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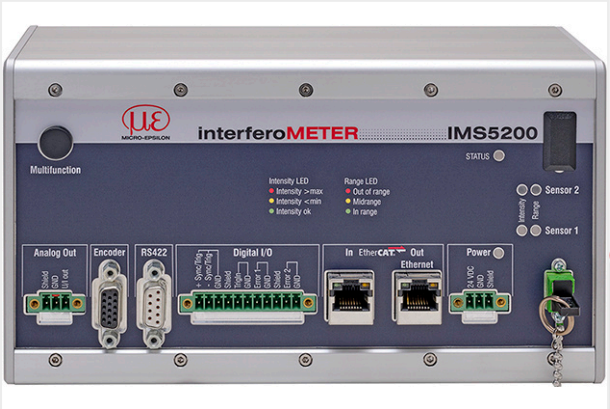

Operating Instructions

interferoMETER IMS5200-TH

IMS5200-TH26

IMS5200MP-TH26

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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 and/or the controller

NOTICE

The supply voltage must not exceed the specified limits.

- Damage to or destruction of the sensor and/or the controller

Avoid shocks and impacts to the sensor and the controller.

- Damage to or destruction of the sensor and/or the controller

Never fold the fiber optics and do not bend them in tight radii.

- Damage to or destruction of the fiber optic cable, failure of the measuring device

Protect the ends of the optical fiber against contamination (use protective caps).

- Failure of the measuring device

Protect the cables against damage.

- Failure of the measuring device

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 measuring system is designed for use in industrial environments and domestic areas.

It is used for

- Thickness measurements
- Monitoring Quality and Checking Dimensions

The measuring system must only be operated within the limits specified in the technical data.

The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the system.

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

1.5 Proper environment

Model		IMS5200-TH26, IMS5200MP-TH26	Option VAC
Protection class	Sensor	IP65 (front)	IP40
		Lenses are excluded from protection class. Contamination of the lenses causes impairment or failure of the function.	
	Controller	IP40	
Temperature range	Storage	-20 … +70 °C	
	Operation	Sensor: +10 … +50 °C (front);	
		Controller: +10 … +50 °C	
Humidity		5 ... 95% (non-condensing)	
Ambient pressure		Atmospheric pressure	
EMC		In accordance with EN 61000-6-3 / EN 61326-1 (Class B) and EN 61 000-6-2 / EN 61326-1	

2 Functional principle, technical data

2.1 Short description

The interferoMETER measuring system includes:

- IMP-VIS-THxx sensor
- IMC5200 controller

The sensor is completely passive as it contains no heat sources or moving parts. This prevents heat expansion, which makes for a highly accurate measurement process.

The controller converts the light signals received from the sensor with a spectrometer, calculates the thickness via the integrated signal processor (CPU) and transmits the measured data via the interfaces or the analog output.

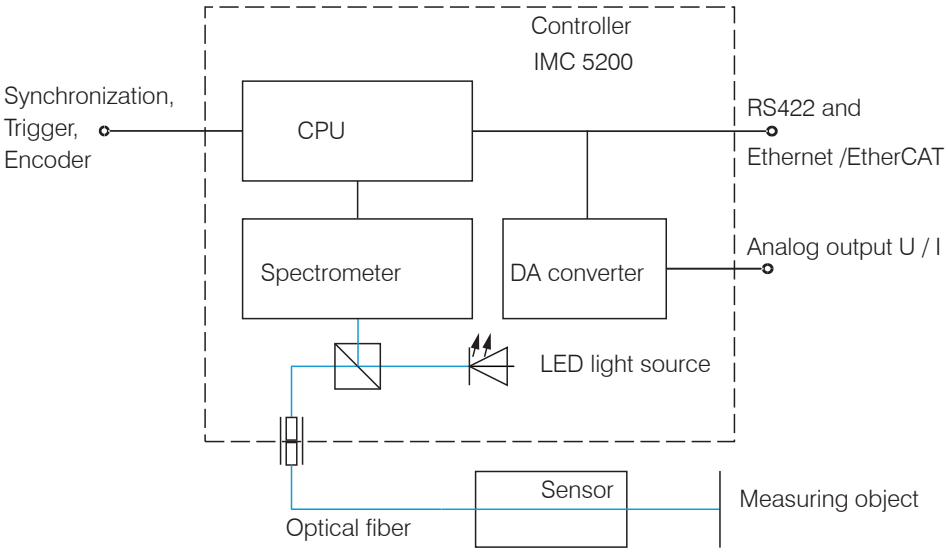


Fig. 2.1: Block diagram IMS5200

2.2 Measuring principle

Polychromatic white light is generated by an LED. The light is coupled into an optical fiber. The light illuminates the measured object. The light reflected by the measuring object on the top and bottom of a layer is received by the sensor and conducted into the controller.

The interferometric measuring principle (superposition of waves) is used. Detection of thicknesses is possible with amplification and elimination.

Distance measurement is not possible with a sensor for thickness measurement.

i	The sensor and controller form a single unit, as the linearization table of the sensor is stored in the controller.

This unique measuring principle enables high-precision measurement of measuring objects. The thickness measurement work only for transparent measuring objects. The transmitter and receiver are arranged on one axis to prevent shadowing.

2.3 Definition of terms

Working distance	Optimal distance between sensor and target
Operating range	Range where the target can move. Target is entirely in this range for a thickness measurement.
MR	Thickness measuring range; maximum thickness is less than the operating range and depends on the refraction index/doping of the target material

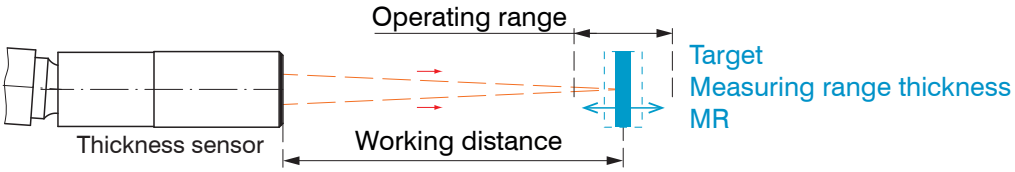


Fig. 2.2: Thickness sensor IMP-VIS-TH with working distance and operating range

2.4 Operating mode

The interferoMETER measuring system enables high-precision thickness measurements of transparent layer materials.

The result of the measurement is a thickness value.

Operating range	± 2mm
Measuring range (thickness)	1 µm ... 100 µm[1]
Measuring range air gap	1.5 µm ... 150 µm
Working range distance	26 mm

Tab. 2.1: Measuring ranges for thickness measurements

The possible resolution here is in the nanometer range.

To get started quickly, it is recommended to use saved configurations (presets) for various target surfaces and applications, see Chap. 5.6.

2.5 Sensor technology

The controller can be operated with up to 20 different linearization tables.

The necessary linearization tables can be stored in the controller.

2.6 Technical data IMS5200

Model		IMS5200-TH26	IMS5200MP-TH26
Working distance		26 mm ±2 mm	
Measuring range	Thickness	1 µm ... 100 µm [1]	
Resolution [2]		< 1 nm	
Measuring rate		continuously adjustable from 100 Hz to 24 kHz	
Linearity [3]		< ±100 nm	
Temperature stability	Sensor	Linearity valid for the entire temperature range	
Multi-peak measurement		1 layer	5 layers
Light source		Internal white LED [4]	
Light spot diameter [5]		55 µm	
Measuring angle [6]		±4°	
Supply voltage		24 VDC ±15 %	
Power consumption		approx. 10 W (24 V)	
Signal input		Sync in, trigger in, 2 x encoders (A+, A-, B+, B-, index), 3 x encoders (A+, A-, B+, B-)	

[1] All data at constant ambient temperature (24 ±2 °C). Measuring range with n=1.5; for air gap measurement between two glass plates (n~1), the measuring range is 1.5 µm ... 150 µm. The measuring object must be within the working distance.

[2] Sampling rate 0.5 kHz, moving average over 64 values, measured on an approx. 30 µm thick (SCHOTT glass D263)

[3] Maximum thickness deviation when passing through the measuring range during measurement of an approx. 30 µm thick glass (SCHOTT D263, n=1.5).

[4] Wavelength band between 480 and 760 nm

[5] In the mid of the measuring range

[6] Maximum tilt angle of the sensor at which a usable signal can be obtained on polished glass (30 µm SCHOTT D263) at the center of the operating range, accuracy decreases as the limit values are approached.

Model		IMS5200-TH26	IMS5200MP-TH26
Digital interface		Ethernet / EtherCAT / RS422 / PROFINET [7] / EtherNet/IP [7]	
Analog output		4 … 20 mA / 0 ... 10 V (16 bit D/A converter)	
Switching output		Error1-Out, Error2-Out	
Digital output		sync out	
Connection	Optical	Pluggable optical fiber via E2000 socket (controller); see accessories for available cables and cable lengths	
	Electrical	3-pin supply terminal strip; encoder connection (15-pin, HD-sub socket, max. cable length 3 m, 30 m with external encoder supply); RS422 connection socket (9-pin, Sub-D, max. cable length 30 m); 3-pin output terminal strip (max. cable length 30 m); 11-pin I/O terminal strip (max. cable length 30 m); RJ45 socket for Ethernet (out) / EtherCAT (in/out) (max. cable length 100 m)	
Mounting	Sensor	Radial clamping, mounting adapter (see accessories)	
	Controller	Free-standing, DIN rail mounting	
Temperature range	Storage	-20 ... +70 °C	
	Operation	+10 ... +50 °C	
Shock (DIN EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each	
Vibration (DIN EN 60068-2-6)		2 g / 20 … 500 Hz in XY axis, 10 cycles each	
Protection class (DIN EN 60529)	Sensor	IP65 (front; option /VAC IP40)	
	Controller	IP40	
Material	Sensor	Stainless steel	
	Controller	Aluminum housing, passive cooling	
Control and indicator elements		Multifunction button: two adjustable functions and reset to factory settings after 10 s; web interface for setup: selectable presets, freely selectable averaging, data reduction, setup management; 4 x color LEDs for intensity, range, status and power	

[7] Optional connection via interface module (see accessories)

3 Delivery

3.1 Unpacking, included in delivery

1 controller	IMC5200
1 sensor	IMP-VIS-THxx
1 accessories IMS5x00	(terminal blocks, Ethernet cables, etc.)
1 Calibration final inspection	
1 Quick Manual	

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

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 (storage):	-20 ... +70 °C (-4 ... +158 °F)
Humidity:	5 ... 95% (non-condensing)

4 Installation

4.1 IMC5200 controller

The IMC5200 controller can be placed on a flat surface or mounted with a TS35 DIN rail according to DIN EN 60715, e.g. in a control cabinet.

When mounting the controller onto a DIN rail, an electrical connection (potential equalization) is established between the controller housing and the mounting rail.

► To remove the controller, push it upwards and pull it forwards.

i Position the controller so that the connections, control and display elements are not concealed.

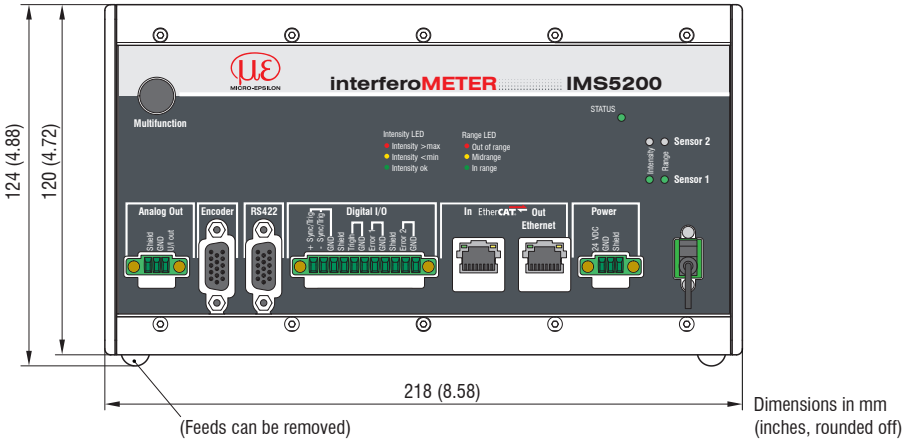


Fig. 4.1: Dimensional drawing front view of the IMC5200 controller

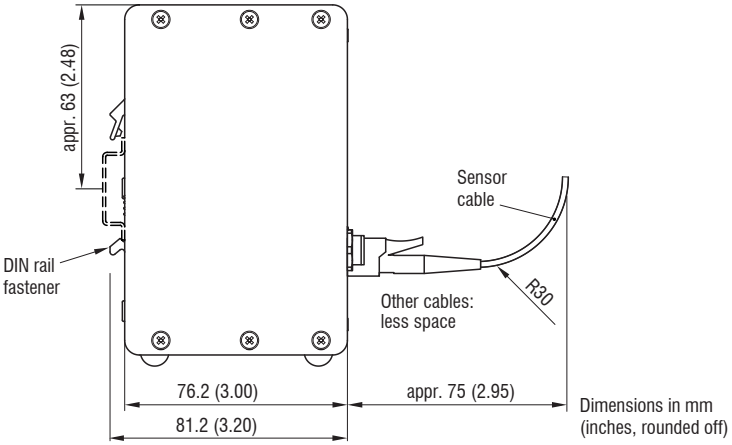


Fig. 4.2: Dimensional drawing side view of the IMC5200 controller

4.2 Operating elements IMC5200

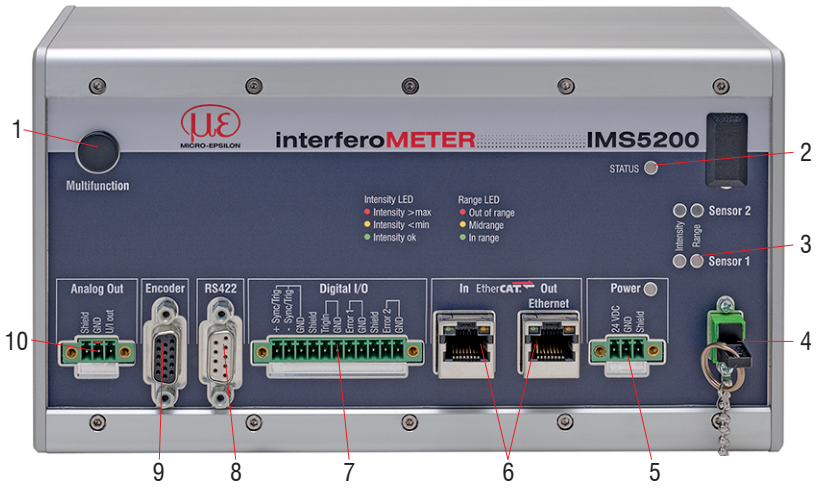


Fig. 4.3: Front view of IMC5200 controller

1	Multifunction button (light source)[8]	6	Ethernet/EtherCAT
2	Status LED	7	Digital I/O
3	LEDs intensity, range	8	RS422 connection
4	Sensor connection channel 1 (optical fiber)	9	Encoder connection
5	Power supply connection, LED Power On	10	Analog output (U / I)

4.3 LEDs controller IMC5200

Power on	Green	Operating voltage available
Status	Off	no error
	If the EtherCAT interface is active, refer to the EtherCAT guidelines for the meaning of the LEDs.	
Intensity 	Red	Signal saturated
	Yellow	Signal too low
	Green	Signal OK
Range	Red	No target present, outside of operating range The expected number of peaks was not found or it was not possible to assign a thickness.
	Yellow	Measuring object near the working distance
	Green	Target in operating range The expected number of peaks was found. A valid thickness could be found for each peak.

