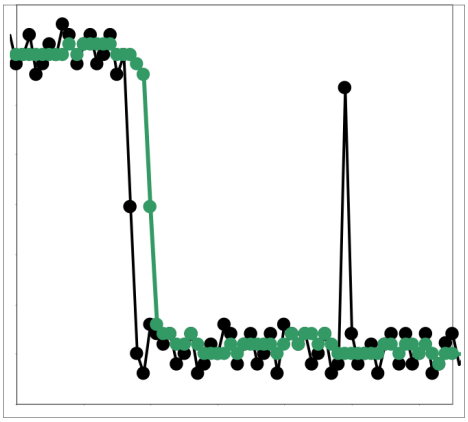
A median value is formed from a preselected number of measured values.

When creating a median value for the sensor, incoming measured values are sorted after each measurement. Then the average value is provided as the median value.

3, 5, 7 or 9 readings are taken into account. This means that individual interference pulses can be suppressed. However, smoothing of the measurement curves is not very strong.

Example: Median value from five readings

... 0 1 [2 4 5 1 3] → Sorted measurements: 1 2 [3] 4 5 $\text{Median}_{(n)} = 3$
... 1 2 [4 5 1 3 5] → Sorted measurements: 1 3 [4] 5 5 $\text{Median}_{(n+1)} = 4$



Application tips

- The measured value curve is not smoothed to a great extent; it primarily eliminates spikes
- Suppresses individual interference pulses
- In short, strong signal peaks (spikes)
- Also suitable for edge jumps (only minor influence)
- To eliminate dirt or roughness in a rough, dusty or dirty environment
- Further averaging can be used after the median filter

—— Signal without averaging
—— Signal with averaging

Tab. 6.18: Median, N = 7

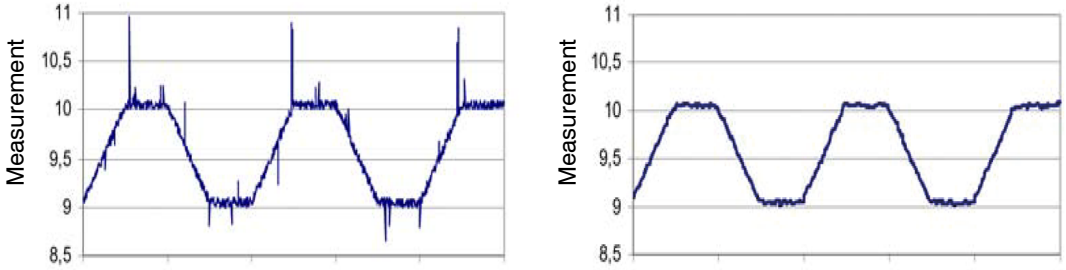


Fig. 6.21: Signal Curve – Profile without Median (Left), with Median N = 9 (Right)

6.6 Post-Processing

6.6.1 Zeroing and mastering

6.6.1.1 General

Use zeroing and mastering to define a nominal value within the measuring range. This shifts the output range. This function is useful for determining a diameter, for example. In this case, mastering can be performed with reference to a test pin nominal value or a paper edge can be zeroed at its desired position.

Mastering (the process of setting master signals and values) is also used to compensate for mechanical tolerances in the sensor measurement setup or to correct chronological (thermal) changes to the sensor. The master value, also called calibration value, is defined as the nominal value.

The master value is the measured value that is output as result of measuring a master object.

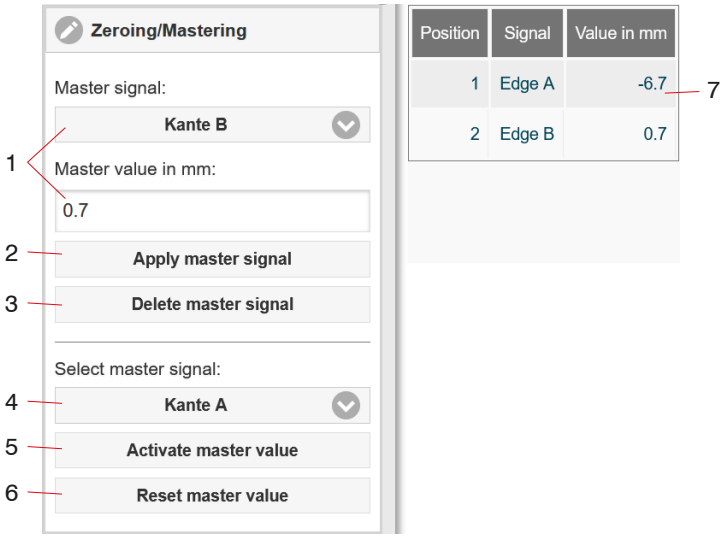
Zeroing is a special feature of mastering, since the master value is `0` here.

Preset `Strip edge`	Master signal	*Edge A*	*Master signals are all internally determined values.* *Calculated values from the calculation functions are not possible as master signals.*
	Master value	*Value*	
Preset `Wire measurement`	Master signal	*Edge A / Edge B / Diameter / Center point*	
	Master value	*Value*	
Preset `Diameter`	Master signal	*Edge A / Edge B / Diameter / Center point*	
	Master value	*Value*	
Preset `Contour measurement`	Master signal	*Edge A / Edge B / Diameter / Center point*	
	Master value	*Value*	
Preset `Multi-segment`	Master signal	*1: Edge A / ... / 8: Edge B / 1: Diameter / ... / 8: Diameter / 1: Center point / ... / 8: Center point*	
	Master value	*Value*	
Preset `Gap measurement`	Master signal	*Edge A / Edge B / Diameter / Center point*	
	Master value	*Value*	
`Inactive`			

6.6.1.2 Zeroing/mastering procedure

i Mastering or zeroing requires a target to be present in the measuring range. The mastering and zeroing processes affect the analog and digital outputs.

- ► Position the measuring object within the measuring range.
- ► Switch to the menu `Settings` > `Postprocessing` > `Zeroing/mastering`.



The sensor manages up to 10 master signals.

1 Selects a signal for the function, assigns master value

2 Each master signal and the associated master value must be confirmed with the `Apply master signal` button.

3 The delete function refers to the master signal listed in (1).

4 It is possible to master a single master signal or all master signals at once.

5 Start function. The function can be performed several times in succession.

6 If you click on the `Reset master value` button, the system reverts to the state before mastering.

7 Overview of all existing signals for the function.

Tab. 6.19: Mastering/zeroing dialog, overview of the individual master signal and values

After mastering, the sensor will provide relative measured values with reference to the master value.

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).

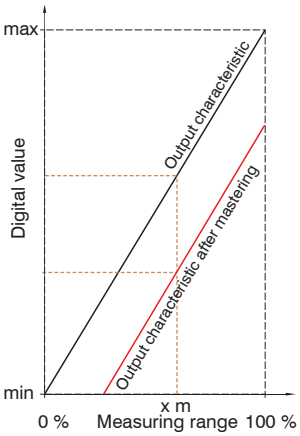


Fig. 6.22: Moving the characteristic during mastering

6.6.2 Statistics

The statistical values are calculated from the measured values within the evaluation range (ROI). The evaluation range is reset for each new measured value. The statistical values are displayed in the `measurement chart` section of the web interface or are output via the interfaces.

The sensor works out the following statistical values based on the measurement result:

- Minimum
- Peak-peak (span)
- Maximum

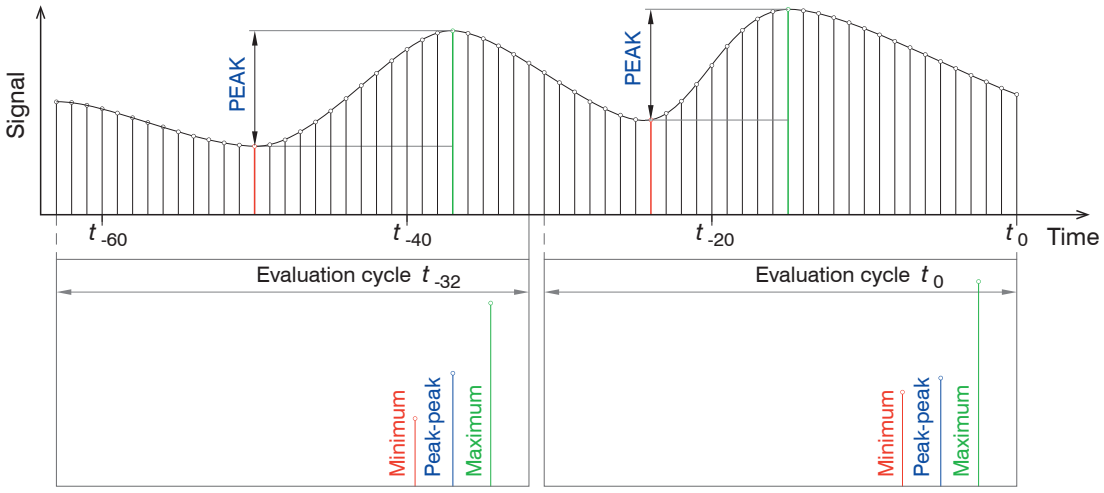


Fig. 6.23: Statistical values with 32 values in the evaluation range (ROI)

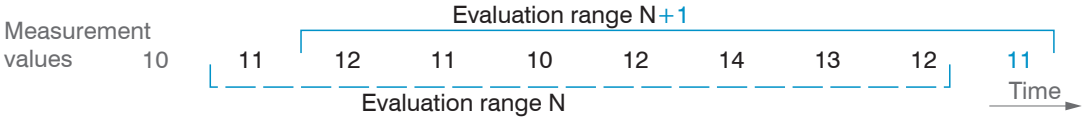
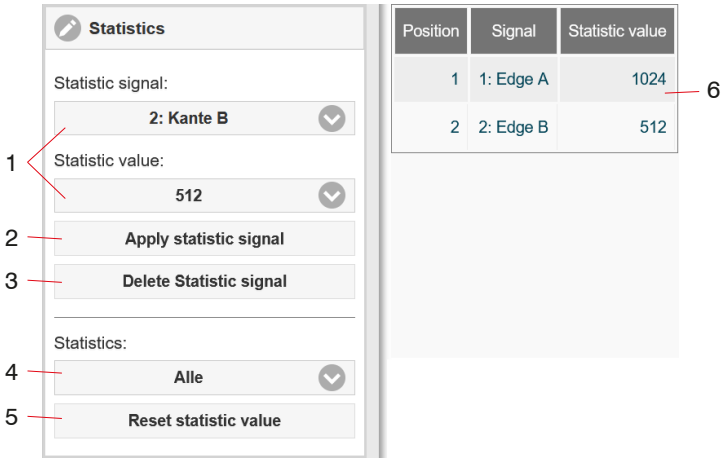


Fig. 6.24: Dynamic updating of the evaluation range using measured values, statistical value = 8

Define statistics

- ► Change to the tab `Settings` > `Postprocessing` > `Statistics`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

Preset `Strip edge`	Statistic signal	*Edge A*	*Statistic signals are all internally determined values.* *Calculated values from the calculation functions are not possible as statistic signals.*
	Statistic value	*Value*	
Preset `Wire measurement`	Statistic signal	*Edge A / Edge B / Diameter / Center point*	
	Statistic value	*Value*	
Preset `Diameter`	Statistic signal	*Edge A / Edge B / Diameter / Center point*	
	Statistic value	*Value*	
Preset `Contour measurement`	Statistic signal	*Edge A / Edge B / Diameter / Center point*	
	Statistic value	*Value*	
Preset `Multi-segment`	Statistic signal	*1: Edge A / ... / 8: Edge B / 1: Diameter / ... / 8: Diameter / 1: Center point / ... / 8: Center point*	
	Statistic value	*Value*	
Preset `Gap measurement`	Statistic signal	*Edge A / Edge B / Diameter / Center point*	
	Statistic value	*Value*	
`Inactive`			



The sensor can manage up to 10 statistic signals.