Tab. 4.1: Meaning controller LEDs Status, Intensity and Range

In the event of a synchronization error, the Intensity and Range LEDs flash in their current color.

[8] Resetting to factory settings: press the `Multifunction` button for more than 10 sec.

4.4 Electrical connections IMC5200

4.4.1 Connection possibilities

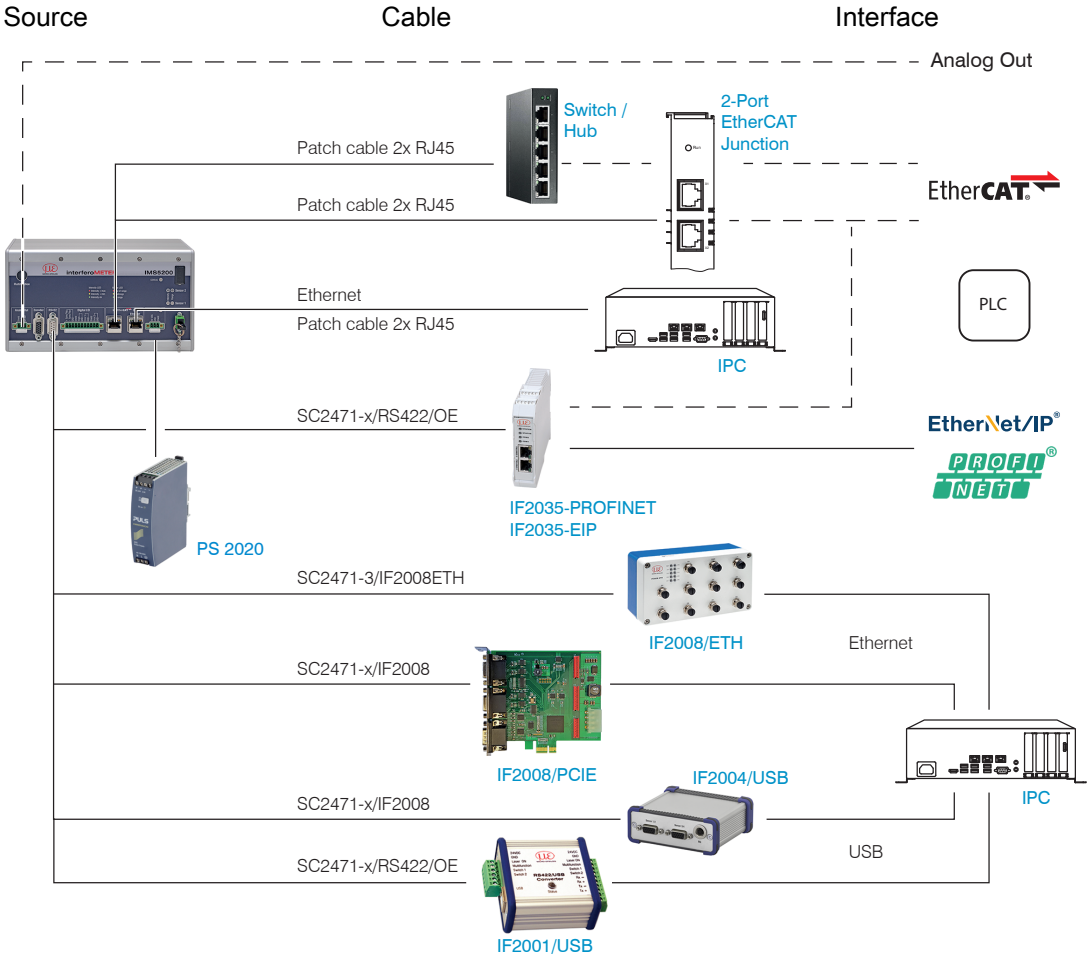


Fig. 4.4: Connection examples on the IMS5200

4.4.2 Handling of the plug-in screw terminals

The IMC5x00 controller has three pluggable screw terminals for supply, digital I/O and analog out, which are included as accessories.

- ► Remove the connecting wire insulation (0.14 ... 1.5 mm²).
- ► Connect the connection wires.

i The screw terminals can be fixed with two captive screws.

4.4.3 Grounding concept, shielding

All inputs/outputs are electrically connected to the supply voltage ground (GND). Only the Ethernet/EtherCAT ports are electrically isolated.

The ground connections (GND; GND422, GND_ENC) of each connection group are galvanically interconnected via chokes.

The shield connections of each connection group are only connected to the controller housing. They are used to connect the cable shieldings for individual connections (power, analog output, switching outputs, synchronization and trigger input).

Only use screened cables shorter than 30 m and connect the cable screen to the Shield or the connector housing.

4.4.4 Supply voltage (power)

Nominal value: 24 V DC (±15 %, P approx. 10 W at 24 V).

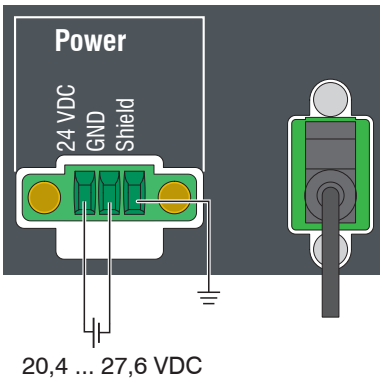


Fig. 4.5: Supply connections and LED on the IMC5x00 controller

- 3-pin pluggable screw terminal (24 VDC, GND, Shield),
- 24 VDC ± 15 %, I_{max} <1 A
- Not electrically separated, GND is electrically connected to GND for switching outputs, synchronization and encoder input.

► Use a shielded cable. Cable length less than 30 m.

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 optionally available power supply unit PS2020 for the controller

After the supply voltage has been switched on, the `Power` LED lights up.

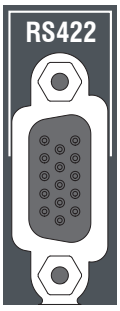
4.4.5 RS422

- Differential signals according to EIA-422, electrically isolated from the supply voltage.
- Receiver Rx with 120 Ohm internal terminating resistor.

► Terminate the transmitter input (TX) on the evaluation unit (receiver) with 90 ... 120 ohms.
► Use a shielded cable. Cable length less than 30 m.
► Connect the ground connections.

i The pin assignment for the 9-pin D-sub socket is not standardized.

Pin	Color SC2471-x/RS422/OE	Name	Signal
3	Green	RX -	Receiver -
2	Brown	RX +	Receiver +
5	Yellow	GND422	Ground RS422
9	Gray	TX +	Transmitter +
1	White	TX -	Transmitter -
Housing	Shield		Cable shield



Tab. 4.2: Pin assignment for the 9-pin D-sub connector (RS422)

4.4.6 Ethernet, EtherCAT

Potential-separated RJ45 standard socket for connecting the IMC5x00 controller

- to an Ethernet network (PC) or
- to the EtherCAT bus system (IN port).

► Use a shielded Ethernet cable (Cat5E, patch cable, 2 m, included in the delivery, overall cable length less than 100 m) to connect controller and network.

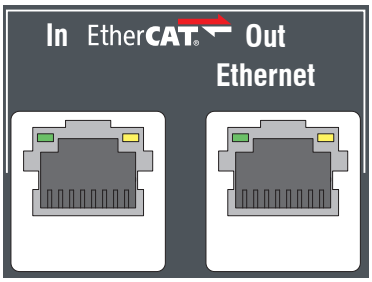


Fig. 4.6: RJ45 sockets for Ethernet, EtherCAT

Both LEDs in each of the plug-in connectors indicate a successful connection and its activity.

The controller can be configured in the following ways:

- Web interface, see Chap. 5, see Chap. 6
- ASCII commands, see Chap. 15
- EtherCAT, see Chap. 16

4.4.7 Analog output

The analog output can be used via the 3-pin screw terminal and is electrically connected to the supply voltage. For the output, you can select current or voltage, see Chap. 6.5.4.

Voltage: Pin U/Iout and Pin GND,
R_i approx. 50 Ohm, R_L > 10 MOhm
Slew rate (without C_L, R_L ≥ 1 kOhm) typ. 0.5 V/µs
Slew rate (with C_L = 10 nF, R_L ≥ 1 kOhm) typ. 0.4 V/µs

Current: Pin U/Iout and Pin GND
R_L ≤ 500 Ohm
Slew rate (without C_L, R_L = 500 Ohm) typ. 1.6 mA/µs
Slew rate (with C_L = 10 nF, R_L = 500 Ohm) typ. 0.6 mA/µs

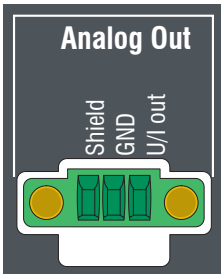


Fig. 4.7: Analog outputs on the controller

► Use a shielded cable. Cable length less than 30 m.

Pin 3 (Shield) is connected to the cover.

As an alternative, the output range can be set to the following values:

Voltage: 0 ... 5 V; 0 ... 10 V;

Current: 4 ... 20 mA.

i	The socket is mechanically coded (red plug-in) in order to avoid any confusion with the power supply.

4.4.8 Switching outputs (digital I/O)

The two switching outputs `Error 1/2` on the 11-pin pluggable screw terminal are electrically connected to the supply voltage.

The switching behavior (NPN, PNP, push-pull) is programmable, I_{max} 100 mA.

The maximum auxiliary voltage for a switching output with NPN switching behavior is 30 V.

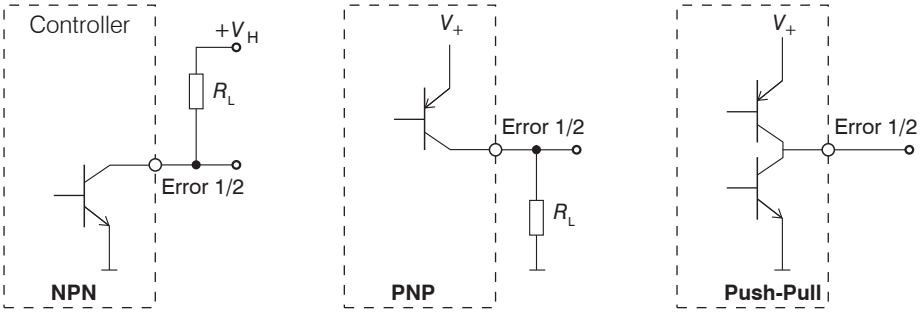


Fig. 4.8: Output behavior and wiring of the TTL switching outputs `Error 1/2`

Switching output 1: pin Error 1 and GND
Switching output 2: pin Error 2 and GND
Cable shield: Shield is connected to the cover. Connect the cable shield.
All GND conductors are interconnected with one another and to the supply ground.

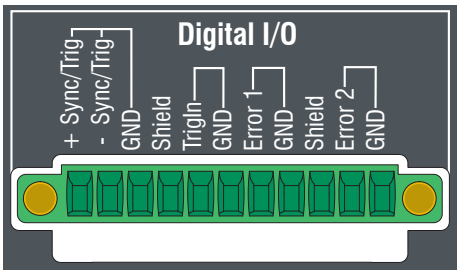


Fig. 4.9: Digital I/O on the controller

► Use a shielded cable. Cable length less than 30 m.

Output level (without load resistor) at a supply voltage of 24 VDC	Low < 1 V; High > 23 V
Saturation voltage with I_{max} = 100 mA	Low < 2.5 V (output - GND)
	High < 2.5 V (output - $V+$)

The saturation voltage is measured

- between output and GND, at output = Low, or
- between output and $V+$, with output = High.

Name	Output active (error)	Output passive (no error)
NPN (Low side)	GND	$V+$
PNP (High side)	$V+$	GND
Push-pull	$V+$	GND
Push-pull, negative	GND	$V+$

Tab. 4.3: Switching behavior of the switching outputs

i The load resistor R_L can be dimensioned according to the limit values (I_{max} = 100 mA, V_{Hmax}= 28 V). When connecting inductive loads, e.g. a relay, the parallel protective diode must not be missing.

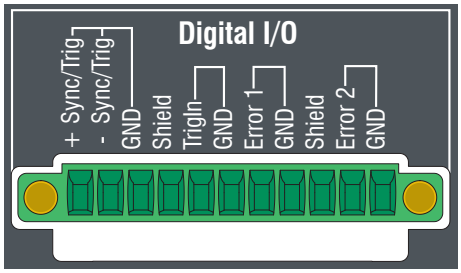
4.4.9 Synchronization (inputs/outputs)

Pin assignment of the 11-pin pluggable screw terminal, see figure.

- +Sync/Trig and -Sync/Trig pins: symmetrical synchronization output/input or trigger input, function and (I/O) direction are programmable
- The terminating resistor RT (120 Ohm) can be switched on or off, see Chap. 6.1.4.