1 Selects a signal for the function, assigns statistic value Click on `Inactive` to end the statistics function.

2 Each statistic signal and the associated statistic value must be confirmed with the `Apply statistic signal` button.

3 The delete function refers to the statistic signal listed in (1).

4 One statistic signal or all statistic signals at once can be selected for the reset function.

5 The statistic values are deleted by resetting with the `Reset statistic value` button. The calculation of new statistical values begins immediately.

6 Overview of all existing signals for the function.

Tab. 6.20: Statistics dialog, overview of the individual statistic signals and values

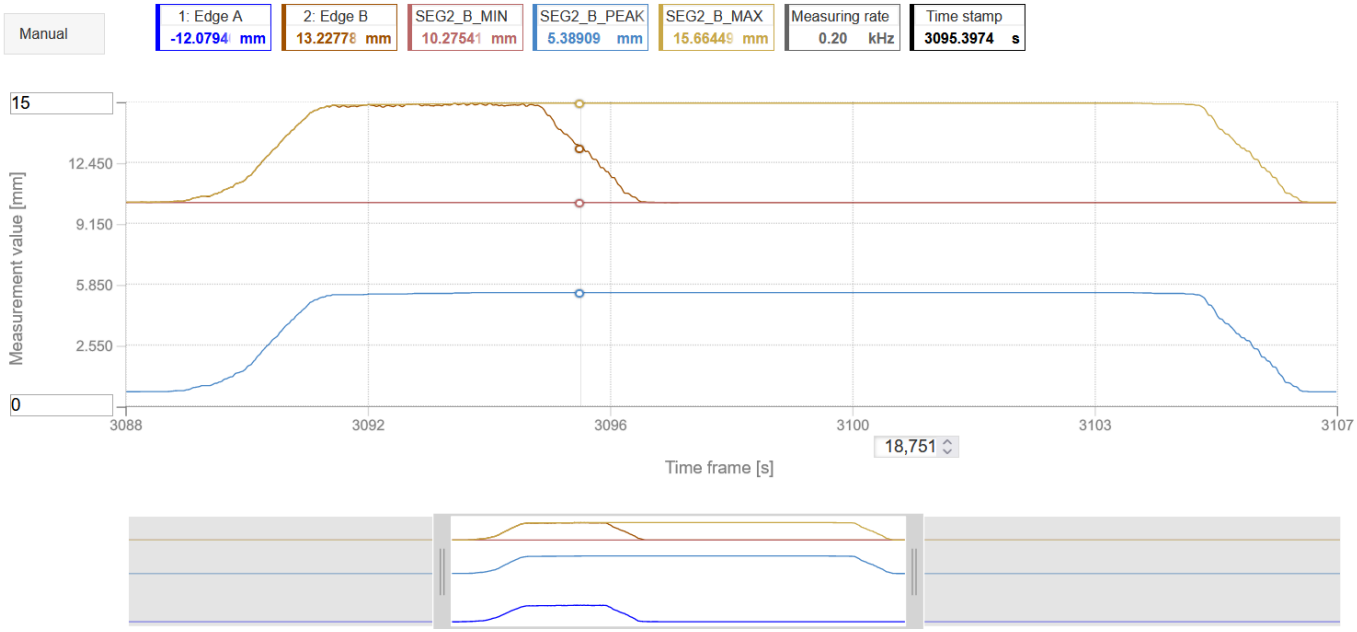


Fig. 6.25: Offline analysis of statistic values with mouse-over function

6.6.3 Data reduction

You can reduce the output of measured values in the sensor by using the web interface or a command to specify that every nth measured value should be output. Data reductions causes only every nth measured value to be output. The other measured values are rejected. The reduction value n can range from 1 (each measured value) to 3,000,000. This allows you to adjust slower processes, such as a PLC, to the fast sensor without having to reduce the measuring rate.

Data reduction	*Value*	*Instructs the sensor which data are excluded from the output, thus reducing the volume of data transmitted.*
Reduction applies to	*RS422 / Analog / Ethernet*	*The interfaces which are provided for the sub-sampling are to be selected with the checkbox.*

Defining a data reduction

- Switch to the tab `Settings` > `Postprocessing` > `Data reduction`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.6.4 Triggering for 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.

Consequently, the values measured immediately before the trigger event are included when calculating the averages or statistics. The triggering of the measured value acquisition and output have the same time response.

Detailed information about the function is available in the “Data Acquisition” section, see Chap. 6.6.4.

Defining triggering for measured value output

- ► Switch to the tab `Settings` > `Postprocessing` > `Triggering (data output)`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

6.7 Outputs

6.7.1 RS422 data output

The RS422 interface has a maximum baud rate of 8000 kBaud. The baud rate is set to 921.6 kBaud when the interface is delivered. Use ASCII commands or the web interface to configure.

The transmission settings for the sensor and PC must match.

Data format: Binary.

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

The RS422 interface transmits **32 bits** per output value. The resolution is 10 nm per value. The maximum number of measured values that can be transmitted for a measuring point depends on the measuring rate of the sensor and the transmission rate set for the RS422 interface. Use the maximum available transmission rate (baud rate) where possible.

RS422 data output	Baud rate	*9.6 / 115.2 / 230.4 / 460.8 / 691.2 / 921.6 / 2000 / 3000 / 4000 / 8000 kBps*
	Signals	*Raw signal / ... / Encoder / Edge A / Edge B / Angle A / Angle B / Diameter / Center / ... / Edge count / ... / Calculation result / Runout / Roundness / Concentricity / Ovality*

Output data are selected for the interfaces separately from all internally determined values and from the calculated values from the computing modules. These data are output in a rigidly defined order. The web interface shows the order.

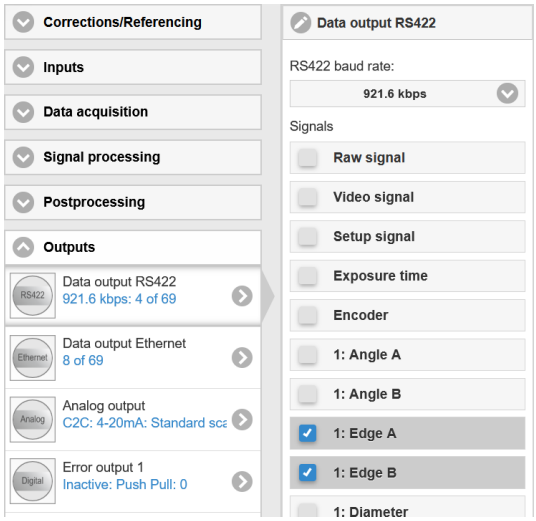


Fig. 6.26: Selection of Output Data via RS422

Data are output when the interface is activated, see Chap. 6.7.5.

Baud rate and signal selection

- ► Switch to the tab `Settings` > `Outputs` > `RS422 data output`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

The output values are identical to the Ethernet interface, see Chap. 6.7.2.

6.7.2 Ethernet data output

When using a static IP address it is necessary to enter the values for the IP address, Gateway and Subnet mask; this is not required when DHCP is used. The sensor is set at the factory to the static IP address 169.254.168.150.

The sensor transmits the Ethernet packets at a transmission rate of 10 Mbit/s or 100 Mbit/s, which is set automatically according to the network or PC that is connected.

All output values and additional information intended for transmission that were captured at a certain time are consolidated into a measured value frame. Several measured value frames are consolidated into a measured value block. A header is added to the start of each measured value frame.

During the transmission of measured value data, the controller sends each measured value (measured value block) to its connected counterpart after the connection has been successfully established. No specific request is required for this.

In the event of changes to the transmitted data or the frame rate, a new header is sent automatically. The measured values are transmitted as a 32-bit signed integer with a resolution of 10 nm. It is possible to limit the volume of data.

Video signals are transmitted in a similar way to the “transmission of measurement data to a measured value server via Ethernet”, except that only one video data set from a measuring cycle is transferred in a measured value block at a time.

This measured value block can also consist of several Ethernet packets, depending on the size of the video signal.

Ethernet data output	Signals	*Raw signal / ... / Encoder / Edge A / Edge B / Angle A / Angle B / Diameter / Center / ... / Edge count / ... / Calculation result / Runout / Roundness / Concentricity / Ovality*

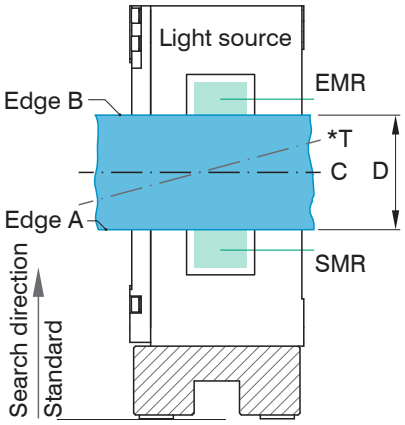
Output data are selected for the interfaces separately from all internally determined values and from the calculated values from the computing modules, see Fig. 6.26. These data are output in a rigidly defined order. The web interface shows the order.

Defining signal selection

- Switch to the tab `Settings` > `Outputs` > `Ethernet data output`.
- Make the desired settings and confirm them by pressing `Save settings`.

Data are output when the interface is activated, see Chap. 6.7.5.

Signal	Minimum	Maximum	Scaling/	Unit
RAW (2048 x 16Bit)	0	1023	Value / 1024 * 100	%
LIGHT (2048 x 16Bit)	0	1023	Value / 1024 * 100	%
RAW2D (512 x 128 pixels x 1 bit)	0	1	Value	Pixels bright
SHUTTER	85	85	Value / 10	µs
ENCODER1	0	UINT32_MAX	Value	Encoder ticks
*[A|B]T	-63000	63000	Value / 100 Valid for the signals: AT, BT, SEG1_AT, SEG1_BT, …, SEG8_AT and SEG8_BT An *AT signal describes the inclination of edge A. An *BT signal describes the inclination of edge B.	Degrees

Signal	Minimum	Maximum	Scaling/	Unit
*[A|B|C|D]	INT32_MIN	0x7ffffeff	Value / 100000 Valid for the signals: A, B, C, D, SEG1_A, SEG1_B, SEG1_C, SEG1_D, … , SEG8_A, SEG8_B, SEG8_C and SEG8_D 0x7FFFFF04 No edge is present 0x7FFFFF07 Measured value cannot be calculated 0x7FFFFF08 Measured value is outside of displayable range 	mm
OVALITY	0	10000	Value / 100	%
ROUNDNESS CONCENTRICITY RUNOUT	0	0x7ffffeff	Value / 100000 Error codes for geometric data, see below.	mm
CNT_EDGE	0	0x7ff	Value	Number
CNT_PIN	0	0x7ff	Value Number of detected segments within measuring range. Prerequisite for this is a transition from bright to dark and a transition from dark to bright.	Number
CNT_GAP	0	0x7ff	Value Number of columns between detected segments.	Number
MEASRATE	2000	100000	10000 / Value	kHz
TRIGGERTIMEDIFF	0	100000	Value / 10	µs
TIMESTAMP	0	UINT32_MAX	Value	µs
COUNTER	0	UINT32_MAX	Value	
STATE	0	UINT32_MAX	Bit key, see below.	
USERNAMED_VALUES	INT32_MIN	0x7ffffeff	Identical to *[A|B|C|D]	mm

Tab. 6.21: Output values with Ethernet

Value	Description
0x7FFFFF10	No calculation is active
0x7FFFFF11	Calculation is active
0x7FFFFF12	Two start events registered
0x7FFFFF13	Two stop events registered
0x7FFFFF14	Timeout, no stop event after 10 seconds

Tab. 6.22: Error codes geometric data

Bit	Description	Bit	Description
0	State switching output 3	12	Sync/Trig active
1	Switching output 3 active	13	State Sync/Trig
3	State of encoder 1 track index	14	Synchronization error
4	State of encoder 1 track B	15	Triggered frame
5	State of encoder 1 track A	24	Status LED
7	Trigger	26	Ethernet link LED
8	State switching output 1	27	Ethernet speed LED
9	Switching output 1 active	29	Shaping-active calculation
10	State switching output 2	30	Shaping-result frame
11	Switching output 2 active	31	Shaping-state error

Tab. 6.23: Bit key STATE

6.7.3 Analog output

Only one measured value can be transmitted. The resolution of the analog output is 16 bit.

Data output from analog output	Output signal	*Edge A / Edge B / Diameter / Center*	*All output signals are internally determined values. Values calculated using the computing functions cannot serve as signals.*	
	Output range	*4 ... 20 mA / 0 ... 5 V / 0 ... 10 V*	*Either the voltage or the current output can be used on the sensor, but not both.*	
	Scaling	*Standard scaling*	*Scaling to -0.5 ... +0.5 * measuring range*	
		Two-point scaling	Start of range	*value*
			End of range	*value*

The first value corresponds to the start of the measuring range and the second value to the end of the measuring range. If the analog range needs to be moved, we recommend using the zeroing or mastering function.

Two-point scaling enables the user to specify separate start and end values (in mm) for the sensor's measuring range. The available output range of the analog output is then spread between the minimum and maximum measured values.

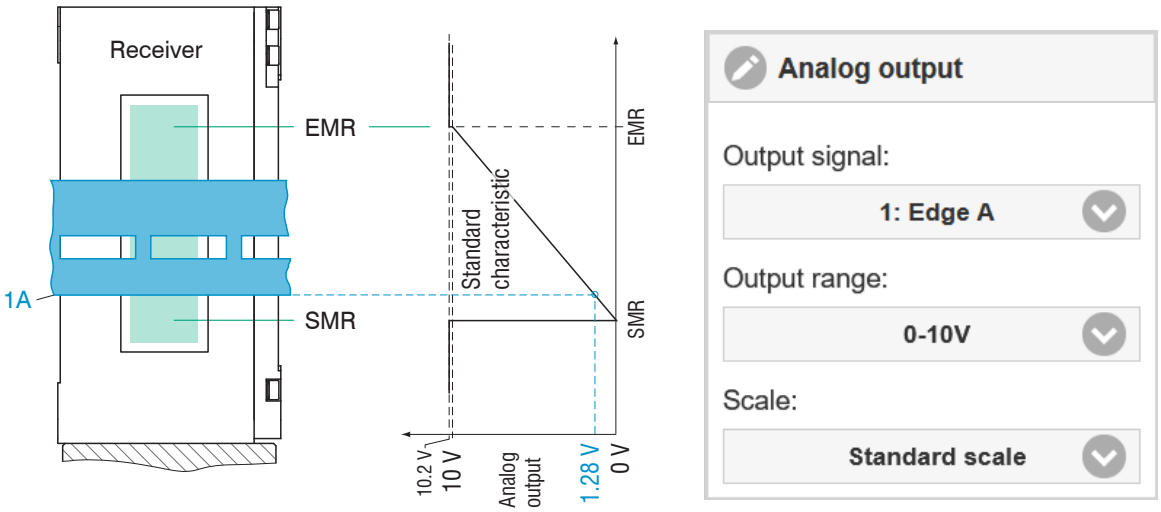


Fig. 6.27: Scaling analog signal 0... 10V, example of edge tracing, search and measurement directions: Standard

i The parameters`Search direction`and`Measurement direction`in the measurement program (data acquisition) influence the analog output.

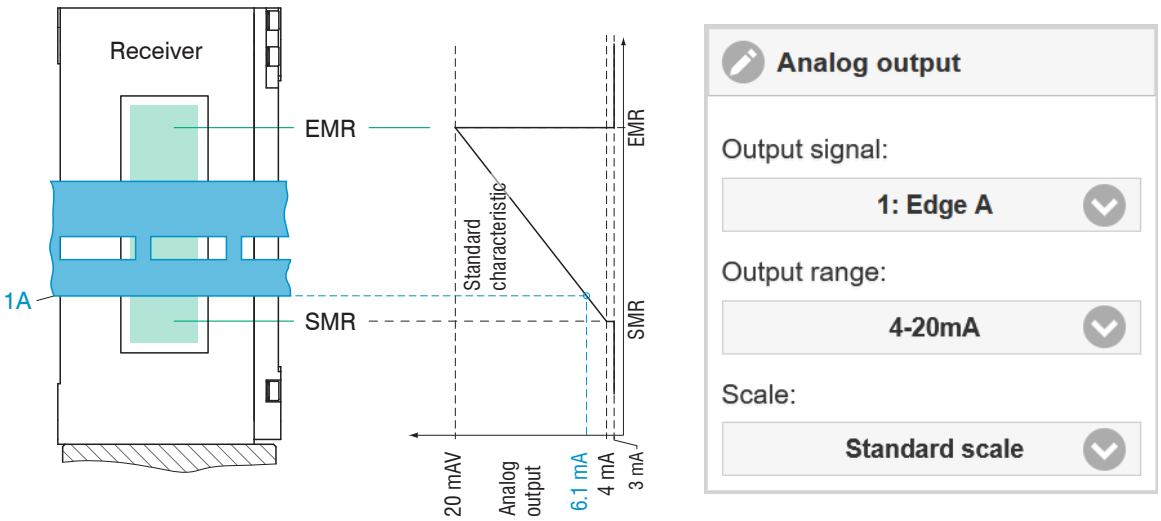


Fig. 6.28: Scaling of analog signal 4... 20mA, example of edge tracing, search and measurement directions: standard

Defining the analog output

- ► Switch to the tab`Settings`>`Outputs`>`Analog output`.
- ► Make the desired settings and confirm them by pressing `Save settings`.

Variables	Value range	Formula
V_{OUT} Voltage in V	[0; 5] Measuring range [0; 10] Measuring range	$d = \left(\frac{V_{OUT}}{5} * MR\right) - 0.5 * MR$ $d = \left(\frac{V_{OUT}}{10} * MR\right) - 0.5 * MR$
MR Measuring range in mm	{10/40}	
d Distance in mm	[-0.5MR; +0.5MR]	

Tab. 6.24: Calculating the measured value from the voltage output, search and measurement directions: standard

Variables	Value range	Formula
I_{OUT} Current in mA	[4; 20] Measuring range	$d = \left(\frac{I_{OUT} - 4}{20} * MR\right) - 0.5 * MR$
MR Measuring range in mm	{10/40}	
d Distance in mm	[-0.5MR; +0.5MR]	

Tab. 6.25: Calculating the measured value from the current output, search and measurement directions: standard

6.7.4 Switching Outputs

6.7.4.1 General, overview

The switching outputs can be used independently of each other for fault or limit value monitoring of a signal.

The switching behavior (switching level) NPN requires an auxiliary voltage and a load resistor for operation.

The switching behavior (switching level) PNP requires a load resistor for operation, see Chap. 4.3.8.

Once the settings have been completed, the switching outputs must be enabled, see Chap. 6.7.5.

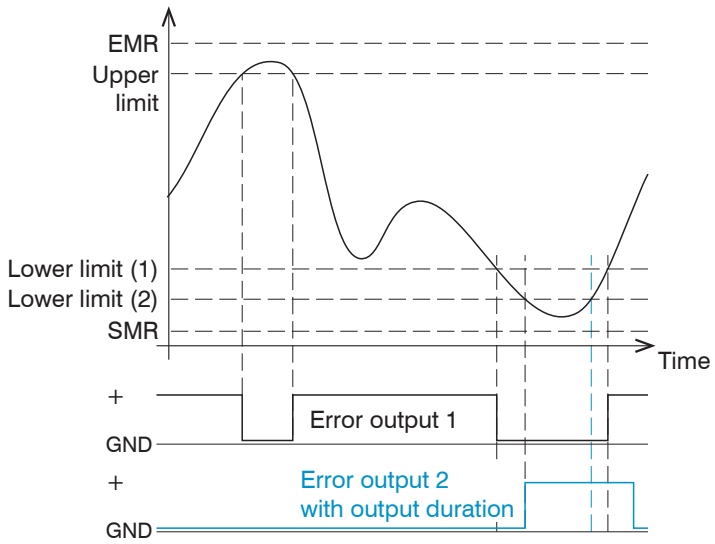
Possible functions

- Monitoring number of edges
- Monitoring limit value(s)

Switching output 1 Switching output 2 Switching output 3	Configuration of switching output	*Expected edges*	Expected edges	*Value*
			Switching level with error	*NPN / PNP / Push pull / Push-Pull negated*
			Minimum output duration ms	*Value*
		Limit	Signal	*Edge / Angle / Diameter / Center point* [12]
			Valid limit values	*Upper / lower / both limits*
			Lower limit mm	*Value*
			Upper limit mm	*Value*
			Switching level with error	*NPN / PNP / Push pull / Push-Pull negated*
			Minimum output duration ms	*Value*
		Inactive		

6.7.4.2 Setting Limit Values

If a value falls above or below a limit value, the switching outputs are activated. Enter a lower and an upper limit value (in mm) for this purpose.



Limit value range -2147 ... +2147
EMR = end of measuring range
Upper limit = maximum for switching output 1
Lower limit (1) = minimum for switching output 1
Lower limit (2) = minimum for switching output 2
SMR = start of measuring range

Tab. 6.26: Switching Output 1 (Both Limit Values, NPN) and Switching Output 2 (Lower Limit Value, PNP)

6.7.4.3 Switching logic

Notes about switching behavior are available under “Electrical Connections”, see Chap. 4.3.8.

6.7.5 Data output

This menu item can be used to activate and deactivate the output of measured values via the individual channels.

- RS422: provides an interface capable of real-time output at a lower data rate.
  In the case of the RS422 interface, the data intended for transmission is selected in the RS422 data output section, see Chap. 6.7.1.
- Ethernet: Enables rapid – but not real-time – data transmission (packet-based data transfer). It can be used to transmit measured values and video data. It is suitable for capturing measured values without direct process control so that they can undergo subsequent analysis. Parameterization is carried out via the web interface or ASCII command set.
  In the case of the Ethernet interface, the data intended for transmission is selected in the Ethernet data output section , see Chap. 6.7.2.

[12] The possible signals depend on the selected preset or setup.

Selecting/activating interfaces

- Switch to the tab `Settings` > `Outputs` > `Data output`.

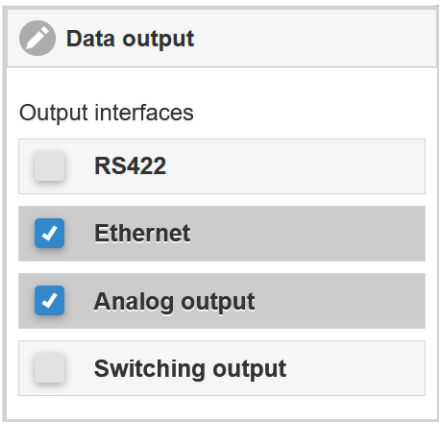


Fig. 6.29: Activating output interfaces

6.7.6 Ethernet settings

Address type	*Static*	IP address	*Value*
		Network mask	*Value*
		Gateway	*Value*
	DHCP		
Ethernet transmission of measured values	*Server TCP/IP*	Server port	*Value*
		Keep-alive signal	*Active / inactive*
		No. of frames	*Automatic*
			Set number / *Value*
	Client TCP/IP / Client UDP/IP	Server address	*Value*
		Port	*Value*
		Keep-alive signal	*Active / inactive*
		No. of frames	*Automatic*
			Set number / *Value*

Define Ethernet interface

- Switch to the tab `Settings` > `Outputs` > `Ethernet settings`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.8 System Settings

6.8.1 Web interface unit

The web interface supports units in millimeters (mm) and inches in the display of the measurement results. Data output via Ethernet / analog output / RS422 is not affected by this setting.

Change unit

- Switch to the tab `Settings` > `System settings` > `Language & Unit`.
- Make the desired settings and confirm them by pressing `Save settings`.