All GND conductors are interconnected with one another and to operating voltage ground.

Signal	Level
Sync/Trig	RS422 (EIA422)
Function and direction are programmable	



Tab. 4.4: Signal level synchronization, triggering

► Activate the termination resistor (120 Ohm) in the last sensor (slave n) in the chain.

Star synchronization

► Connect the `Sync+` and `Sync-` pins of controller 1 (master) in a star configuration with the `Sync+` and `Sync-` pins of controller 2 (slave) to sensor n in order to synchronize two or more sensors with each other

- Sub-loop length less than 30 m in star synchronization

Chain synchronization

► Connect the `Sync+` and `Sync-` pins of controller 1 (master) to the `Sync+` and `Sync-` pins of controller 2 (slave 1). Connect the pins of the following sensors to synchronize two or more sensors with each other

- Total line length less than 30 m in chain synchronization

► Use shielded cables with twisted wires.

► Connect the cable shield to the housing.

► Program sensor 1 to `Master` and all other sensors to `Slave`, see Chap. 6.1.1.

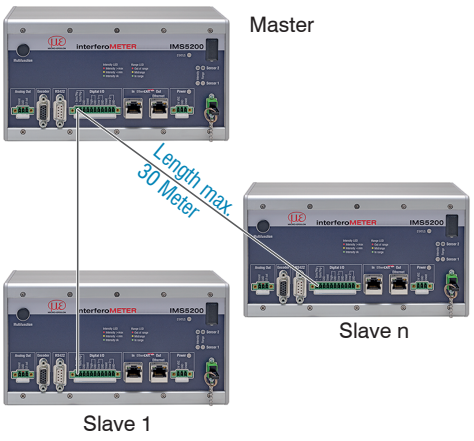


Fig. 4.10: Synchronization of several controllers, star-shaped

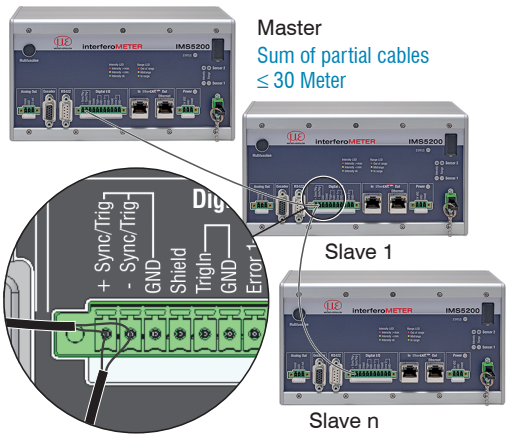


Fig. 4.11: Synchronization of several controllers, daisy-chained

► Connect all GND connections of the supply to each other if the sensors are not supplied by a common power supply.

i If the controllers are operated using EtherCAT, synchronization is performed using this connection.

4.4.10 Triggering

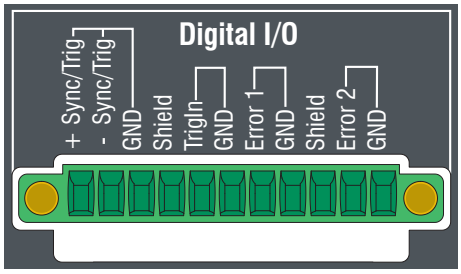
The pluggable 11-pin screw terminal with `Digital I/O` has two trigger inputs.

Input Sync/Trig

The Sync/Trig port can also be used as symmetrical trigger input.
Configure the Sync/Trig ports of the controllers as trigger inputs.
The trigger source must supply a symmetrical output signal according to the RS422 standard.
For asymmetrical trigger sources, we recommend inserting the SU4 level converter (3 channels TTL/HTL to RS422) between trigger source and controller.
Encoders are not suitable for trigger purposes.

Electrical properties

- Programmable logic (TTL/HTL),
- TTL: Low level ≤ 0.8 V; High level ≥ 2 V
- HTL: Low level ≤ 3 V; High level ≥ 8 V (max. 30 V),
- Minimal pulse width 50 µs



TrigIn input

The TrigIn switching input is equipped with an internal pull-up resistor of 15 kOhm. An open input is identified as High.
Switching contacts, transistors (NPN, N-channel FET) or PLC outputs can be used as trigger sources.

4.4.11 Encoder inputs

Two encoders can be connected to the 15-pin HD-Sub socket[9] can be connected simultaneously and supplied via 5 V.

Each encoder provides the signals A, B and N (zero impulse, reference, index) The maximum pulse frequency is 1 MHz.

RS422 level (symmetrical) for A, B, N

Encoder supply 5 V: each 5 V, max. 300 mA

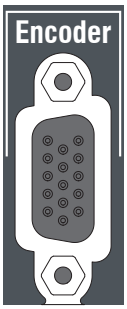


Fig. 4.12: 15-pin HD socket

[9] If the encoders are operated without reference tracks (N), the reference tracks (N) can be used as a third encoder.

Encoder	Pin	Signal	Encoder	Pin	Signal
1	1	GND ENC1	2	11	GND ENC2
	5	A1+		3	A2+
	4	A1-		2	A2-
	10	N1+/A3+[9]		8	N2+/B3+[9]
	9	N1-/A3-[9]		7	N2-/B3- [9]
	15	B1+		13	B2+
	14	B1-		12	B2-
	6	ENC U_p +5V		6	ENC U_p +5V
Connector housing		Controller housing		Cable shield	

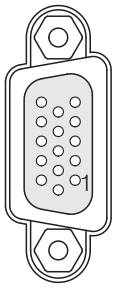


Fig. 4.13: View on solder pin side male cable connector

Tab. 4.5: Pin assignment for encoder inputs

► Use a shielded cable. Cable length less than 3 m. Connect the cable shield to the housing.

Connection conditions

- The encoders must supply symmetrical RS422 signals.
- If the encoder has no RS422 outputs, we recommend a level converter SU4 (3 channels TTL/HTL to RS422) between trigger signal source and controller.
- The two encoders can be supplied with the controller voltage ENC U_p +5 V and loaded with a maximum of 300 mA. If you use supply voltage, the cable to the encoder must not be longer than 3 meters.

The inputs are not electrically isolated from supply voltage.

4.5 Sensor cable

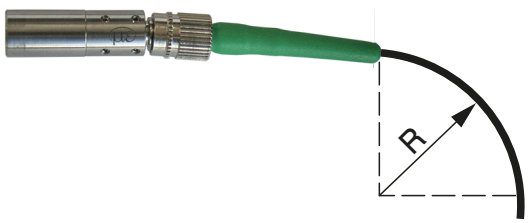
Sensor and controller are connected through an optical fiber.

- Do not shorten or extend the optical fiber.
- Do not pull or carry the sensor by the optical fiber.
- The glass fiber has a diameter of 50 µm.

Contamination of the plug-in connector should be avoided; otherwise, there may be particle deposits and a strong loss of light. Use a One-Click™ Cleaner to clean the optical connectors.

i Strictly avoid
- any soiling of the plug, e.g. dust or fingerprints,
- unnecessary plugging processes,
- applying any mechanical stress to the optical fiber (bending, pinching, pulling, drilling, knotting, etc.),
- tight curvature of the optical fiber because the glass fiber is damaged in the process and this causes permanent damage.

Never bend the sensor cable more tightly than the permitted bending radius.

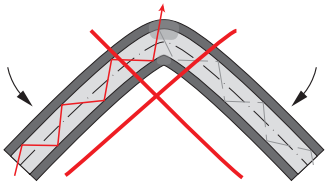


C2401-x / C2400/PT-x / C2401/PT3-x
Fixed installation:
R = 30 mm or more

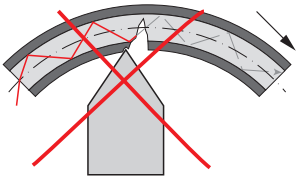
Movably routed:
R = 40 mm or more

[9] If the encoders are operated without reference tracks (N), the reference tracks (N) can be used as a third encoder.

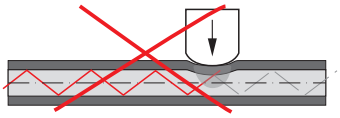
Do not kink the sensor cable.



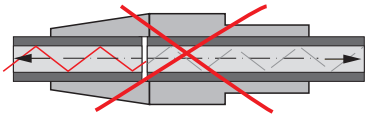
Do not pull the sensor cable over sharp edges.



Do not crush the sensor cable, do not use cable ties to secure it.



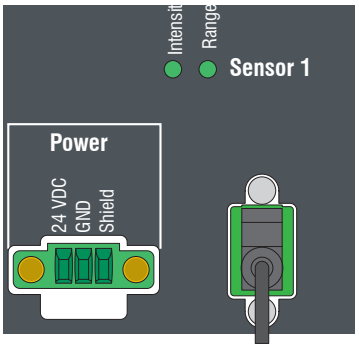
Do not pull on the sensor cable.



The optical fiber is plugged in. Optional lengths up to 50 m, drag chain/robot-compatible optical fibers, or optical fibers with metal protective tubing are available.

Connecting the fiber optic cable to the IMC5200 controller

- ► Remove the dummy plug from the green optical fiber socket on the controller.
- ► Insert the sensor cable (green plug, E2000/APC) into the socket, ensuring that the plug is correctly aligned.
- ► Insert the plug until it locks into place.



Removing the optical fiber from the controller

- ► Press the release lever on the sensor plug downwards and pull the sensor plug out of the socket.
- ► Plug the dummy plug back in.

i	Close the optical inputs and outputs with dummy plugs when no optical fiber is connected.

4.6 Sensors

4.6.1 Sensor dimensions

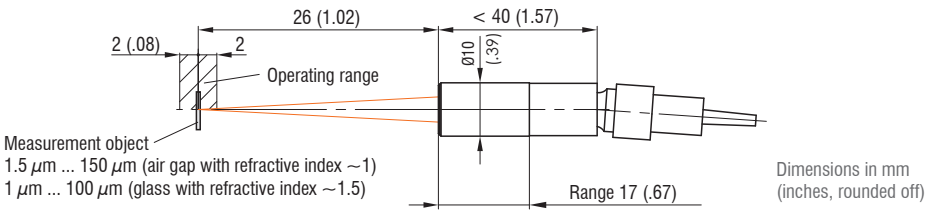
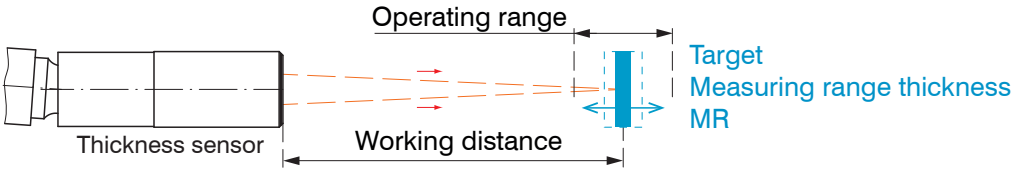


Fig. 4.14: IMP-TH26 Thickness sensor

4.6.2 Start of measuring range

For each sensor a minimum working distance must be maintained.



The operating range is arranged symmetrically to the working distance.

The exact value for the working distance can be found in the acceptance report.

4.6.3 Mounting, Mounting Adapter

The IMP series sensors use an optical measuring principle that allows for measurements in the nm range.

i Ensure careful handling during installation and operation.

Fasten the sensors with a circumferential clamp. This type of sensor mounting ensures the highest level of reliability because the sensor's cylindrical housing is clamped over a relatively large area. It is essential to have in difficult installation situations, such as on machines, production lines, etc.

► Use a MA5400-10 mounting adapter to mount the IMP-TH26 sensors.

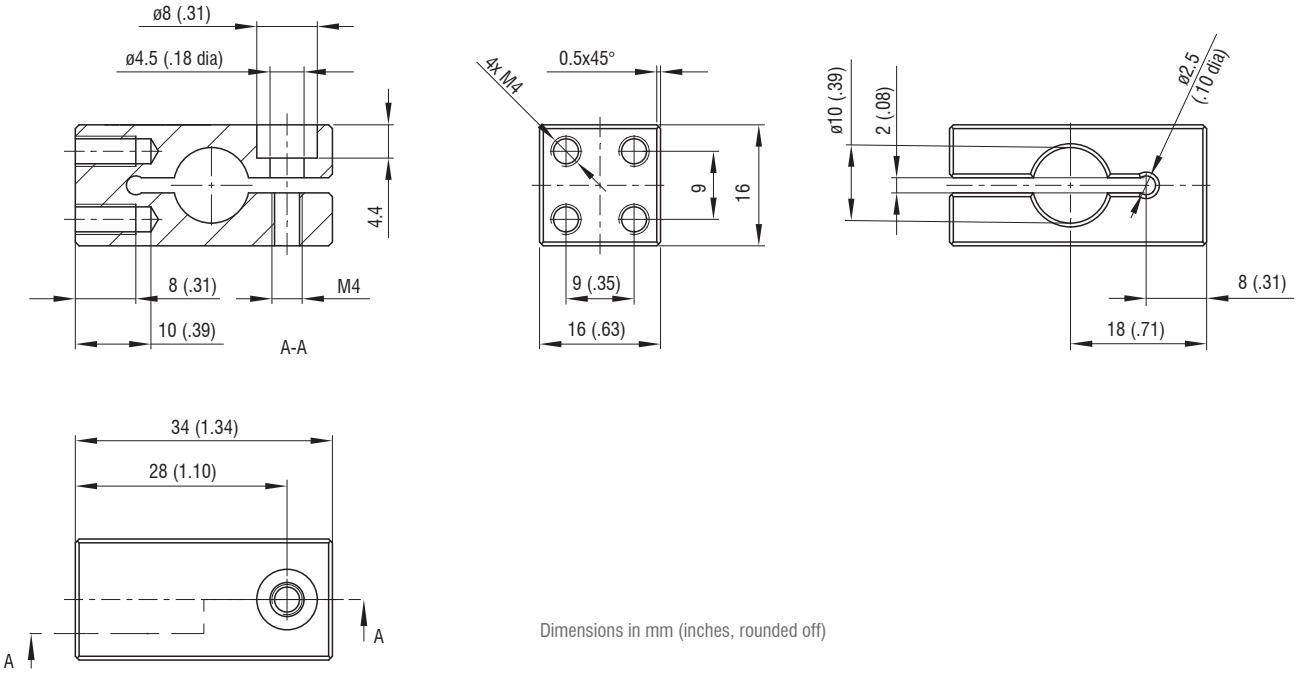


Fig. 4.15: MA5400-10 Mounting adapter

5 Operation

5.1 Commissioning

- Connect the controller to a power supply, see Chap. 4.
- Connect the sensor and the controller using the optical fiber, see Chap. 4.5.