6.8.2 Load & save

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

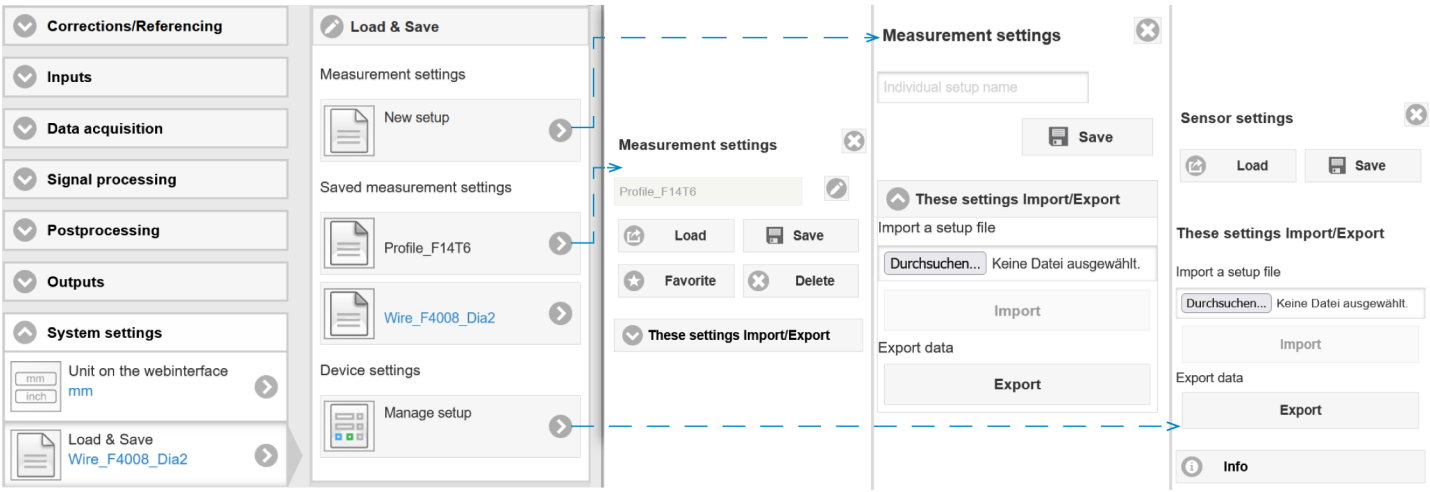


Fig. 6.30: Administration of user settings

Define, save or load data sets

- ► Switch to the `Settings` > `System settings` > `Load & save` tab.
- ► Make the desired settings and confirm them by pressing `Save settings`.

Saving settings	Activate existing setup	Save change in active setup	Determine setup after booting
Menu `New setup`	Menu `Load & safe`	Menu bar	Menu `Load & safe`
Define the setup name in the field `Individual setup name` ,e.g., Profile_F14T6, and confirm the entry by clicking the `Save` button.	Click on the desired setup with the left mouse button. The `Measurement settings` dialog opens. Click on the `Load` button.	Click on the `Save settings` button in the horizontal menu bar.	Click on the desired setup with the left mouse button. The `Measurement settings` dialog opens. Click the `Favorite` button.

Tab. 6.27: Manage setups in the sensor, possibilities and procedure

Save setup on PC	Load setup from PC
Menu `Load & safe`	Menu `Load & safe`
Click on the desired setup with the left mouse button. The `Measurement settings` dialog opens. Click on the `Export` button.	Click on the desired setup with the left mouse button. The `Measurement settings` dialog opens. Click on the `Browse` button. A Windows dialog for file selection opens. Choose the desired file and click on the button `Open`. Click the `Import` button

Tab. 6.28: Setups with PC/notebook, possibilities and procedure

6.8.3 Import & export

The `Import & Export` menu provides an easy way of exchanging parameter sets with a PC/notebook.

A parameter set contains:

- The current settings, setup(s),
- The initial setup for sensor booting
- The device settings

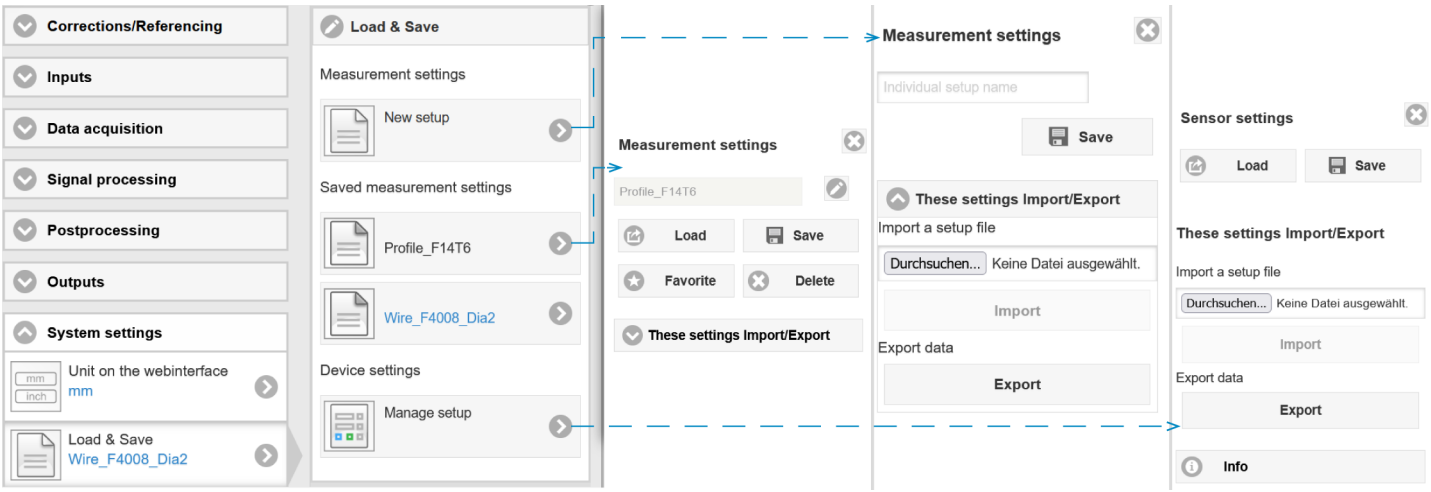


Fig. 6.31: Preparing a data set for export

Storing parameter set on PC	Loading parameter set from PC
Menu `Import & Export`	Menu `Import & Export`
Click on the `Create a parameter set` button. The `Choose export data` dialog opens. Compose a parameter set by selecting/deselecting the check-boxes. Click on the `Transmit file` button. The operating system places the parameter set in the `Download` area. The resulting file name for the adjacent example is `<...\Downloads\ODC2700_BASICSETTINGSTINGS_MEASSET-TINGS... .JSON> .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.

Tab. 6.29: Exchanging parameter sets with a PC/Notebook, options and procedure

6.8.4 Access authorization, login, logout

Assigning passwords prevents unauthorized changes to settings. The password protection is disabled in the delivery condition and the `Professional` level is active. When the configuration has been completed, you should enable password protection. The standard password for the Professional 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
View settings	yes	yes
Change settings, change passwords	no	yes
View measured values, video signals	yes	yes
Scale graphs	yes	yes
Restore factory settings	no	yes

Tab. 6.30: Rights in the user hierarchy

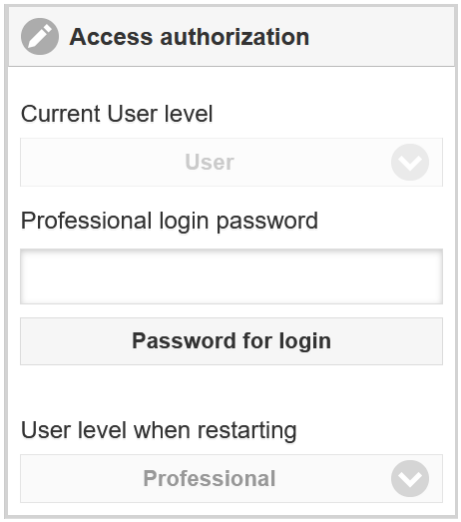


Fig. 6.32: Changing to Professional level

Changing to Professional level

- Switch to the tab `Settings` > `System settings` > `Access authorization`.
- Enter the standard password “000” or a custom password into the `Professional login password` box, and click `Password for login`.

The user management enables the assignment of a user-defined password in operating mode `Professional`.

Password	*Value*	*All passwords are case-sensitive; numbers are allowed. Special characters are not permitted.*
User level on restart	*User / Professional*	Defines the user level that is enabled after restart. Micro-Epsilon recommends the selection Professional here.

6.8.5 Resetting the sensor

You can reset individual settings to the factory setting in this menu area.

Measurement settings	*Resets the preset to the web edge option and all parameters, except for interface settings, to the factory settings.*
Device settings	*Resets all settings for the Ethernet and RS422 interfaces to the factory settings.*
Reset all	*Resets the device and measurement settings to factory settings.*
Restart sensor	*The sensor is restarted with the most recently stored settings.*

Performing a reset

- Switch to the tab `Settings` > `System settings` > `Reset sensor`.
- Select the desired function.

6.8.6 Light source

This allows the light source to be switched on and off in the sensor.

Light source on/off

- Switch to the tab `Settings` > `System settings` > `Light source`.
- Select the desired function.

7 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/.

8 Cleaning

We recommend cleaning the protective glass at regular intervals.

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.

9 Service, repair

If the receiver or light source is 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 incl. cables to:

MICRO-EPSILON
Eltrotec GmbH
Manfred-Wörner-Straße 101
73037 Göppingen / Deutschland

Tel: +49 (0) 7161 / 98872-300
Fax: +49 (0) 7161 / 98872-303
eltrotec@micro-epsilon.com
www.micro-epsilon.com/contact/worldwide/
www.micro-epsilon.com

10 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.

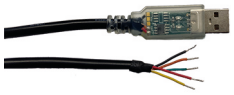
- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.

- 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.

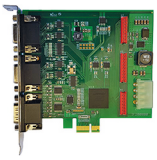
11 Factory settings

Parameter	Factory settings
Analog Output	Current, 4 ... 20 mA
RS422 baud rate	921600 bps
Static IP address	169254168150
Gateway	169254001001
Subnet	255255000000
Calculation	Moving averaging, edge A, 8 values
Encoder, interpolation	1
Encoder, max. value	4294967295
Encoder, set to value	0
Encoder, reference track	no effect
Web interface language	German
Mastering, Zeroing	no
Measuring Rate	2.5 kHz
Region of interest	0 ... 100 %
Triggering	no
Measurement configuration, preset	Web edge
Signal Quality	Balanced
Statistics	Edge A, 256 values

12 Optional accessories

PC/SC2700-x		Cable for power supply, RS422 and synchronization; one side 12-pin socket M12, other side open ends; cable length x = 3 m, 5 m, 10 m, 20 m [13]
CE2700-1		Transmitter-receiver extension cable, cable length 1 m
PC/SC2700-3/IF2008		Interface and supply cable for connection to the IF2008/PCIE interface card or the IF2004/USB 4-way converter; cable length 3 m [13]
SCD2700-x		Digital output cable for connection to an Ethernet/ EtherCAT interface; with a 4-pin M12 male connector on one side and an RJ45 male connector on the other; cable length x = 3 m, 5 m, 10 m, 20 m
SCD2700-5 M12		Digital output cable, 5 m long, for connection to an Ethernet/ EtherCAT interface (with a 4-pin M12 round male connector on both sides), drag chain-compatible
SCA2700-x		Cable for analog output, switching inputs and outputs; one side 17-pin plug M12, other side open ends; cable length x = 3 m, 5 m, 10 m, 20 m
PC/SC2700-3/DPU		Interface and supply cable for connecting a DPU to the ODC2700, qualified for drag chain use, sensor side 12-pin M12 plug, interface side 15-pin HD Sub plug, for supply, synchronzation and RS422 signal Transmission, cable length 3 m
PCE2700-3/M12		Interface and supply cable for connecting a sensor to the IF2008/ETH, cable length 3 m, sensor side 12-pin M12 plug, interface side 12-pin type Binder socket
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
IC2001/USB		IC2001/USB single-channel RS422/USB converter cable

[13] Minimum bending radius (permanently flexible) min. 7.5 x outer cable diameter

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
IF2008/PCIE		IF2008/PCIE interface card for the synchronous capture of 4 digital sensor signals or 2 encoders. In conjunction with the IF2008E, a total of 6 digital sensor signals, 2 encoders, 2 analog signals, and 8 I/O signals can be captured synchronously.
IF2004/USB		4-channel converter from RS422 to USB suitable for cable PC/SC2700-3/IF2008; including driver, connections: 2 × sub-D, 1×terminal block
Dual Processing Unit		The controller is used for D/A conversion and to process two sensor signals. Connections: 1x RJ45 for Ethernet, 1x USB, 2x 15-pin Sub-D female connector for RS422, 1x pluggable pin strip 16-pin for power supply, laser on/off, trigger, analog output
IF2008/ETH		8-Channel RS422 to Ethernet converter with industrial M12 male/female connector,connection of up to 8 sensors; four programmable switching in-/outputs (TTL and HTL logic)
PS2031		PS2031 universal plug-in power supply 100-240 V/24 V/ 1 A; 2 m PVC; terminal-2P-BU-ge; with additional male connector for UK and USA
IF2008-Y adapter cable		To connect up to two sensors on one port of the IF2008/PCIE interface card.
EK1100 bus coupler		Bus coupler; for use on an EtherCAT master; can only be used together with EK1122
EK1122 bus terminal		Bus terminal; for use in conjunction with a bus coupler and SCD2700-x on an EtherCAT master; 2-port EtherCAT junction for two sensor signals

13 ASCII communication

13.1 General

The ASCII commands can be sent to the sensor/controller via the RS422 or Ethernet interfaces (port 23). 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 <Enter>

Reference	<Enter>	Must include 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 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.

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 Exx, where xx stands for a unique error number, comes before the prompt. Moreover, instead of error messages, warning messages (“Wxx”) may be output. Warnings are structured analogously to error messages. Warnings do not prevent commands from being executed.

13.2 General commands

13.2.1 Help on commands

`HELP [HELP|<Command>]`

Outputs a list of possible commands, along with general or command-specific help texts.

Commands without parameters

- <Command>: Execute command

Commands with parameters

- <Command>: Displays the current parameter settings
- <Command> <Parameter1> [<Parameter2> [...]]
  Generates any number of parameters.
- <Command> <Parameter1> <Parameter2> ... <Parameter...>
  Generates a fixed number of parameters.

Command response

Cursor – the sensor is ready for the input.

- E<ddd> <Msg>: Error message, execution canceled
- W<ddd> <Msg>: Warning, execution in progress
- <ddd>: Three-digit number
- <Msg>: Message

Format description

- (): Grouping
- []: Optional parameter
- <>: Placeholder
- |: List

If a parameter contains spaces, it must be placed inside quotation marks.

Examples

- a|b: Use either a or b
- a b: Both parameters are required
- a [b [c]]: Any number of parameters: a, a b, or a b c

```
IPCONFIG DHCP|(STATIC [<IPAddress> [<Netmask> [<Gateway>]]])
```

Defines the Ethernet interface. You can select DHCP or STATIC with further parameters. If you define the gateway, you must also specify the IP address, its type, and the net mask.

```
PASSWD <Old password> <New password> <New password>
```

To change the password, all parameters are required.

13.2.2 Retrieve sensor information

```
GETINFO
```

Outputs information to the sensor.

```
GETINFO
Name: ODC2700-40
Serial: 1123070012
Option: 000
Article: 4321034
MAC-Address: 00-0C-12-01-E5-2F
Variant: 000
Version: 005.004
Hardware-rev: 02
Boot-version: 004.000
BuildID: 23
Timestamp: 2024-02-19T12:45:47+01:00
Measuring range: 40.00mm
Output-variant: PHY
->
```

Fig. 13.1: Sensor response to GETINFO

13.2.3 Reply type

```
ECHO [ON|OFF]
```

The reply type describes the structure of a command reply. In read mode, the command name is always output.

- ON: The command name and the command reply or an error message is output.
- OFF: Nothing but the command reply or an error message is output.

13.2.4 Parameter overview

```
PRINT [ALL]
```

This command outputs a complete or partial list of all configuration parameters and their values.

13.2.5 Synchronization

```
SYNC [NONE|SLAVE_SYNCTRIG|SLAVE_TRIGIN|MASTER|MASTER_ALT]
```

Defines or displays the settings for synchronization.

- NONE: No synchronization
- SLAVE_SYNCTRIG: Works as a slave and waits for the synchronization pulse from an external source at the Sync/Trig input
- SLAVE_TRIGIN: Works as a slave and waits for the synchronization pulse from an external source at the digital input TrigIn
- MASTER: Operates as master and provides the synchronization pulse
- MASTER_ALT: Works as a master and provides the synchronization pulse for alternating mode (pulse is generated between two exposure times)

13.2.6 Reset

```
RESET
```

Resets the sensor and restarts it.

13.2.7 Reset Counter

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

Resets the internal counter, e.g., for synchronization.

- TIMESTAMP: Timestamp
- MEASCNT: Measured value counter (profile counter)

13.3 User level

13.3.1 Changing to the “Professional” User Level

```
LOGIN <password>
```

Changes the current user level to PROFESSIONAL (see command GETUSERLEVEL)

Passwords must have at least 1 character and can contain a maximum of 31. The following characters are permitted: a-zA-Z0-9 _(),;.:-_/.

If the password contains spaces, the entire password must be placed inside quotation marks (“password”).

- password: Defined password

13.3.2 Changing to the “User” User Level

```
LOGOUT
```

Changes the current user level to USER

13.3.3 User level query

```
GETUSERLEVEL
```

Outputs the current user level.

13.3.4 Setting the user level on restart (standard user)

```
STDUSER [USER|PROFESSIONAL]
```

Sets the user level to Standard. The user is also stored after a RESET and restart of the system.

13.3.5 Changing the Password

```
PASSWD <old_password> <new_password> <new_password>
```

Changes the password for the PROFESSIONAL user level.

Passwords must have at least 1 character and can contain a maximum of 31. The following characters are permitted: a-zA-Z0-9 _(),;.:-_/.

If the password contains spaces, the entire password must be placed inside quotation marks (“password”).

13.4 Correction, Referencing

13.4.1 Light correction

```
LIGHTCORR [ROI] [FORCE]
```

Performs a calibration of the light correction table (light referencing).

- ROI: The light correction is only applied to the region of interest (defined by ROI command). Areas outside the ROI are set to the factory setting.
- FORCE: Overwrites the correction table, even if soiling has been detected.

13.4.2 Light correction status

```
LIGHTCORRSTATUS
```

Indicated the status of the light correction. Indicates whether light correction is available or not.

- CLEAN: Light correction is available, no soiling was detected in the entire measuring range.
- WITH_RESTRICTIONS: Light correction is available, no soiling was detected in the ROI.
- POLLUTED: Light correction is available, but soiling was detected during light correction.
- NOT_AVAILABLE: No light correction available

13.4.3 Printing the Correction Table

```
LIGHTCORR_PRINT
```

Prints the light correction table.

13.4.4 Deleting the Correction Table

```
LIGHTCORR_DEL
```

Deletes the light correction table.

13.4.5 Soiling Check

```
SOILINGCHECK [ROI] [OBJ_IGNORE]
```

Checks the sensor for soiling.

- ROI: Only checks the ROI (region of interest, defined by the ROI command)
- OBJ_IGNORE: Ignores targets (measuring objects); the soiling check is only performed for the exposed sensor area. Completely dark areas with sharp edges are excluded from the check.

13.4.6 Soiling status

```
POLLUTIONSTATUS
```

Displays the current status of the soiling.

Indicates whether the soiling check was successful or not.

- CLEAN: No soiling was detected in the entire measuring range
- WITH_RESTRICTIONS: Neither in the ROI nor in the entire measuring range where measuring objects were ignored.
- POLLUTED: Soiling check failed

13.5 Multifunction inputs

13.5.1 Defining the TTL/HTL Input

```
INPUT_LEVEL [TTL|HTL]
```

Defines the input level for TTL/HTL.

- TTL: The input accepts a TTL level
- HTL: The input accepts a HTL level

13.5.2 Selecting the multifunction input function

```
INPUT_MUX [value]
```

Assignment of digital inputs -> Encoder(A B R)/Trigger(T)

- value: ABT|ATB|BAT|BTA|TAB|TBA|ABR|ARB|BAR|BRA|RAB|RBA

1st letter: Multifunction input 1

2nd letter: Multifunction input 2

3rd letter: Multifunction input 3

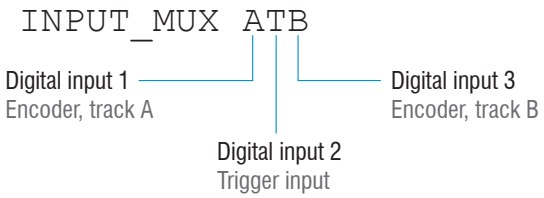


Fig. 13.2: Example assignment of multifunction inputs

13.6 Triggering

13.6.1 Trigger source

```
TRIGGERSOURCE [NONE|SYNCTRIG|TRIGIN|SOFTWARE|ENCODER1]
```

Defines the source for detected trigger events.

- NONE: Ignores all trigger sources
- SYNCTRIG: Uses the Sync/Trig input
- TRIGIN: Uses the TrigIn input
- SOFTWARE: Uses the software trigger generated via the TRIGGERSW command
- ENCODER1: The encoder is used for triggering

13.6.2 Effect of triggering

```
TRIGGERAT [INPUT|OUTPUT]
```

- INPUT: Triggers measurement data acquisition
- OUTPUT: Triggers measurement data output

13.6.3 Trigger mode

`TRIGGERMODE [EDGE|PULSE]`

This command triggers a trigger based on a level or an edge if TRIGGERSOURCE is set to SYNCTRIG or TRIGIN.

- PULSE: Level trigger
- EDGE: Edge trigger

See TRIGGERLEVEL

13.6.4 Trigger level

`TRIGGERLEVEL [HIGH|LOW]`

Defines the level or the edge for triggering.

- HIGH: Rising edge / High
- LOW: Falling edge / Low

13.6.5 Software trigger

`TRIGGERSW`

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

13.6.6 Number of measurement values to be output

`TRIGGERCOUNT [NONE|INFINITE|<n>]`

Defines the number of values that are output during a trigger event.

- NONE: Stops triggering
- INFINITE: Starts continuous output after first trigger event
- n: 1 ... 32766 Number of values that are output during every trigger event

13.6.7 Step Size

`TRIGGERENCSTEPSIZE [<value_of_step_size>]`

Defines the distance between the triggers.

If the value is set to 0 and the encoder value is between min. and max., all values are output.

If <value_of_step_size> is greater than 0, then TRIGGERENCMIN and TRIGGERENCMAX should be a multiple of <value_of_step_size>.

See TRIGGERENCMIN and TRIGGERENCMAX

- value_of_step_size: 0 .. 2^31-1

13.6.8 Encoder trigger minimum

`TRIGGERENCMIN [<value>]`

Defines the minimum encoder value for triggering.

If TRIGGERENCSTEPSIZE is greater than 0, then <value> should be a multiple of TRIGGERENCSTEPSIZE.

See TRIGGERENCMIN and TRIGGERENCSTEPSIZE

- value: 0 ... 4294967294

13.6.9 Encoder trigger maximum

`TRIGGERENCMAX [<value>]`

Defines the maximum encoder value for triggering.