Initializing starts after the voltage supply has been switched on. The measuring system is ready for use after approx. 10 seconds. To ensure precise measurements, let the measuring system warm up for approx. 60 minutes. This can be configured via the website integrated in the controller, via ASCII commands, see Chap. 15, or via EtherCat, see Chap. 16.

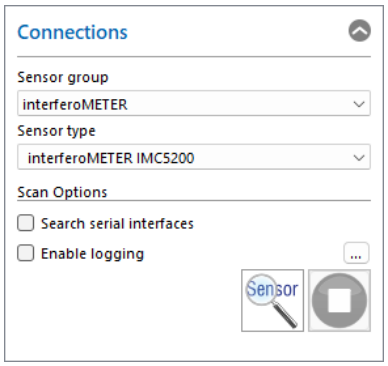
5.2 Control via Ethernet

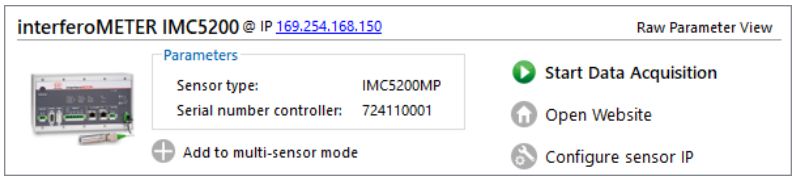
5.2.1 Requirements

The controller provides web pages for configuration. Operation is only possible while there is an Ethernet connection to the controller.

To support easy initial operation of the controller, it is set to the static IP address 169.254.168.150 by default. Use this address for a direct connection with a browser. If you have set your browser such that it accesses the Internet via a proxy server, in browser settings please add the controller IP address to the IP addresses that should not be routed via the proxy server. The MAC address of the measuring instrument can be found on the rating plate of the controller and on the acceptance report.

i	You require an HTML5-capable web browser. This applies from the following browser versions: Google Chrome 25.0 | Internet Explorer 11.0 | Mozilla Firefox 19.0

<table>
<tr><th colspan="2">Direct connection to PC, controller with static IP (factory setting)</th><th>Network</th></tr>
<tr><td>PC with static IP</td><td>PC with DHCP</td><td>Controller with dynamic IP address, PC with DHCP</td></tr>
<tr><td colspan="2">Connect the controller to a PC via an Ethernet direct connection (LAN). Use a LAN cable with RJ45 plugs for this purpose.</td><td>Connect the controller to a switch using a direct Ethernet connection (LAN). Use a LAN cable with RJ45 plugs for this purpose.
Enter the controller in the DHCP / register the controller with your IT department.</td></tr>
<tr><td></td><td>Wait until Windows has established a network connection (connection with limited connectivity).</td><td>Your DHCP server assigns an IP address to your controller. You can query this IP address with the program sensorTOOL.exe.</td></tr>
<tr><td colspan="3">Start the <code>sensorTOOL.exe</code> program.
You can find this program online at https://www.micro-epsilon.de/download/software/sensorTOOL.exe.
 

Click the <code>Sensor</code> button.
Now select the desired controller from the list.</td></tr>
<tr><td>In order to change the address settings, click the <code>Configure Sensor IP</code> button.
• Address type: Static IP address
• IP address: 169.254.168.150[10]
• Subnet mask: 255.255.0.0</td><td></td><td></td></tr>
<tr><td colspan="3"> 

Click the <code>Open Website</code> button to connect the controller to your default browser.</td></tr>
<tr><td></td><td></td><td>OR: When using DHCP with the DHCP server coupled to the DNS server, access to the controller is possible using a host name with the structure “IMC5x00_SN<Serial number>”.
Start a web browser. To reach an IMC5x00 with serial number “01234567”, type “IMC5x00_SN01234567” into the address bar of the browser.</td></tr>
</table>

Tab. 5.1: Options for connecting to a LAN

5.2.2 Access via web interface

Interactive websites for configuring the controller will now appear in the web browser. The controller is active and delivers measurement values.

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

Fig. 5.1: First interactive website after calling up the IP address

The horizontal navigation contains the following functions:

- The search function permits time-saving access to functions and parameters.
- `Home`. The web interface automatically starts in this view with measurement chart, Configuration and Signal quality.
- `Settings`. This menu contains all sensor parameters, see Chap. 6.
- `Measurement chart`. Measurement chart with digital display or video signal display.
- `Info`. Contains information on the sensor, including measuring range, serial number and software version.
- Web interface language selection

All settings are immediately copied and transmitted to the controller.

Parallel operation via the web browser and ASCII commands is possible; the last setting applies.

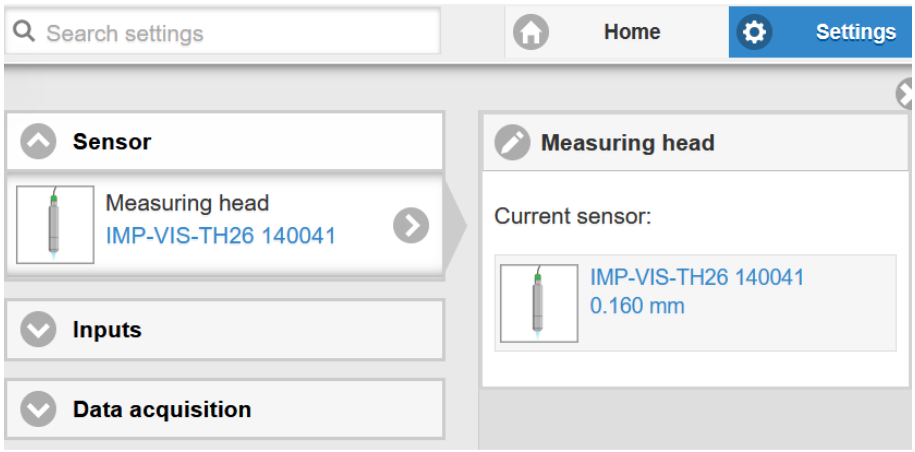
The appearance of the web sites can change depending on the functions. Dynamic help texts with excerpts from the operating instructions supports you during sensor configuration.

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

5.3 Select sensor

Controller and sensor(s) are coordinated to one another at the factory.

► Go to the `Settings > Sensor` menu.
► Select a sensor from the list.



The calibration data of up to 20 different sensors can be saved in the controller. Calibration is done at factory only.

5.4 Multifunction button

The `Multifunction` button on the controller is assigned multiple functions. This can be used to operate the light source, for example.

The button is assigned the `LED on/off`function at the factory. Modification of the assignment is possible in the `Settings > Inputs` menu. Modifying the assignment requires the `Professional` authorization.

Button function 1 / 2	Set/reset master value	Starts or stops mastering of the selected signals
	LED	*Turns the light source on/off for the sensor*
	Inactive	*Key has no function*

There are two defined time intervals for pressing the button; each of these can be assigned a function.

All time intervals are indicated by the LEDs flashing/lighting up.

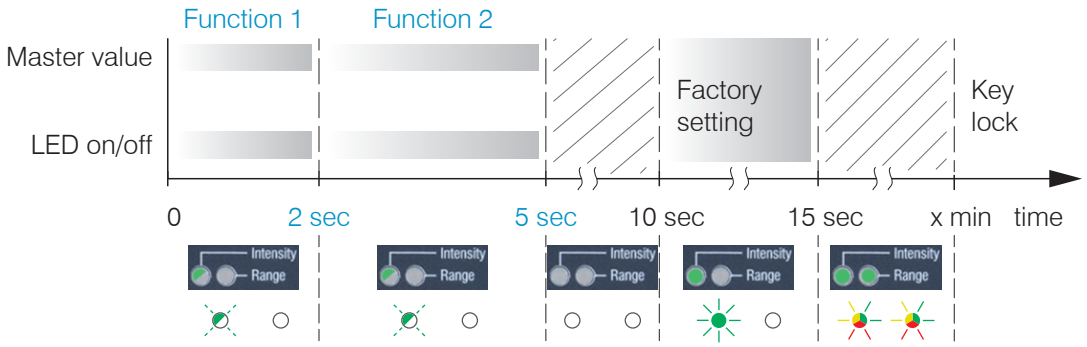


Fig. 5.2: Actuation duration of Multifunction button

Legend of the menu structure:

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

5.5 Positioning measuring object, thickness measurement

The Intensity and Range LEDs help you to align the sensor with the target during commissioning.

Switch the light source on or off in the `Settings > System settings` menu.

- ► Position the sensor perpendicular to the measuring object.
- ► If possible, position the measuring object in the mid of measuring range of the operating range.

The position of the peak in the FFT signal depends on the thickness of the target. This keeps the position stable even if the target moves.

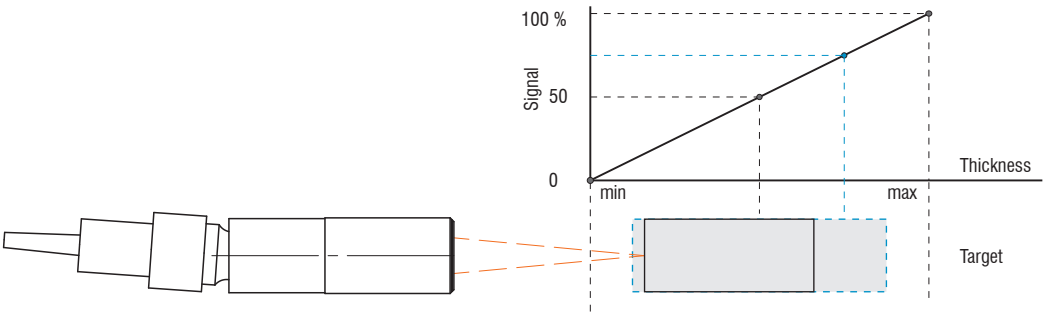


Fig. 5.3: Thickness measurement basics

The Range LED on the front of the controller indicates the position of the target relative to the sensor.

Red	No target present or target outside of measuring range
Yellow	Target close to mid of measuring range
Green	Measuring object in measuring range

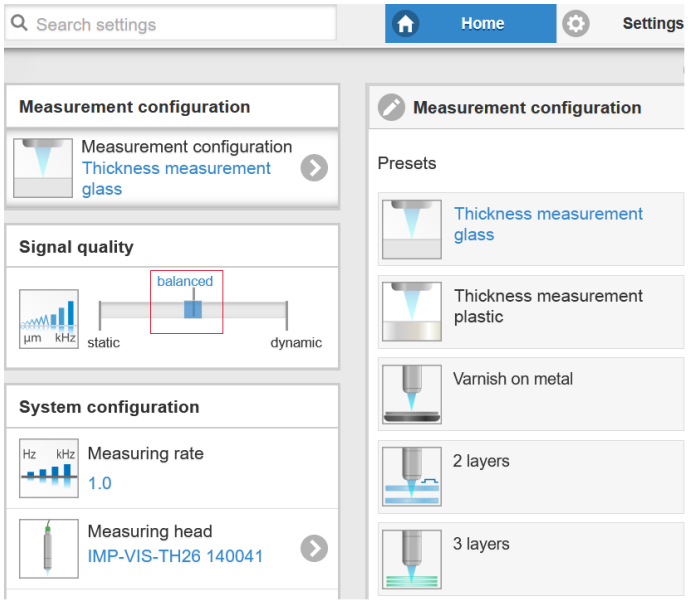
5.6 Presets, setups, measurement configuration, signal quality

Definition

- Preset: Manufacturer-specific program with settings for frequent measurement tasks; cannot be overwritten. You can select a preset in the `Home > Measurement configuration` tab.
- Setup: User-specific program with relevant settings for a measurement task. You can select a setup in the tab
  - `Home > Measurement configuration` or
  - menu `Settings > System settings > Load & Save > Measurement settings`
- Initial setup at boot (sensor start): a favorite can be selected from the setups, which is automatically activated at sensor start. If no favorite is determined from the setups, the sensor activates the `Standard` preset at startup.

The default setting of the controller does not contain any setup.

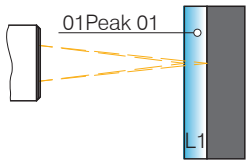
Conventional measurement configurations (Presets) for various target surfaces are saved in the controller. This means you can quickly get started with your individual measurement task. Basic features such as peak and material selection and the calculation functions are already set in the preset.

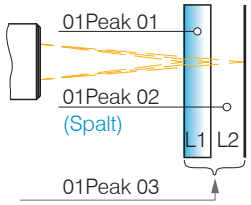


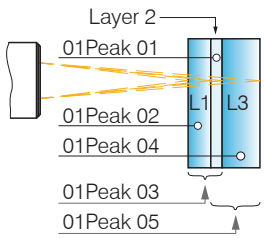
► Go to the `Home > Measurement configuration` menu and start the configuration selection. Select a saved configuration (preset).