If TRIGGERENCSTEPSIZE is greater than 0, then <value> should be a multiple of TRIGGERENCSTEPSIZE.

See TRIGGERENCMIN and TRIGGERENCSTEPSIZE

- value: 1 ... 4294967295

13.7 Encoder Settings

13.7.1 Encoder interpolation

`ENCINTERPOL [1|2|4]`

This command can be used to set or retrieve the interpolation of the encoder.

13.7.2 Encoder reference track

`ENCREF [NONE|ONE|EVER]`

- NONE: No encoder reference track is used
- ONE: Encoder is only set to the start value on the first pulse
- EVER: Encoder is set to the start value on each pulse

13.7.3 Setting encoder reference track

`ENCSET 1`

The command sets the ENCVALUE.

13.7.4 Encoder start value

`ENCVALUE [<value>]`

The command defines the start value for the encoder.

The start value must be less than the value of the ENCMAX command.

- value: 0 ... 4294967294

13.7.5 Maximum value of encoder

`ENCMAX [<value>]`

Command allows a maximum encoder value to be set.

The maximum value must be greater than the start value of the ENCVALUE command.

- value: 1 ... 2^32-1

13.7.6 Resetting the encoder reference track

`ENCRESET 1`

Resets the reference track of the encoder counter. As a result, the next reference pulse becomes the first one again.

13.8 Interfaces

13.8.1 Ethernet settings

```
IPCONFIG DHCP|(STATIC [<IPaddress> [<netmask> [<gateway>]]])
```

Defines the settings for the Ethernet interface.

- DHCP: IP address and gateway are automatically queried via DHCP. If no DHCP server is available, the system searches for a LinkLocal address.
- STATIC: Sets an IP address, the net mask, and the gateway (format: ddd.ddd.ddd.ddd)

13.8.2 Settings for transmitting measured values via Ethernet

```
MEASTRANSFER NONE
MEASTRANSFER SERVER/TCP [<port>]
MEASTRANSFER CLIENT/TCP [<IP> [<port>]]
MEASTRANSFER CLIENT/UDP [<IP> [<port>]]
```

Defines or displays the settings for Ethernet communication and data transfer.

- NONE: Ethernet connection is deactivated
- SERVER/TCP: The controller makes a TCP/IP server available
- CLIENT/TCP: The controller runs as a TCP/IP network station
- CLIENT/UDP: The controller runs as a UDP/IP network station
- IP: IP address of the server network
- Port: Communication port (1024 ... 65535), default is 1024

13.8.3 Ethernet Count Method

```
MEASCNT_ETH [0 | <count>]
```

Defines or displays the maximum number of frames per packet that are transmitted via Ethernet.

- 0: Number of frames per packet is assigned automatically
- count: Maximum number of frames per packet (0 ... 350)

13.8.4 Setting the RS422 Baud Rate

```
BAUD RATE [9600|115200|230400|460800|691200|921600|2000000|3000000|4000000]
```

Can be used to display or set the baud rate for the RS422 interface. The unit is bit/s

13.8.5 TCP settings

```
TCPKEEPALIVE [ON|OFF]
```

The settings are applied to new TCP connections. Existing connections remain unaffected.

The command parameter can be:

- ON: Activates the TCP "keep alive" function (see RFC 1122)
- OFF: Deactivates the TCP "keep alive" function

13.8.6 Terminator

```
TERMINATION [OFF|ON]
```

Defines the connection of a terminating resistor in the synchronization line in order to avoid reflections.

- OFF: No terminating resistor

- ON: Terminating resistor

13.9 Parameter management, load/save settings

13.9.1 Basic Settings

```
BASICSETTINGS READ | STORE
```

- READ: Basic (connection) settings are read from the memory
- STORE: Basic (connection) settings are stored in the memory

13.9.2 Output of Changed Settings

```
CHANGESETTINGS
```

- MEASSETTINGS is output if any parameters in the measurement settings have changed since the MEASSETTINGS STORE command was last executed.
- BASICSETTINGS is output if any parameters in the basic settings have changed since the BASICSETTINGS STORE command was last executed.

13.9.3 Exporting Sensor Settings

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

Exports the sensor settings.

- MEASSETTINGS: Exports the measurement settings with the name <SettingName>
- BASICSETTINGS: Exports the basic settings only
- MEASSETTINGS_ALL: Exports all measurement settings
- ALL: Exports all basic and measurement settings

13.9.4 Importing Sensor Settings

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

Imports settings into the sensor.

- FORCE: Allows existing settings to be overwritten
- APPLY: Applies the imported settings
- ImportData: Data in JSON format

13.9.5 Factory reset

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

Resets the sensor to its factory settings.

- ALL: Deletes all settings and loads the factory settings
- MEASSETTINGS: Deletes all measurement settings
- BASICSETTINGS: Deletes all basic settings

13.9.6 Measurement settings

```
MEASSETTINGS <subcommand> [<name>]
```

Setting the measurement task

Definitions

- Setup: User-specific program containing the relevant settings for a measuring task

- Preset: Manufacturer-specific program containing settings for common measuring tasks that cannot be overwritten
- Initial setup at boot (sensor start): a favorite can be selected from the setups, which is automatically activated at sensor start.

Loads manufacturer-defined presets or user-specific setups from the sensor or saves user-specific setups in the sensor.

Subcommands

- PRESETMODE: Returns the currently used Preset mode (signal quality). When a setup is used, the answer is NONE.
- PRESETMODE <mode>: Sets a preset mode (signal quality), <mode> STATIC|BALANCED|DYNAMIC.
- PRESETLIST: Lists all existing manufacturer-specific programs. Sensor response among others: "WEB EDGE" | "FINE WIRE" | "DIAMETER".
- CURRENT: Returns the name of the currently used presets or setups.
- READ <name>: Loads a preset or setups <Name> of non-volatile memory. The program is directly executed in the sensor. Note the upper and lower case of the program name
- STORE <name new>: Saves the current user-specific settings to a setup <Name> or a new setup <name> in a non-volatile memory.
- RENAME <name> <name new> [FORCE]: Renaming measurement setting. An existing measurement setting can be overwritten with FORCE.
- DELETE <name>: Removes setup <name> from memory.
- INITIAL AUTO: Loads the last saved setup or preset used when starting the sensor
- INITIAL <name>: Determines the setup <Name> for the next sensor start. Presets cannot be entered.
- Returns the name of the setup intended for the next start of the sensor. Alternatively, the sensor responds with MEAS-SETTINGS INITIAL AUTO when this command had been sent before.
- LIST: Lists the names of all saved setups
- FORCE: Allows saved setups to be overwritten.
- <name> The name of a user-specific setting (setup).
- <name new> The name of a user-specific setting (setup). The name must consist of at least two characters and may be a maximum of 31 characters long. The following characters are permitted: a-zA-Z0-9_. The names of the presets and the designation "AUTO" are not permitted.

13.10 Measurement

13.10.1 Selecting the Measuring Program

```
MEASMODE EDGEHL|EDGELH|DIA|GAP|SEGMENT
```

Defines the measuring program.

- EDGEHL: Light-dark edge; position of first light-dark edge
- EDGELH: Dark-light edge; position of the first dark-light edge
- DIA: Diameter (distance from first light-dark edge to dark-light edge) and position of the diameter center axis
- GAP: Gap (distance from first dark-light edge to light-dark edge) and position of the gap center axis
- SEGMENT: Segment (difference between the two selected edges and positions of the various center axes)
  See DEFSEG1...DEFSEG8

The position is the distance to the beginning of the line (see MEASDIR).

13.10.2 Edge Search Direction

```
SEARCHDIR STANDARD|INVERSE
```

Sets the edge search direction.

- STANDARD: Searches for edges by moving away from the mounting rail (the first edge is the one next to the mounting rail)
- INVERSE: Searches for edges by moving toward the mounting rail (the first edge is the one furthest away from the mounting rail)

13.10.3 Measurement Direction

```
MEASDIR STANDARD|INVERSE
```

Sets the measurement direction for the edges.

- STANDARD: The measurement direction begins at the start of the measuring range (SMR, mounting rail) and moves toward the end of the measuring range.
- INVERSE: The measurement direction begins at the end of the measuring range (EMR) and moves toward the start of the measuring range (mounting rail).

13.10.4 Number of Expected Edges

```
EXPEDGES <value>
```

Defines the number of expected edges for the ERROROUT command.

- Value: 0 ... 251

13.10.5 Defining Segments

```
DEFSEG1 <edge A> <edge B>
DEFSEG2 <edge A> <edge B>
DEFSEG3 <edge A> <edge B>
DEFSEG4 <edge A> <edge B>
DEFSEG5 <edge A> <edge B>
DEFSEG6 <edge A> <edge B>
DEFSEG7 <edge A> <edge B>
DEFSEG8 <edge A> <edge B>
```

Select the edges for each of the segments 1-8 (edge = 0...252 (252: last edge)).

13.10.6 Setting the measuring rate

```
MEASRATE <frequency>
```

Defines the measuring rate (frequency) in kHz.

13.10.7 Frame Averaging

```
FRAME_AVG [ON|OFF]
```

Switches frame averaging on or off. This command corresponds to frame averaging in the context of data acquisition.

13.10.8 Range of interest

```
ROI <begin> <end>
```

Defines the region of interest (0 <= begin < end <= 2047).

13.10.9 Edge filter

```
EDGEFILTER1 [ON|OFF [<low> <high> [<ignoreval>]]]
EDGEFILTER2 [ON|OFF [<low> <high> [<ignoreval>]]]
```

Edge filters 1 and 2 prevent signal jumps when measuring over rising edges and steps.

- ON|OFF: Activate or deactivate the edge filter
- Low: Limit value at which the filter is switched off. Value range: -2147.0 ... 2147.0 (unit mm)

- High: Limit value at which the following measured values are replaced by the last measured value before the limit value is exceeded Value range: -2147.0 ... 2147.0 (unit mm)
- ignoreVal: Maximum number of measured values for which the edge filter is applied.

13.10.10 Outputting a Signal with the Edge Filter

```
EDGEFILTER1SIGNAL [<signal>]
EDGEFILTER2SIGNAL [<signal>]
```

Sets or displays the selected signal for edge filter calculation 1 or 2. The META_EDGEFILTER1SIGNAL and META_EDGEFILTER2SIGNAL commands list all the available signals that can be used for the output.

13.10.11 List of Edge Filter Signals

```
META_EDGEFILTER1SIGNAL
META_EDGEFILTER2SIGNAL
```

Lists all the available signals that can be selected for the EDGEFILTER1SIGNAL and EDGEFILTER2SIGNAL commands.

13.10.12 Switching the LED on and off

```
LED OFF | ON
```

Switches the LED on and off.

13.11 Edit measured value

13.11.1 Tilt Correction

```
TILTCORRECTION [ON|OFF]
```

Switches tilt correction on (ON) or off (OFF).

13.11.2 Computation, computation module, averaging

```
COMP [<id>]
COMP <id> MEDIAN <signal> <median data count>
COMP <id> MOVING <signal> <moving data count>
COMP <id> RECURSIVE <signal> <recursive data count>
COMP <id> CALC <factor1> <signal> <factor2> <signal> <offset> <name>
COMP <id> THICKNESS <signal> <signal> <name>
COMP <id> COPY <signal> <name>
COMP <id> NONE
```

The COMP command can be used to display, create, adjust or delete individual settings for data processing and calculation. The averaging functions MEDIAN, MOVING and RECURSIVE influence the output signal <signal>.

Value	Meaning
id	1 ... 10
signal	A measurement data signal (see META_COMP)
median data count	3|5|7|9
moving data count	2|4|8|16|32|64|128|256|512|1024|2048|4096
recursive data count	2 .. 32767
factor 1	-32768.0 .. 32767.0 (unit mm)
factor 2	-32768.0 .. 32767.0 (unit mm)
offset	-2147.0 .. 2147.0 (unit mm)
name	Name of the new signal. The name must contain at least two characters and a maximum of 15 characters. Permitted characters are: a-zA-Z0-9. The name must begin with a letter. Command names – e.g. STATISTIC, MASTER, NONE, ALL – are not permitted.

List of predefined functions:

- MEDIAN: Sorts the incoming measurement values <median data count> and outputs the mean value as the median. This means that individual interference pulses can be suppressed.
- MOVING: The arithmetic average is calculated using the selectable number of consecutive measured values <moving data count>.
- RECURSIVE: Each new measured value is added, as a weighted value, to the sum of the previous ones. This permits a high degree of smoothing of the measured values.
- CALC: Enables individual calculations with one or more signals. Formula: CALC = (<factor1> * <signal>) + (<factor2> * <signal>) + <offset>. The result of the calculation is written to a new signal <name>.
- THICKNESS: Thickness calculation by forming the difference between two signals. Is also possible with the CALC function: (1 * <signal>) + (-1 * <signal>) + 0.
- COPY: Duplicates a signal; this effect can also be achieved with the CALC function, e.g. with (1 * <signal>) + (0 * <signal>) + 0.
- NONE: deletes a calculation block.

13.11.3 List of Possible Calculation Signals, Computing Module

```
META_COMP [<id>]
```

Lists the signals that can be used for the COMP command. The COMP command imposes restrictions concerning which signals can be used when, and in terms of which signals are permitted.

- id: 1 ... 10

13.11.4 Statistic Signals

```
META_STATISTICSIGNAL
```

Lists all the signals that are available for the STATISTICSIGNAL command.

13.11.5 Statistic signals settings

```
STATISTICSIGNAL [<signal>]
```

```
STATISTICSIGNAL <signal> NONE|INFINITE|<depth>
```

Display, configure or delete entries for the statistics settings

Entries for statistics settings generate new signals in the form of:

- <signal>_MIN
- <signal>_MAX
- <signal>_PEAK

These new signals output the minimum value, maximum value and peak value (maximum - minimum) of the last <depth> measurement cycle of <signal>. The INFINITE option can be selected instead of a fixed depth and causes the new signals to contain the statistics of all <signal> data. The NONE option is used to delete the statistical configuration. The STATISTIC and RESETSTATISTIC commands are used to reset the values for the new signals. The META_STATISTICSIGNAL command lists all available signals that can be used for this command.

- Signal: Measurement data signal (see META_STATISTICSIGNAL)
- Depth: 2|4|8|...|8192|16384
  Number of measured values used to calculate the statistical values of a signal.

13.11.6 Selecting Statistic Signals

```
META_STATISTIC
```

Lists all the signals configured with STATISTICSIGNAL that can be selected for the STATISTIC command.

13.11.7 Resetting statistics

```
STATISTIC ALL|<signal> RESET
```

Resets the values for the STATISTICSIGNAL command.

- <signal>_MIN
- <signal>_MAX
- <signal>_PEAK
- signal: Measurement data signal (see META_STATISTIC)

13.11.8 List of Possible Mastering Signals

```
META_MASTERSIGNAL
```

Lists all the available signals that can be selected for the MASTERSIGNAL commands.

13.11.9 Configuring the Master Signal

```
MASTERSIGNAL [<signal>]
MASTERSIGNAL <signal> <master value>
MASTERSIGNAL <signal> NONE
```

- <signal> A measurement data signal (see META_MASTERSIGNAL)
- <master value> A value in mm between -2147.0 and 2147.0

For displaying, setting, or deleting master entries. The master value is the value with which the current measured value is aligned if mastering has been activated. Mastering can be activated with the MASTER command. The META_MASTERSIGNAL command lists all the available signals that can be used for this command. The display output shows all signals and their currently set master values.

13.11.10 List of Configured Mastering Signals

```
META_MASTER
```

Lists the signals (configured with the MASTERSIGNAL command) that can be selected for the MASTER command.

13.11.11 Master Settings

```
MASTER [<signal>]
MASTER [ALL|<signal> [SET|RESET]]
```

Defines the mastering settings or displays the current master settings.

The SET master function takes a current measured value from <signal> and <signal> master value (configurable via MASTERSIGNAL) in order to define the offset. The offset is then applied to all subsequent measured values.

Example: If the master value is 0 and <signal> has a value of 0.5 mm according to the latest measurement, then an offset of -0.5 mm is applied to <signal>. The RESET function resets the offset to 0. The display output provides a list of signals and shows the word ACTIVE if mastering is currently active for the signal concerned. If mastering is not active, it shows the word INACTIVE.

- signal: A measurement data signal (see META_MASTER)

13.12 Geometric data

`SHAPING <subcommand> | <subcommand> <value>`

Calculates the output values for roundness, runout, concentricity and ovality. This function requires one event for start and one for stop.

`SOURCE [<start> <stop>]`

Subcommand. Defines the sources for the start and stop event.

`start: [<NONE|TRGIN|SYNCTRIG|SOFTWARE|ENCODER1>]`

- NONE: Disabled
- TRIGIN: Use the multifunction inputs (INPUT_MUX, SHAPING MODE, SHAPING LEVEL). An edge is detected, a level is present for the first time.
- SYNCTRIG: Use the synchronization input (SHAPING MODE, SHAPING LEVEL)
- SOFTWARE: Use the command SHAPING SW
- ENCODER1: Use an encoder value (SHAPING ENCMIN, SHAPING ENCMAX) when the encoder value is reached.

`stop: [<NONE|TRGIN|SYNCTRIG|SOFTWARE|ENCODER1|PERIOD|FRAMECOUNT>]`

- NONE: Disabled
- TRIGIN: Use the multifunction inputs (INPUT_MUX, SHAPING MODE, SHAPING LEVEL). An edge is detected, a level is no longer present.
- SYNCTRIG: Use the synchronization input (SHAPING MODE, SHAPING LEVEL)
- SOFTWARE: Use the command SHAPING SW
- ENCODER1: Use an encoder value (SHAPING ENCMIN, SHAPING ENCMAX) when the encoder value no longer applies.
- PERIOD: Time following the start event.
- FRAMECOUNT: Particular quantity of measured values to be calculated after the start event.

`OUTPUT [CONTINUOUS|CALCULATION|RESULT]`

Subcommand. Specifies how and when geometric data are output.

- CONTINUOUS: Standard, output stream is not stopped
- CALCULATION: Data output takes place only when a calculation is also active, i.e. between the start and stop event
- RESULT: Only the result is output

`MODE [<PULSE|EDGE>]`

Subcommand. Event triggered by level or edge.

- PULSE: Level triggers event
- EDGE: Edge triggers event

`LEVEL [<LOW|HIGH>]`

Subcommand. Event triggered by high/low level or rising/falling edge.

- LOW: falling edge or low level triggers event
- HIGH: rising edge or high level triggers event

`ENCMIN [value>]`

Subcommand. Encoder value for start event, value range [0 ... 4294967294].

`ENCMAX [value>]`

Subcommand. Encoder value for stop event, value range [1 ... 4294967295].

`ENCSTEPSIZE [<value>]`

Subcommand. Number of encoder steps after which a measured value is to be calculated in each case, value range [0 ... 4294967295].

`PERIOD [<value>]`

Subcommand. Time until stop event for a rotation, value range [0.000 ... 10] seconds.

`FRAMECOUNT [<value>]`

Subcommand. Defined number of measured values for stop event, value range [0 ... 4294967295].

`SW`

Subcommand. Command triggers start/stop event.

13.13 Data Output

13.13.1 Digital output selection

`OUTPUT [NONE|([RS422] [ETHERNET] [ANALOG] [ERROROUT])]`

Defines the interface for transmitting the measured values or displays the current setting.

- NONE: No output
- RS422: Output via RS422 (see OUT_RS422)
- ETHERNET: Output via Ethernet (see OUT_ETH)
- ANALOG: Output via analog output (see ANALOGOUT)
- ERROROUT: Error/status information is output via the error output (see ERRORLIMITSIGNAL1 and ERRORLIMIT-SIGNAL2)

13.13.2 Selecting the interface for a reduced data rate

`OUTREDUCEDEVICE NONE | ([RS422] [ANALOG] [ETHERNET])`

Defines the interface via which the output of measured values is to be reduced by only transmitting every nth measured value.

- NONE: No reduction in data output
- RS422: Reduced data output via RS422
- ANALOG: Reduced data output via ANALOG
- ETHERNET: Reduced data output via ETHERNET

13.13.3 Reducing Data Output

`OUTREDUCECOUNT [<n>]`

Defines or displays the interval for the packets.

Reduces the data output by transmitting only every nth measurement packet.

- n: 1 ... 3000000 packet intervals (1 means that all packets will be transmitted)

13.13.4 Error handling

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

Defines how measured values should be output in the event of an error.

- NONE: No hold period, error values are output
- INFINITE: Retains the last measured value infinitely

- n: 1 ... 1024
  Retains the last measured value for a maximum of <n> measurement cycles affected by errors; after that, error values are output.

13.14 Selecting the Measured Values to be Output

13.14.1 Selecting Ethernet Signals

```
OUT_ETH [<signal1>] [<signal2>] ... [<signalN>]
```

Defines the signals that are to be output via Ethernet. The META_OUT_ETH command lists all the signals available for the output.

13.14.2 Signals for Ethernet Output

```
META_OUT_ETH [MEAS|VIDEO|CALC]
```

Lists all the available signals that can be selected for the OUT_ETH command.

If one of the options MEAS, VIDEO, or CALC is available, the output is filtered and only the selected signal is displayed.

13.14.3 Information About the Output of Values via Ethernet

```
GETOUTINFO_ETH
```

Lists all selected output signals for the Ethernet interface.

13.14.4 Selecting RS422 Signals

```
OUT_RS422 [<signal1>] [<signal2>] ... [<signalN>]
```

Defines the signals that are to be output via RS422. The META_OUT_RS422 command lists all the signals available for the output.

13.14.5 Signals for RS422 Output

```
META_OUT_RS422 [MEAS|VIDEO|CALC]
```

Lists all the available signals that can be selected for the OUT_RS422 command.

If one of the options MEAS, VIDEO, or CALC is available, the output is filtered and only the selected signal is displayed.

13.14.6 Information About the Output of Values via RS422

```
GETOUTINFO_RS422
```

Lists all selected output signals for the RS422 interface.

13.15 Switching output

13.15.1 Limit Value Type for Switching Outputs

```
ERROROUT1 NONE|ERRORLIMIT|EXPEDGES
ERROROUT2 NONE|ERRORLIMIT|EXPEDGES
ERROROUT3 NONE|ERRORLIMIT|EXPEDGES
```

The command defines the signal output for the relevant switching output.

- NONE: No switching outputs
- ERRORLIMIT: Error limit defined by the commands

ERRORLIMITSIGNAL1, ERRORLIMITVALUES1, and ERRORLIMITCOMPARETO1
ERRORLIMITSIGNAL2, ERRORLIMITVALUES2, and ERRORLIMITCOMPARETO2
ERRORLIMITSIGNAL3, ERRORLIMITVALUES3, and ERRORLIMITCOMPARETO3

- EXPEDGES: Error output if CNT_EDGE does not match the value of the EXPEDGES command.

13.15.2 Possible Signals for Error Outputs

```
META_ERRORLIMITSIGNAL1
META_ERRORLIMITSIGNAL2
META_ERRORLIMITSIGNAL3
```

Lists all the available signals that can be selected for the corresponding ERRORLIMITSIGNAL1, ERRORLIMITSIGNAL2, and ERRORLIMITSIGNAL3 commands.

13.15.3 Assigning the error output signal

```
ERRORLIMITSIGNAL1 [<signal>]
ERRORLIMITSIGNAL2 [<signal>]
ERRORLIMITSIGNAL3 [<signal>]
```

The command defines or displays the signal for the corresponding switching output. This setting applies to the digital inputs and outputs (see OUTPUT ERROROUT).