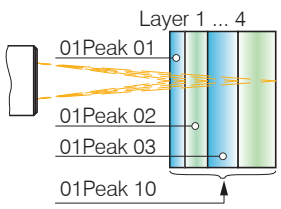
Below is an overview of all possible presets:

Presets			IMS5200-TH	IMS5200MP-TH
	Thickness measurement Glass	Thickness measurement e.g. against glass, material BK7, highest peak. Layer 1: BK7, Layer 2: Air calibration Ethernet data output: 01PEAK01	•	•
	Thickness measurement Plastics	Thickness measurement e.g. against PMMA, transparent plastics, highest peak, no averaging. Layer 1: PMMA, Layer 2: Air calibration Ethernet data output: 01PEAK01	•	•
	Varnish on Metal	Thickness measurement varnish Highest peak Layer 1: PS, Layer 2: Air calibration Ethernet data output: 01PEAK01	•	•
	2 layers	Gap monitoring between glass and mask Three peaks are evaluated, peaks sorted by height Layer 1 = BK7, Layer 2 = Air, Ethernet data output: 01PEAK01, 01PEAK02 and 01PEAK03		•
		Peak numbering applies to: Layer 1 (S1) < Layer 2 (S2)		
	3 layers	Laminated glass Six peaks are evaluated, peaks sorted by height Layer 1 = BK7, Layer 2 = PC, Layer 3 = BK7, Ethernet data output: 01PEAK01, 01PEAK02, 01PEAK03		•
		Peak numbering applies to: Layer 2 < Layer 1 (L1) < Layer 3 (L3); Layer 1 (L1) and Layer 2 < Layer 3 (L3)		
	4 layers	Display glass Ten peaks are evaluated, peaks sorted by height Layer 1: Air, Layer 2: Air, Layer 3: Air, Layer 4: Air Ethernet data output: 01PEAK01, 01PEAK02, 01PEAK03, 01PAK04 01PEAK10		•
		Peak numbering applies to: Layer 1< Layer 2 < Layer 3 < Layer 4; Layer 1 and Layer 2 < Layer 3 Define material selection and data output		









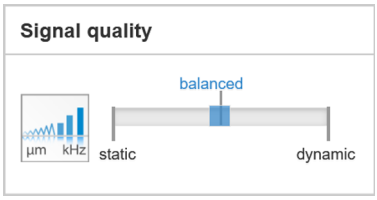
Then, you can apply your own settings. When saving a modified preset, the web interface displays a dialog for entering a setup name. This prevents presets from being overwritten by accident.

The signal quality is set to `balanced` at the factory.

You can use the `Signal quality` function to influence the measuring rate and the respective averaging for all presets.

Averaging with the `Median` function is specified by the preset.

The subsequent moving averaging is specified by the `Signal quality` function.



Averaging, measuring rate	Description
static Moving with 128 values Measuring rate 0.2 kHz	In the signal quality section, you can switch between three basic settings (static, balanced and dynamic). The reaction in the chart and system configuration is immediately visible.
balanced Moving with 16 values Measuring rate 1 kHz	
dynamic Moving with 4 values Measuring rate 6 kHz	

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

Individual material selection is possible in the `Settings > Data recording > Material selection` menu.

5.7 FFT signal

► Go to the `Measurement chart` menu. Show the FFT signal display with `FFT`.

The signal in the graphics window shows the thicknesses of the measured layers of the measuring object.

Left 0 % (thin measuring object or layer) and right 100 % (thicker measuring object or layer). The corresponding measured value is marked by a vertical line (peak marking). The diagram starts automatically when the website is accessed. 100 % intensity corresponds to the value 2048.

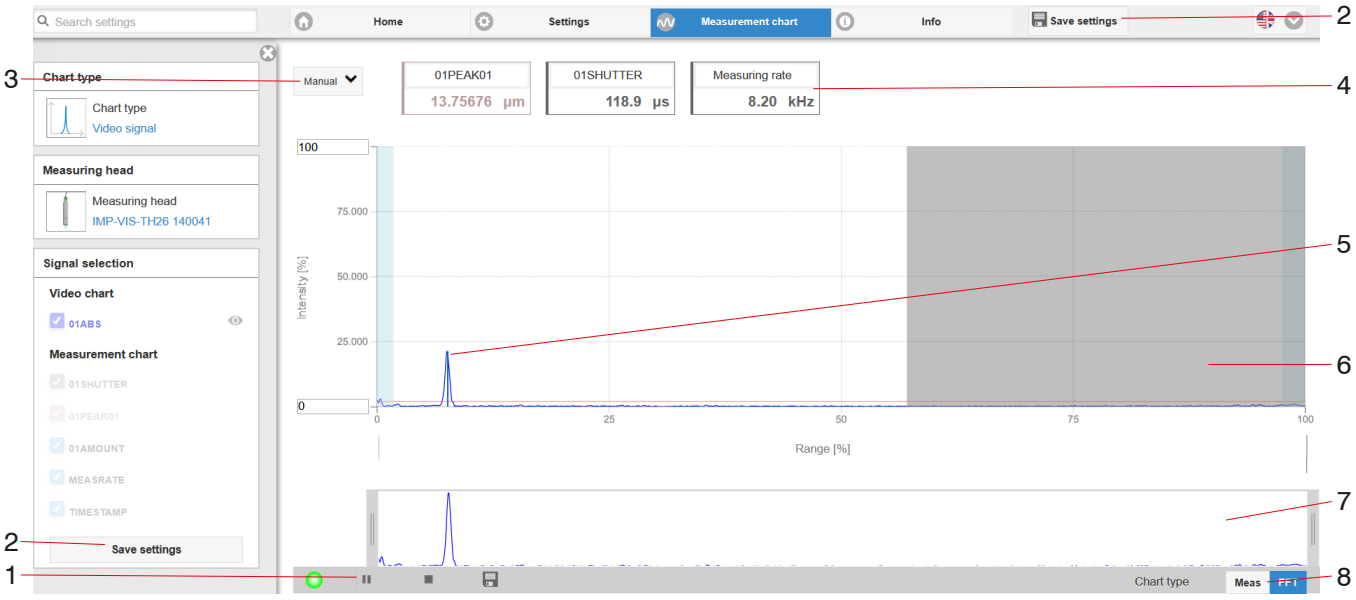


Fig. 5.4: Website FFT signal

The FFT website contains the following functions:

1 The LED visualizes the state of measured value transmission.
- green: measured value transmission in progress
- yellow: waiting for data in trigger state
- gray: measured value transmission paused

The data query is controlled with the `Play/Pause/Stop/Save` buttons of the measured values that were transmitted. `Stop` halts the diagram; data selection and the zoom function are still possible. `Pause` pauses the recording. `Save` opens the Windows selection dialog for the file name and location to save the selected FFT signals or correction tables in a CSV file. This contains all pixels, their (selected) intensities in % and other parameters.

Click on the ► button (Start) to display the measurement results.

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

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

4 The current values of the exposure time and the selected measuring rate are also displayed above the graphic.

5 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 graphic field.

6 The masked area can be restricted if necessary and is then limited by an additional light blue shading on the right and left. The peaks remaining in the resulting range are used for the evaluation.

7 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. Can also be moved with the mouse in the center of the zoom window (arrow cross).

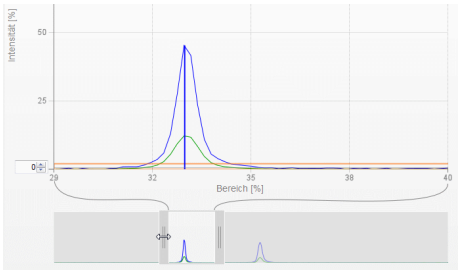


Fig. 5.5: Zooming with slider: one-sided

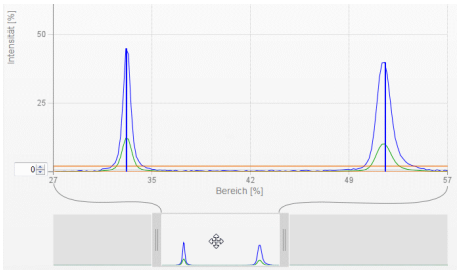


Fig. 5.6: Zooming with slider: range shift with arrow cross

8 The two buttons allow you to switch between the FFT signal and the display of the measured value.

5.8 Thickness measurement with web page display

► Align the sensor perpendicularly to the object to be measured.

► Then move the sensor (or the measuring object) closer and closer from a distance until the end of the measuring range corresponding to the sensor used is approximately reached.

As soon as the object is within the measuring field of the sensor, this is shown by the `Range` LED (green or yellow). Alternatively, you can watch the FFT signal.

LED	Status	Description
Intensity	Red	Signal saturated
	Yellow	Signal too low
	Green	Signal OK
Range	Red	No target or target outside of measuring range
	Yellow	Target in mid of measuring range
	Green	Target within the measuring range

Tab. 5.2: Meaning of LEDs during distance measurement

Opening the `Meas` chart type in the `Measurement chart >` opens the following website. The chart starts automatically when the website is accessed. The large graphic window on the right shows the value-time graph.

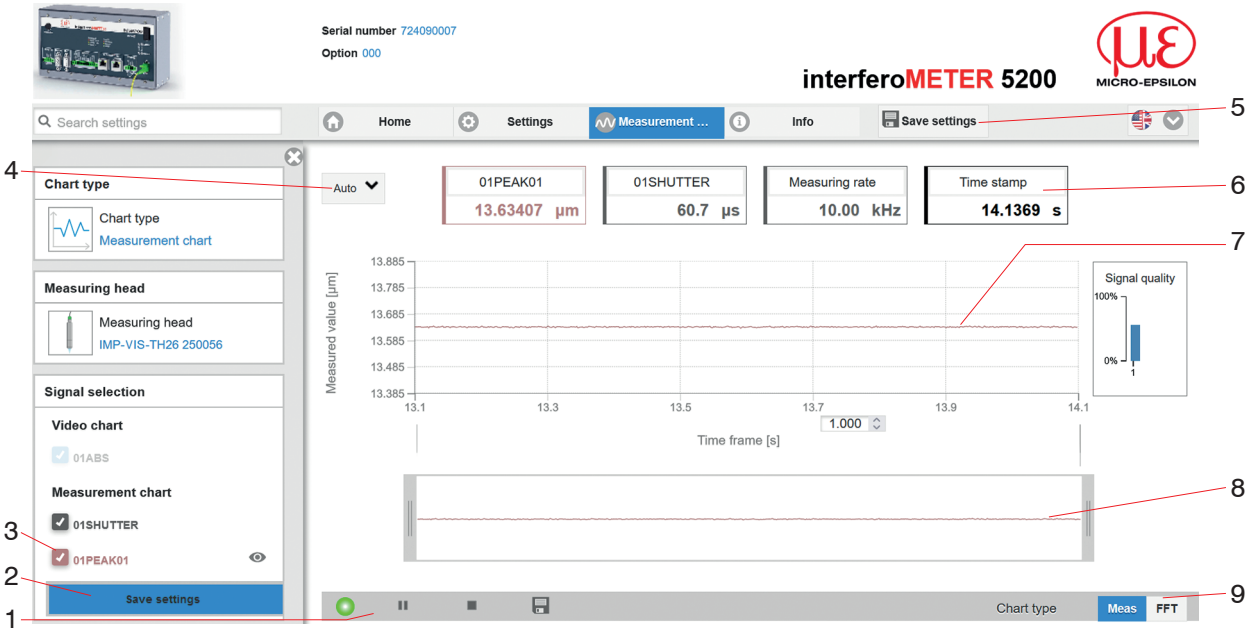


Fig. 5.7: Measurement chart (thickness measurement)

1 The LED visualizes the state of measured value transmission.
- green: measured value transmission in progress
- yellow: waiting for data in trigger state
- gray: measured value transmission paused

The data query is controlled with the `Play/Pause/Stop/Save` buttons of the measured values that were transmitted. `Stop` halts the diagram; data selection and the zoom function are still possible. `Pause` pauses the recording. `Save` opens a Windows selection dialog for the file name and save location to save the last 10,000 values in a CSV file (separation using semicolon).
Click on the ► button (Start) to display the measurement results.

2 The changes of the signal selection only become effective when you click on the `Save settings` button.

3 In the left-hand window, the signals can be switched on or off during or after the measurement.
Inactive curves are grayed out and can be added by clicking on the check mark. The changes take effect when the settings are saved.
Use the eye symbols to show and hide the individual signals. The calculation continues in the background.
- 01PEAK01: Thickness signal curve over time

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

5 Quickly save to the last saved parameter set (setup). The button is accessible on every settings page.

6 Current values for thickness, exposure time, current measuring rate and time stamp are shown in the text boxes above the graph. Errors are also displayed.

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

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

9 The two buttons allow you to switch between the FFT signal and the display of the measured value.

5.9 Save/load settings

This menu enables you to save current device settings in the controller or activate saved settings. You can permanently save eight different parameter sets in the controller.

Unsaved settings will be lost when the device is switched off. Save your settings in Setups. Unsaved settings will be lost when the device is switched off. Save your settings in Setups.

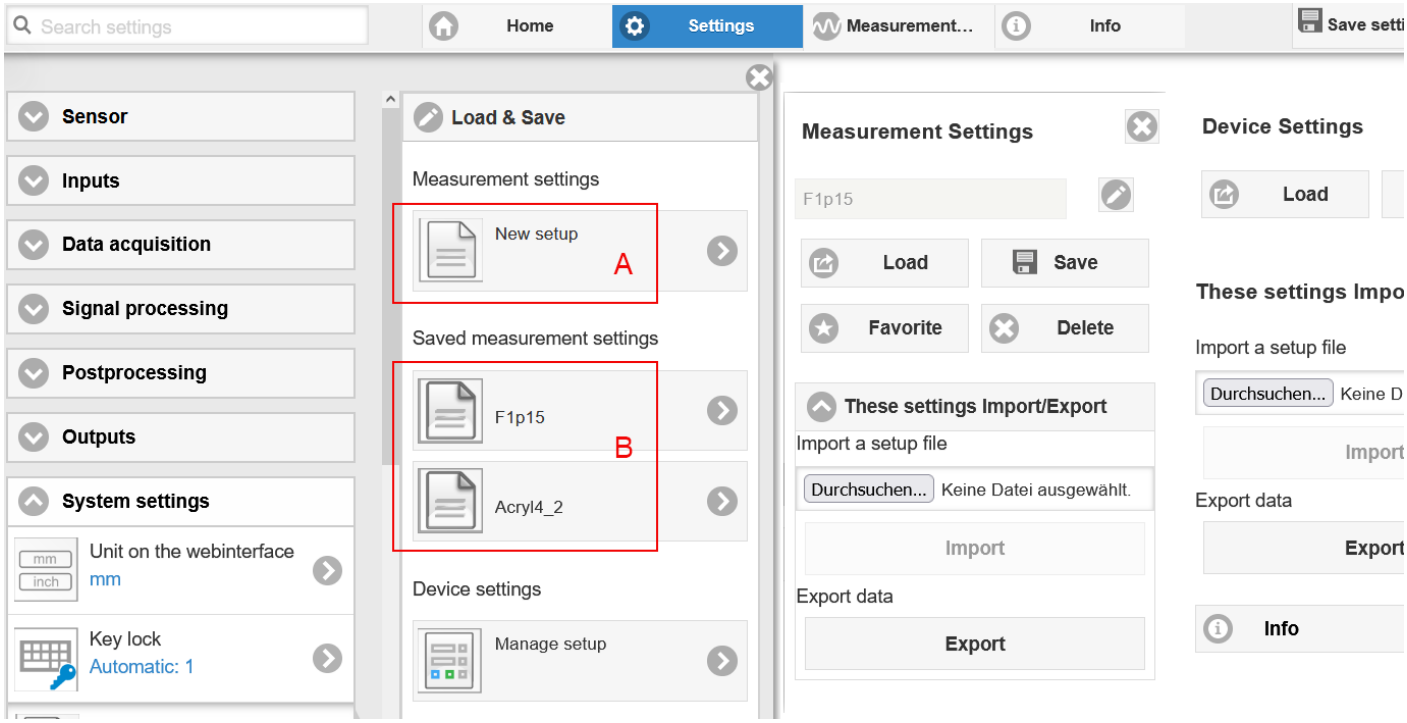


Fig. 5.8: Manage user programs

► Switch to the `Settings > Load & Save` menu.