The META_ERRORLIMITSIGNAL1, META_ERRORLIMITSIGNAL2, and META_ERRORLIMITSIGNAL3 commands list all the available signals of the corresponding switching outputs that can be used for the output.

See also ERRORLIMITCOMPARETO1 and ERRORLIMITVALUES1, ERRORLIMITCOMPARETO2 and ERRORLIMITVALUES2, ERRORLIMITCOMPARETO3 and ERRORLIMITVALUES3.

13.15.4 Setting the Upper (Overshooting)/Lower (Undershooting) Limit Value for the Switching Outputs

```
ERRORLIMITCOMPARETO1 [LOWER|UPPER|BOTH]
ERRORLIMITCOMPARETO2 [LOWER|UPPER|BOTH]
ERRORLIMITCOMPARETO3 [LOWER|UPPER|BOTH]
```

The command defines or returns the limit value for the corresponding error output.

- LOWER: Undershooting
- UPPER: Overshooting
- BOTH: Undershooting or overshooting

13.15.5 Limits for overshooting/undershooting of switching outputs

```
ERRORLIMITVALUES1 [<lower limit [mm]> <upper limit [mm]>]
ERRORLIMITVALUES2 [<lower limit [mm]> <upper limit [mm]>]
ERRORLIMITVALUES3 [<lower limit [mm]> <upper limit [mm]>]
```

This command defines the lower and upper limit values for the relevant switching output or displays the current setting.

The settings are applied to the relevant digital input/output (see ERROROUT1, ERROROUT2, ERROROUT3).

The ERRORLIMITCOMPARETO1, ERRORLIMITCOMPARETO2, and ERRORLIMITCOMPARETO3 commands define whether the lower limit value, upper limit value, or both limit values should be applied.

- <lower limit [mm]> = -2147.0 ... 2147.0
- <upper limit [mm]> = -2147.0 ... 2147.0

13.15.6 Switching Output Hold Period

```
ERROROUTHOLD1 <hold period [ms]>
ERROROUTHOLD2 <hold period [ms]>
ERROROUTHOLD3 <hold period [ms]>
```

This command defines the minimum hold period for the limit value of the ERROROUT1, ERROROUT2, ERROROUT3 commands.

See also:

```
ERRORLIMITVALUES1
ERRORLIMITVALUES2
ERRORLIMITVALUES3
```

- <hold period [ms]> = 0 ... 10000 [ms]

13.15.7 Switching Behavior of Error Outputs

```
ERRORLEVELOUT1 [NPN|PNP|PUSHPULL|PUSHPULLNEG]
ERRORLEVELOUT2 [NPN|PNP|PUSHPULL|PUSHPULLNEG]
ERRORLEVELOUT3 [NPN|PNP|PUSHPULL|PUSHPULLNEG]
```

This command defines the output type for the relevant switching output or displays the current setting.

13.16 Analog output

13.16.1 Selecting the Signal for the Analog Output

```
ANALOGOUT [<signal>]
```

Select a signal for the analog output

- signal: Signal selected for output. The META_ANALOGOUT command lists all the signals available for an output.

13.16.2 Possible Signals for Analog Output

```
META_ANALOGOUT
```

Lists the available signals that can be used for the ANALOGOUT command.

13.16.3 Selection of the output range for the analog output

```
ANALOGRANGE [0-5V|0-10V|4-20MA]
```

Defines the output range for the analog output.

- 0-5 V: Measured value is specified in the range of 0 to 5V.
- 0-10 V: Measured value is specified in the range of 0 to 10V.
- 4-20mA: Measured value is specified in the range of 4 to 20mA.

13.16.4 Scaling of the analog output

```
ANALOGSCALEMODE [STANDARD|TWOPOINT]
```

Set or adjust the scaling of the analog output.

- STANDARD: Use measuring range of sensor
- TWOPOINT: The measured values are scaled to the range specified by the ANALOGSCALERANGE command.

13.16.5 Selecting the scaling range for the analog output

`ANALOGSCALERANGE <limit 1> <limit 2>`

Sets the upper and lower scaling values for the analog output. The unit is mm.

- <limit 1> = (-2147.0 ... 2147.0) [mm], must not be the same as <limit 2>.
- <limit 2> = (-2147.0 ... 2147.0) [mm], must not be the same as <limit 1>.

13.17 Measurement Data Format

13.17.1 Transferring measured data to a measurement server via Ethernet

During transfer of measured value data to a measurement server, the sensor/controller sends each measured value to a measurement server or a connected client after the connection (TCP or UDP) has been successfully set up. No specific request is required for this.

Any distances and additional information to be transmitted that are logged at one point in time are combined to form a value frame. A number of measurement frames are combined into a measurement block. The block is given a header and fits into a TCP/IP or UDP/IP packet. The header is mandatory at the start of a UDP or TCP packet. If any changes are made to the transmitted data or the frame rate, a new header will be sent automatically.

All measurement data and the header are transmitted in little-endian format.

The structure of a header is the same for video and measurement data transfer and comprises

- Preamble (32 bits)
- Part number (32 bits)
- Serial number (32 bits)
- Length video data (32 bits)
- Length measurement data (32 Bit)
- Frame number (32 Bit)
- Counter (32 bits)

Header entry	Description
Preamble	uint32_t - 0x41544144 “DATA”
Article no.	
Serial number	
Length video data	[Byte]
Length measurement data	[Byte]
Number of frames	Number of frames covered by this header With video output, the field for the number of measurement data frames is set to one in the packet.
Counter	Counter with the number of measurements processed.

Tab. 13.1: Details of a header

A data packet typically contains one or more measurement data frames.

A measurement data frame comprises one or more signals. The content of a measurement data frame can be set using the OUT_ETH command. The structure of a measured value frame can be queried via GETOUTINFO_ETH.

The pixels of the frame signal are each described by a 16-bit word. The relevant value range is 0 … 4095.

The measurement values are provided as 32 bit signed integer with 10 nm resolution.

13.17.2 Data format RS422 interface

13.17.2.1 Bit Structure

Description	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data value (measurement value) at least 2 bytes, maximum 5 bytes	1	D6	D5	D4	D3	D2	D1	D0
	1	D13	D12	D11	D10	D9	D8	D7
	1	D20	D19	D18	D17	D16	D15	D14
	1	D27	D26	D25	D24	D23	D22	D21
	0	0	0	0	D31	D30	D29	D28
Footer	0	F	0	EoF	C	DT		O

- Data value
  - 4 bits minimum
  - 32 bits maximum
- F (Footer followed)
  - 0. No additional footer byte
  - 1. Additional footer byte

Bit 5 must be 0 to allow for differentiating the footer from the “>” character.

- EoF (End of Frame)
  - 0. Additional packet with data from the current frame follows
  - 1. Last packet with data from the current frame
- C (Change Bit)

Change of sensor configuration (only RS422 data output). Is automatically reset after output.

- DT (Data type)
  - 0. Measurement values
  - 1. Video signals (FFT)
  - 2. Reserved
  - 3. Reserved
- O (Overflow)
  - 0. No UART overflow
  - 1. UART overflow, the data are valid, but data frames are missing

13.17.2.2 Description

The format consists of one or several data values and a footer, which concludes the data packet. The end of a data value and the footer are coded in the 7th bit of each byte:

- 1 Additional data byte follows
- 0 End of data value or footer.

A bit that has not been set marks the end of the data value. Starting with the second bit that has not been set, the footer follows.

A mix of different bit widths is possible (e.g., 18/32 bit). Video signals can also be transmitted as data values. Measuring signal packets are differentiated from video signal packets via the data type (DT). A video signal is always transmitted in a separate data packet with its own footer. Thus, if there are two video signals + measurement values, three data packets, incl. one footer each, are transmitted. For each measuring frame, several video data packets, but only one measured data packet, can be transmitted. The EoF bit in the footer marks whether the data packet that was just transmitted is the last packet in a continuous measuring frame from the sensor/controller.

The minimum bit width to be transmitted is 14 bits, the maximum width is 32 bits. All unused bits are 0. Bit widths are not dynamically changed among several frames. Changes to the data packet or the relevant sensor/controller configuration are indicated by the change bit (C). It refers to the measurement frame that has just been received. The change bit is only

set for one measurement frame and is automatically reset. If a measurement frame consists of several data packets, the change bit is set in all footers.

The overflow bit (O) indicates that one or several measurement frame were not transmitted between the current and previous measuring frame. The bit is transmitted only once for each identified loss and is then reset. If a measurement frame consists of several data packets, the overflow bit is set in all footers. If measurement frame are permanently lost, the bit is set permanently.

ASCII replies are only allowed between the last data packet in a measuring frame (EoF bit has been set) and the next data packet.

13.17.2.3 Examples

Video signal 1

Description	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Pixel 1 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel n (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel 512 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Footer	0	0	0	0	0	0	1	0

Video signal 2

Description	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Pixel 1 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel n (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel 512 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Footer	0	0	0	0	0	0	1	0

Measurement values

Description	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Measurement value (32 Bit)	1	D00 ... D06						
	1	D07 ... D13						
	1	D14 ... D20						
	1	D21 ... D27						
	0	0	0	0	D28 ... D31			
Footer	0	0	0	1	0	0	0	0

ASCII reply:

ECHO OFF\r\n->

Video signal 1

Description	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Pixel 1 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel n (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Pixel 512 (14 bits)	1	D00 ... D06						
	0	D07 ... D13						
Footer	0	0	0	0	0	0	1	0

13.18 Error messages

Code	Description
E100	E100 Internal error
E104	Timeout
E200	I/O operation failed
E202	Access denied
E204	Received unsupported character
E205	Unexpected quotation mark
E210	Unknown command
E212	Command not available in current context
E214	Entered command is too long to be processed
E220	Timeout, command aborted
E222	The requested function/parameter is not available in this software release
E230	Unknown parameter
E231	Empty parameters are not allowed
E232	Wrong parameter count
E233	Command has too many parameters
E234	Wrong or unknown parameter type
E236	Value is out of range or the format is invalid
E237	Parameter size too small
E238	Parameter size too large
E255	Parameter is unavailable with the current configuration
E262	Process is already active

E270	No signals selected
E272	Invalid combination of signal parameters, please check measure mode and signal selection
E275	The given selection of signals is incomplete. Please select at least one distance signal.
E276	Given signal is not selected for output
E277	One or more values were unavailable. Please check output signal selection.
E281	Not enough memory available
E282	Unknown output signal
E283	Output signal is unavailable with the current configuration
E284	No configuration entry was found for the given signal
E320	Wrong info-data of the update
E321	Update file is too large
E322	Error during data transmission of the update
E323	Timeout during the update
E324	File is not valid for this sensor
E325	Invalid file type
E327	Invalid checksum
E331	Validation of import file failed
E332	Error during import
E333	No overwrite during import allowed
E340	Too many output values for RS422 selected
E350	The new passwords are not identical
E351	No password given
E355	Name/description already exists or is not allowed
E356	Names/description length is invalid
E357	Name/description contains invalid characters
E358	Name/description contains invalid characters at the beginning or at the end
E360	Name already exists or not allowed
E361	Names must be at least 2 characters long and contain only characters: a-zA-Z0-9_

E362	Storage region is full
E363	Setting name not found
E364	Setting is invalid
E600	ROI begin must be less than ROI end
E606	Minimal value must be less than maximal value
E610	Encoder triggering: The minimum value has to be less than the maximum value
E611	Encoder's start value must be less than the maximum value
E612	Encoder triggering: The step size is greater than the difference between minimum and maximum
E615	Synchronisation as slave and triggering at level or edge are not possible at the same time
E616	Software triggering is not active
E621	The entry already exists
E626	Dataset not available
E628	The value of the lower limit is greater than the upper limit
E640	LightCorr check failed
W316	Sensor changes to fieldbus/recovery mode
W526	Output signal selection modified by the system
W530	The IP settings have been changed
W580	Dependent setting parameters were also modified
W602	Lightcorrwarning

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