Manage setups in the controller, options and sequence			
Save settings	**Activate existing setup**	**Save changes in the active setup**	**Determine setup after booting**
`Load and save` menu, section A	`Load & Save` menu	Menu bar	`Load & Save` menu
Enter the name for the setup, e.g. F1p15 and confirm the entry with the `Save` button.	Click on the desired setup with the left mouse button, area B. The `Measurement settings` dialog opens. Click the `Load` button.	Click on the `Save settings` button	Click on the desired setup with the left mouse button, area B. The `Measurement settings` dialog opens. Click the `Favorite` button.

The current settings will also be available in the controller after it has been switched off/on.

You can also use the `Save settings` button at top right, in each settings page as quick cache for the last parameter set saved.

i When switching on, the last parameter set saved in the controller is loaded.

Switch setups with PC/notebook, options	
Save setup on PC	**Load setup from PC**
`Load & Save` menu	`Load & Save` menu
Click on the desired setup with the left mouse button, area B. The `Measurement settings` dialog opens. Click on the button `Export`.	Left-click on `New setup`. The `Measurement settings` dialog opens. Click on the button `Search`. A Windows dialog for file selection opens. Select the desired file and click the `Open` button. Click on the `Import` button.

6 Advanced settings, web interface

6.1 Inputs

6.1.1 Synchronization

Legend of the menu structure:

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

If multiple sensors are to measure the same target at the same time, the controllers can be synchronized with one another. The sync output of the first controller IMC5x00-Master is connected to the sync inputs of further controllers, see Chap. 4.4.9.

Master	*First controller in the measuring chain; synchronizes all subsequent controllers.*
Slave Sync/Trig	*Controller operates in dependence on the first controller. Input expects TTL or HTL level.*
Slave TrigIn	*The entry expects TTL or HTL levels and enables external synchronization. The TrigIn input is controlled by an external synchronization source, e.g., a frequency generator. Min. 0.1 ... 6 kHz. It is also possible to simultaneously synchronize multiple controllers externally.*

If the controllers are operated using an EtherCAT interface, synchronization must be performed via EtherCAT.

6.1.2 Encoder

Maximum two[11] Encoder values can be assigned to the measuring data exactly, output and also used as triggering condition. This precise assignment to the measured values is ensured by outputting exactly the encoder values that were present halfway through the exposure time of the measured value (the exposure time may vary due to the control). Tracks A and B enable direction recognition. Each of the three encoders can be set separately. The assignment of the encoder socket, see Chap. 4.4.11.

Encoder 1 / 2 / (3)	Interpolation	*single / double / quadruple resolution*
	Maximum value	*value*
	Effect on reference track	*no effect / set to value once for marker / set to value for all markers*
	Set to value	*value*
	Set encoder value via software	
	Reset detection of first reference marker	

6.1.3 Button function

The Multifunction button on the controller is assigned multiple functions. Details can be found in the Multifunction, see Chap. 5.4 section.

6.1.4 Termination, terminating resistor

For the `Sync/Trig` digital input, the terminating resistor in the operating mode `Synchronization > Slave` in the last controller of the series must be switched on.

Termination	on / off	*The terminating resistor avoids reflections.*

6.1.5 Input level

For the `TrigIn` digital input, the logic level must be defined with which it is controlled.

[11] The reference tracks can be used as a third encoder, see Chap. 4.4.11.

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

6.2 Data recording

6.2.1 Measuring rate

The selection of the measuring rate is made in the menu `Settings > Data acquisition > Measuring rate`.

- ► Select the required measuring rate.

The measuring rate can be set continuously in a range from 0.1 kHz to 24 kHz. The increment is 100 Hz.

Procedure:

- ► Position the measuring object in the mid of the operating range if possible. Change the measuring rate until you obtain a stable signal over the entire operating range, but one that is not oversaturated.

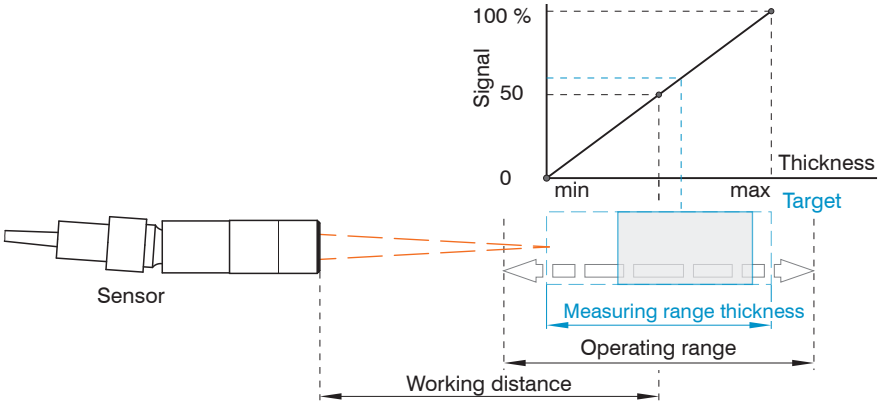


Fig. 6.1: Defining measuring range and output signal

- ► To do this, observe the `Intensity` LED.

LED	State		Description
Intensity	Red	Continuous	Raw signal is saturated or no peak selectable
	Yellow		Peak can be analyzed, but at reduced linearity
	Green		Peak can be analyzed, specified measured result

- ► Select the measuring rate so that the `Intensity` LED lights up green.
- ► If necessary, change the exposure mode, use Manual mode.
- ► Use the desired measuring rate and set the exposure time. Otherwise, the exposure time determines the possible measuring rate.

If the signal is low (`Intensity` LED is yellow) or saturated (`Intensity` LED is red), the controller will carry out measurements, but measuring accuracy might not correspond to the specified technical data.

6.2.2 Region of interest (ROI)

The evaluation ranges of the interferoMETER can be set individually.

The evaluation range can be selected in the `Settings > Data recording > Evaluation range` menu.

The masking limits the range for the thickness measurement in the FFT signal.

This function is used to mask the background, if it extends into the measuring range.

ROI 1 and ROI 2 evaluation ranges	Start of range in %	*value*
	End of range in %	*value*

Masking (start/end of range) is entered into the two boxes on the left (in %).

i When limiting the evaluation range, a peak is only detected if it is completely within the evaluation range and above the threshold. This can reduce the measuring range.

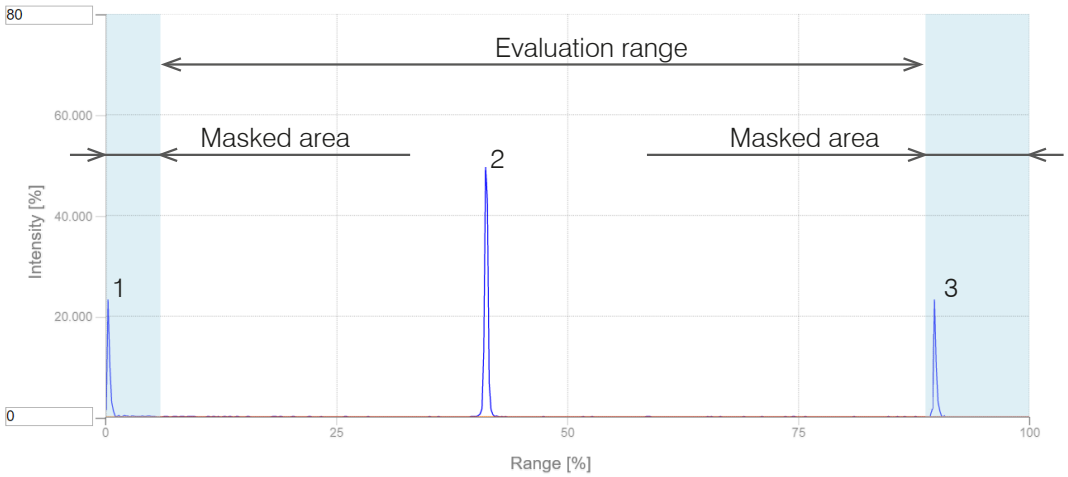


Fig. 6.2: Limitation of the FFT signal used

The example shown in the figure uses the peak (2) for the evaluation, while peaks (1) and (3) are not used.

► Set the desired evaluation range.

6.2.3 Number of peaks

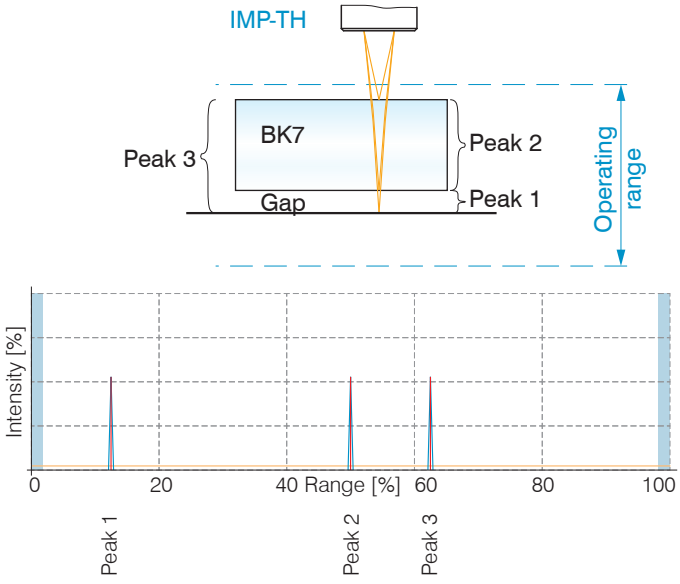
Number of peaks of the FFT signal used for evaluation of the thickness measurement. The number of peaks is selected in the menu `Settings > Data recording > Number of peaks`.

This function is possible for the following systems:

- IMS5200MP-THxx

The IMS5200-THxx standard system evaluates one layer.

Example of a layer of glass and gap; measurement peak sorting: First peak, associated material selection



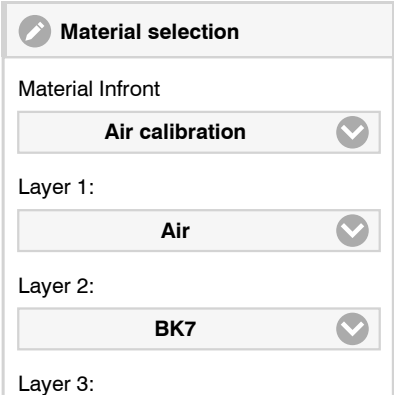
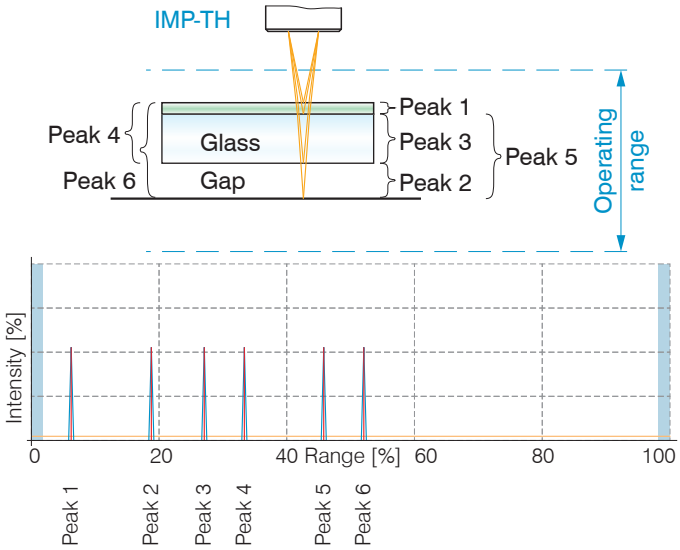


Fig. 6.3: Measurement arrangement of two layers with associated material selection

The material selection for a thickness measurement starts with the thinnest layer (layer 1) independent of the physical arrangement in the measuring object.

For layer 3, it is not necessary to select a material. Peak 3 stands for a combination layer of glass and air. The controller evaluates this layer; however, the result has no meaning in the measurement.

Example of three layers of lacquer, glass and gap, measurement peak sorting: First, associated material selection



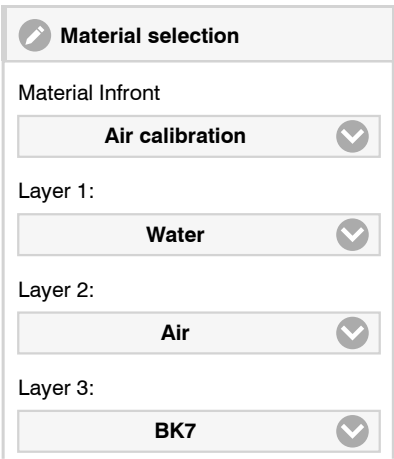


Fig. 6.4: Measurement arrangement of three layers with corresponding material selection

Layer 4 is the material selection for the combined layer[12] of Peak 4.

The IMS5200MP-TH measures the thickness of the combination layers of the entire material. If it is not possible to separate the layers, individual layers cannot be measured – the total thickness is only meaningful if both layers are made of the same material and therefore have the same refractive index.

[12] The IMC5200MP-TH controller also evaluates combined thicknesses of the different layers.

If the layers consist of different materials with different refractive indices and the individual layers can be measured, the total thickness can be determined using the IMC5200MP-TH controller and signal processing (calculation programs).

For layer 4, it is not necessary to select a material. Peak 4 stands for a combination layer of lacquer and glass. The controller evaluates this layer; however, this result is not significant in the context of the measurement.

6.2.4 Measpeak sorting

The selection of the peak/s dictates which region in the signal is used for the thickness measurement.

- Switch to the material selection in the menu `Settings > Data recording`.
- Switch to the chart type `FFT`.
- Choose between `By position` or `By height`.

Selecting `By Position` enables narrowing down the required peaks.

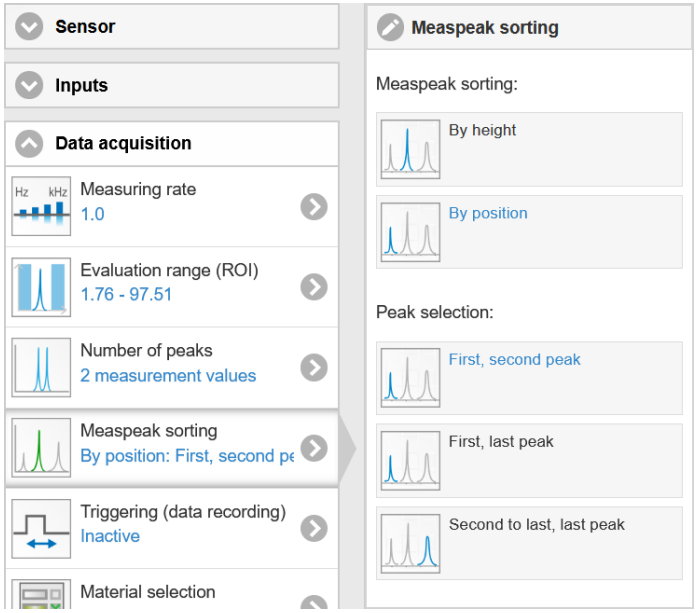
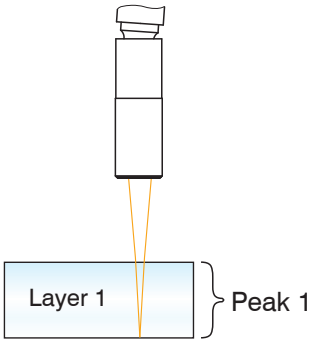
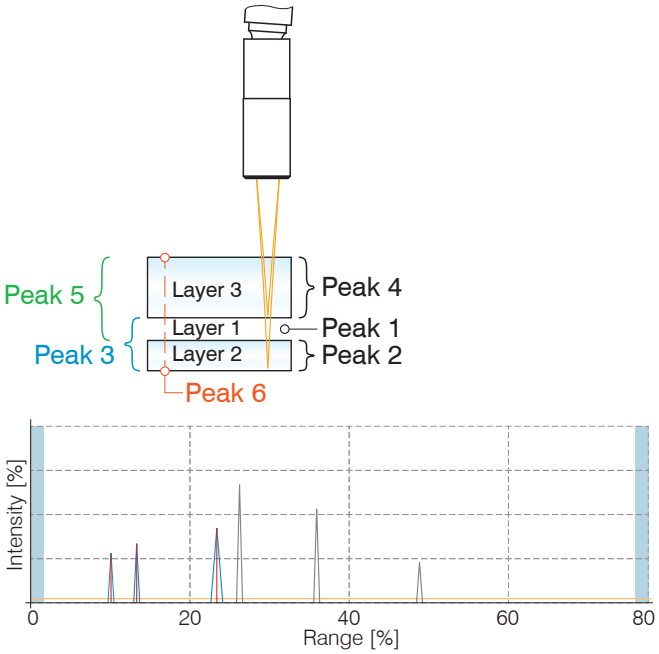
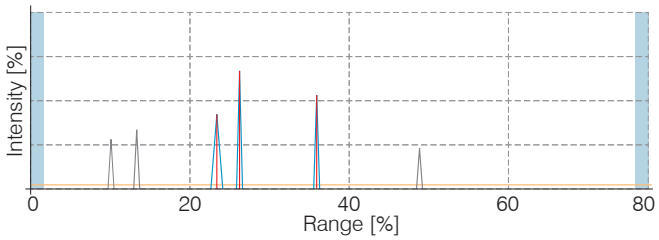


Fig. 6.5: Optimization of peak selection

IMS5200-THxx	IMS5200MP-THxx
Thickness measurements	
 The system evaluates one layer. The peak in the FFT signal already corresponds to the thickness. It is not necessary to decide between the first and highest peak.	Each peak represents a thickness value. The peaks are counted starting at the start of the measuring range (for the thinnest layer) toward the end of the measuring range (for the thickest layer). Combined thicknesses of adjacent layers are also evaluated. The material selection for a thickness measurement starts with the thinnest layer (layer 1) independent of the physical arrangement in the measuring object, see Chap. 6.2.6.  *Fig. 6.6: Evaluation starts from the first peak, e.g. 3 out of 4 peaks*  *Fig. 6.7: Evaluation starts from the highest peak, e.g. 3 out of 4 peaks*

The number of peaks of the FFT signal that are used for evaluation in thickness measurement are to be determined separately, see Chap. 6.2.3.

In the case of a target consisting of several transparent layers, the material must be assigned for each layer, see Chap. 6.2.6.

6.2.5 Triggering

6.2.5.1 General

Measured value input or output by the interferoMETER can be controlled using an external electrical trigger signal or commands. Both analog and digital outputs are affected by this.

- The triggering does not affect the preselected measuring rate.
- As external trigger inputs, `Sync/Trig` or `TrigIn` are used, see Chap. 4.4.10.
- Factory setting: no triggering, the controller starts with the data transmission output immediately after being switched on.
- The pulse duration of the trigger signal is at least 5 µs.

Trigger settings are performed in the `Settings > Data recording > Trigger data recording` menu. The triggering of the data acquisition and output have the same time response.

Sync/Trig TrigIn	Trigger type	*Level*	Trigger level	Low level / High level	
		Edge	Trigger level	Falling edge / rising edge	
			Number of measured values	*Manual selection*	*value*
				infinite	
Software	Number of measured values			*Manual selection*	*value*
				infinite	
	Start triggering				
Encoder 1/2			Lower limit		*value*
			Upper limit		*value*
			Increment		*value*
Inactive			*Continuous data acquisition*		

`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

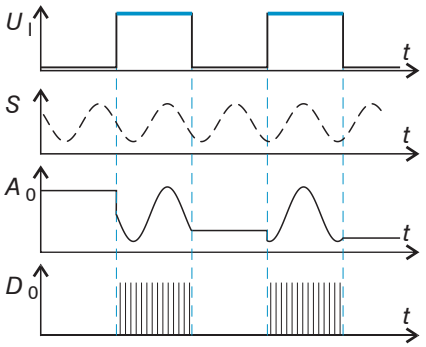


Fig. 6.8: Triggering with active high level (U_I), associated analog signal (A_O) and digital signal (D_O)

`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

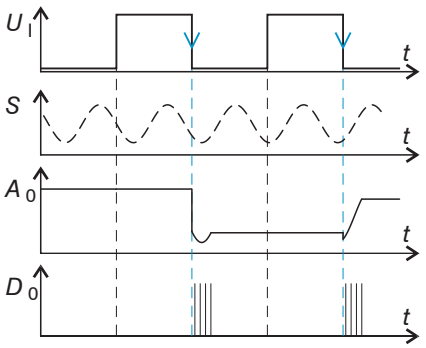


Fig. 6.9: Triggering with falling edge (U_I), associated analog signal (A_O) and digital signal (D_O)

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

`Encoder triggering`. Starts the data acquisition by encoder.

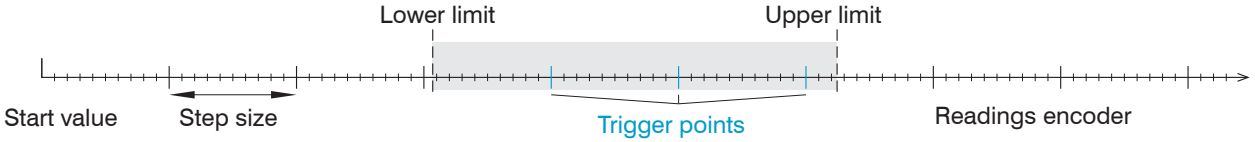


Fig. 6.10: Definition of terms for encoder triggering

i	There are no measurement values within the increment. Retain this if averaging is used for measurements.

6.2.5.2 Triggering data acquisition

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

When calculating averages, measured values immediately before the trigger event cannot be included; instead older measured values are used, which had been entered during previous trigger events.

6.2.5.3 Triggering Measured Value Output

The measured values are computed continuously and independently of the trigger event. A trigger event merely triggers output of the values via a digital or analog interface.

Therefore, any values measured immediately before the trigger event are included in calculating mean values (averages) or statistics.

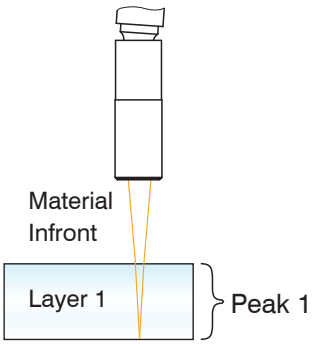
The measured value at the time of the trigger event is output with a delay.

6.2.6 Material selection

The refractive index needs to be corrected in the controller for an exact thickness measurement. Only air or vacuum may be present between the sensor face and the measuring object (Material Infront); other media such as water or alcohol are not permissible.

Controller IMC5200-TH

- ► Switch to the `Settings > Data recording > Material selection` menu.
- ► Assign the material according to the target used.



You can edit or add to the material table. For a new material, a phase index and group refractive index is required.

- ► To do this, go to the menu `Settings > Data recording > Link to material table`.

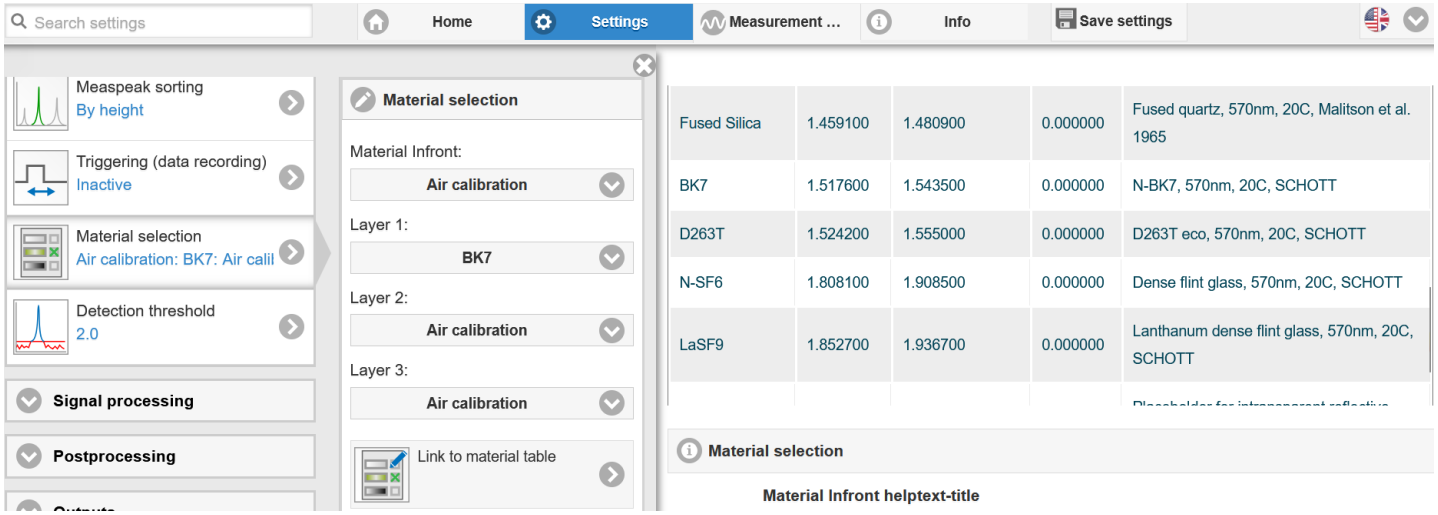
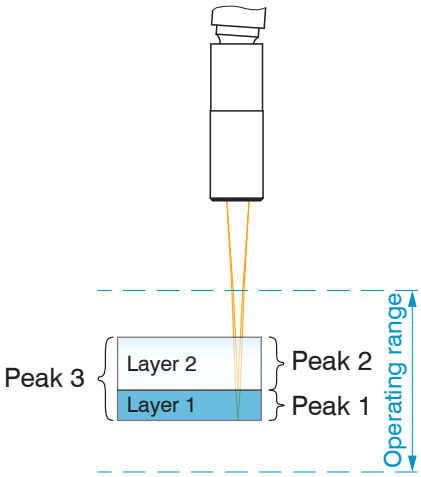


Fig. 6.11: Material selection of measuring object

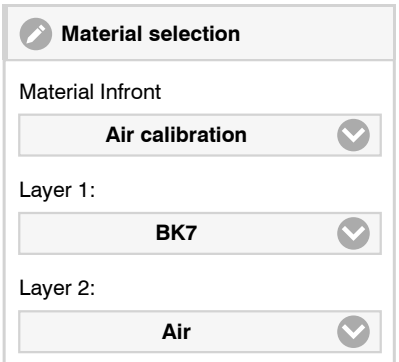
The surface of the subsequent material is also required to calculate the thicknesses.

Controller IMC5200MP-TH

- ► Switch to the `Settings > Data recording > Material selection` menu.
- ► Assign the materials to the individual layers according to the target used.



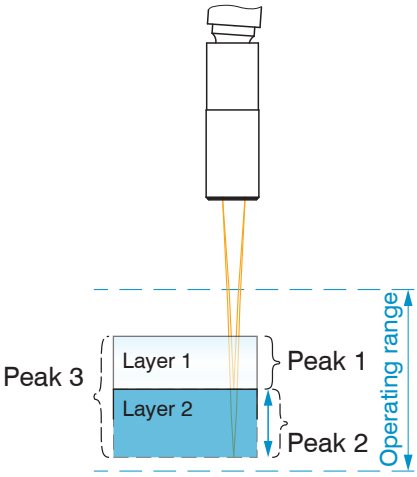
The material selection for a thickness measurement starts with the thinnest layer (layer 1) independent of the physical arrangement in the measuring object.



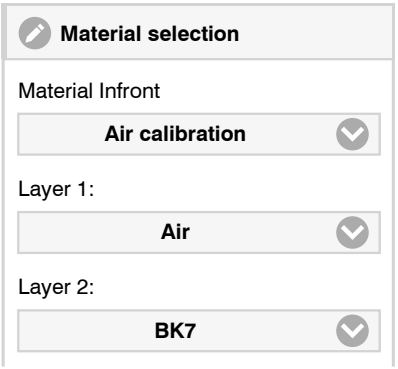
Controller IMC5200MP-TH

Compared to the example above, the thickness of the lower layer (blue) has increased and is larger than the upper layer. For this case, the material selection must be adjusted.

In the FFT signal, Peak 1 and Peak 2 change places, see Chap. 5.8, see Chap. 6.2.4 .



The IMC5200MP controller also evaluates combined thicknesses of the different layers. For Peak 3, a corresponding material for Layer 3 (= Layer 1 + Layer 2) is to be selected.



6.2.7 Detection threshold

The detection threshold (in digits relative to the magnitude signal) defines the minimum signal quality for including an FFT signal peak in the analysis. The controller evaluates the highest peak. It is therefore essential to evaluate the FFT graph to determine this.

Detection threshold in %	*value*

Define the detection threshold: In general, set the threshold high enough to prevent any interfering peaks from being detected.

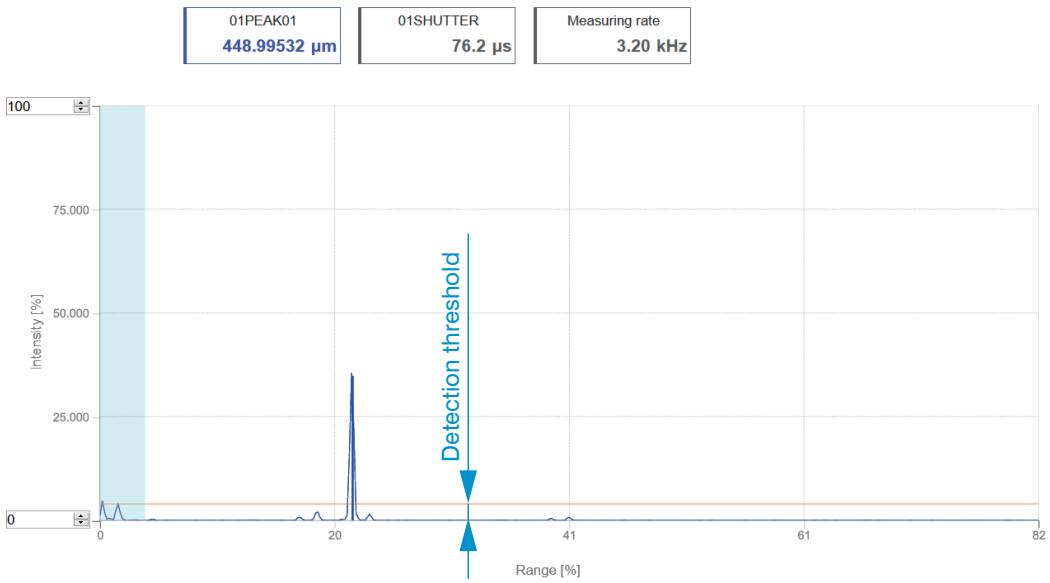


Fig. 6.12: Measurement with secondary peaks in a material that is not optically dense

i Peaks of highly doped silicon typically exhibit low intensities. If necessary, reduce the detection threshold so that these peaks are taken into account in the evaluation.

6.3 Signal processing, calculation

6.3.1 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.

			IMS5200	IMS5200MP
Median			·	·
Moving mean			·	·
Recursive average			·	·
Thickness	Calculating the difference Two signals or results, Peak/result B < peak/result A			·
Formula	Peak A - peak B			
Calculation	Summation Two signals or results			·
Formula	Factor 1 * peak/result A + factor 2 * peak/result B + offset			
Duplicate	Creates a copy of a signal			·
Calculation parameters (calculation program)	Factor 1 / 2	*value*	-32768.0 … 32767.0	
	Offset	*value*	-21.47 ... 21.47	
Calculation parameters (Median program)	Averaging type		Recursive / Moving / Median	
	Number of values	*value*	Recursive: 2 ... 32000	
			Moving: 2 / 4 / 8 / 16 / 32 / 64 / 128 / 256 / 512 / 1024 / 2048 / 4096	
			Median: 3/5/7/9	
The number of values states over how many sequential measured values in the controller should be averaged before a new measured value is output.				

Tab. 6.1: Available programs · = possible function

Sequence for creating a calculation block.

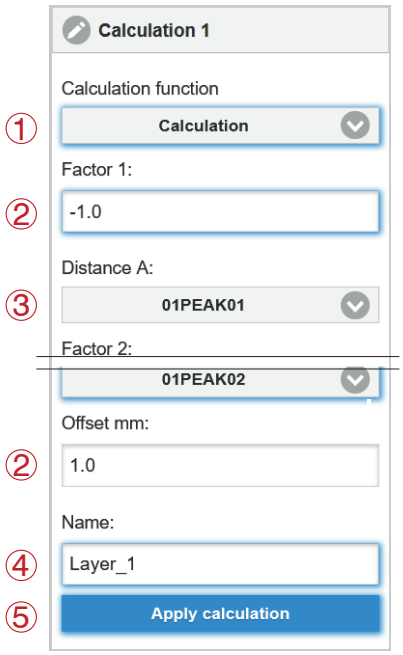
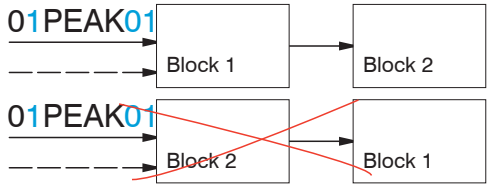
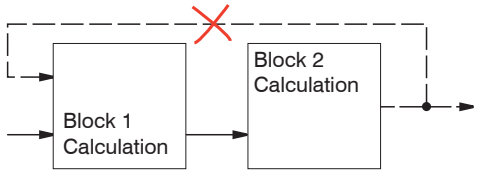


Fig. 6.13: Sequence for the program selection

- ► 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 button `Store calculation`.

The programs Calculation and Thickness have two data sources. The Averaging and Duplicate programs each have one data source.

6.3.2 Definitions

Distance value(s)	01PEAK01, 01PEAK02, 01PEAK06
Max. 10 calculation blocks per channel/sensor. The calculation blocks are processed sequentially.	
Feedback couplings (algebraic loops) over one or several blocks are not possible. Only the distance values or the calculated results from the previous calculation blocks can be used as data sources.	
Processing sequence: 1. Unlinearized thickness 2. Linearization of the thickness 3. Refractive index correction of the thickness 4. Error handling in the event of no valid measurement value 5. Calculation 6. Mastering 7. Statistics	

6.3.3 Averaging

6.3.3.1 General

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

Measurement averaging

- improves the resolution,
- allows hiding 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 set average value type and the number of values must be saved in the controller so that they are retained after switching off.

The controller is delivered with “moving average, averaging value = 16” as factory settings, i.e. averaging is not enabled by default.

Defining measurement averaging

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

6.3.3.2 Moving mean

Moving mean

The arithmetic average M_{mov} is calculated and output using the selectable filter width N of consecutive measurement values. 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

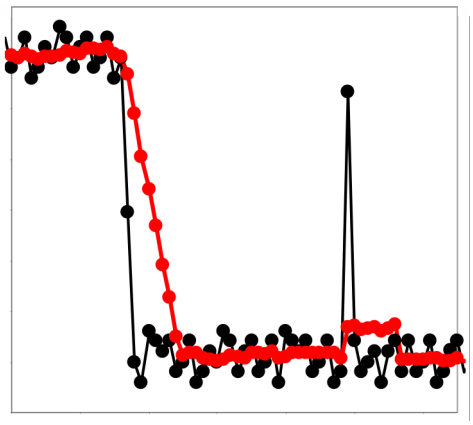
... 0, 1, [2, 2, 1, 3] → $\frac{2, 2, 1, 3}{4} = M_{mov}(n)$

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

Measured values

Output value

Note	For the moving average, only powers of 2 are permitted for the averaging number N. The highest averaging value is 1024.



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. 6.2: Moving average, N = 8

6.3.3.3 Recursive average

Recursive average

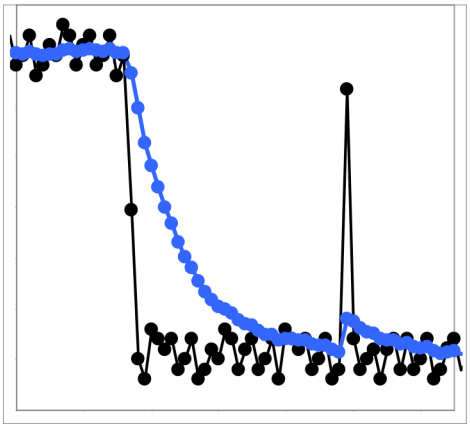
Each new measured value *MW*(n) is weighted and added to (n-1) times the previous average value.

Formula:

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

N = averaging number, *N* = 1 ... 32767
n = measured value index
MW = measurement value
M_{rec} = mean value or output value

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. 6.3: Recursive average, N = 8

6.3.3.4 Median

Median

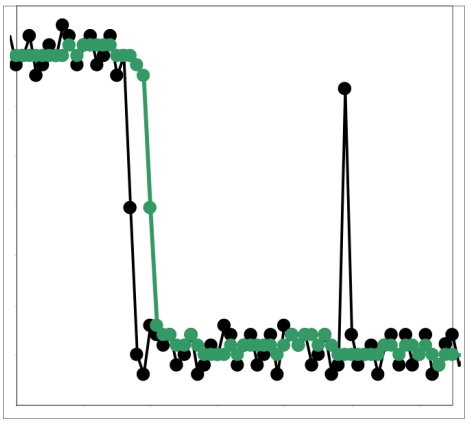
A median value is formed from a preselected number of measured values.

When creating a median value for the controller, incoming measured values are sorted after each measurement. The middle value is then output as the median.

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 from measurement values

... 0 1 2 4 5 1 3 → Sorted measurements: 1 2 3 4 5 Median$_{(n)}$ = 3
... 1 2 4 5 1 3 5 → Sorted measurements: 1 3 4 5 5 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. 6.4: Median, N = 7

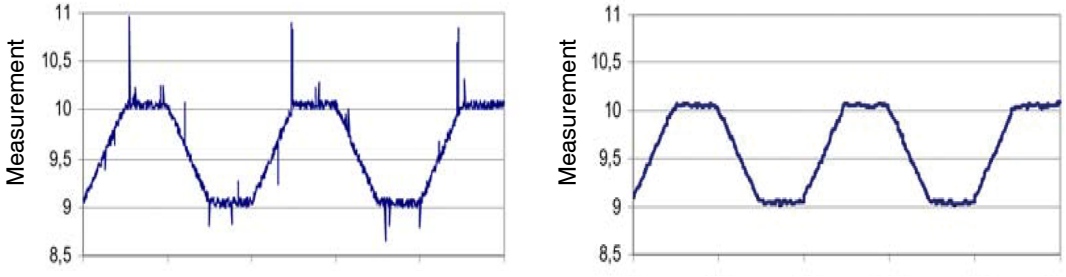


Fig. 6.14: Signal profile without median (left), with median N = 9 (right)

6.4 Post-Processing

6.4.1 Zeroing, mastering

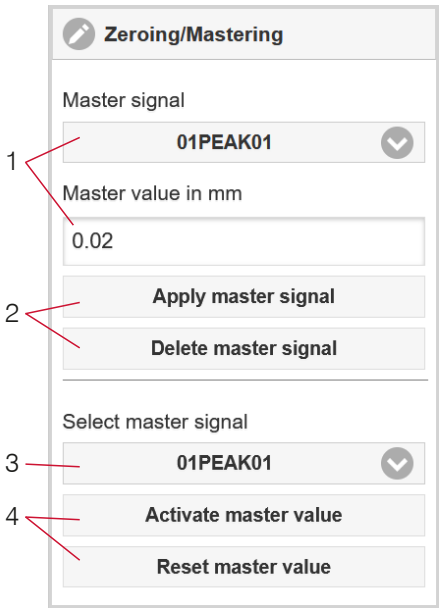
Use zeroing and mastering to define a nominal value within the measuring range. This shifts the output range. This feature can be useful, for example, when several sensors carry out measurements simultaneously in thickness and planarity measurements. When measuring the thickness of a transparent target, you need to specify the actual thickness of a master object as `Master value`.

Master value in mm	value	*Specification, e.g. of the thickness of a master piece.* *Value range: -2.147 ... +2.147 mm (-0.083 ... +0.083 inch)*

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

The measured value provided at the controller output when measuring a master object is the `Master value`. Zeroing is a special feature of mastering, since the master value is “0” here.

i	"Mastering" or "Zeroing" requires a target to be present in the measuring range. "Mastering" and "Zeroing" affect the analog, switching and digital outputs.



1 Selects a signal for the function, assigns master value.
2 Button for storing or deleting a master signal.
3 Selects a certain signal or function.
4 Starts/stops the function.

Fig. 6.15: Mastering dialog, overview of individual master values

When setting a master, the output 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).

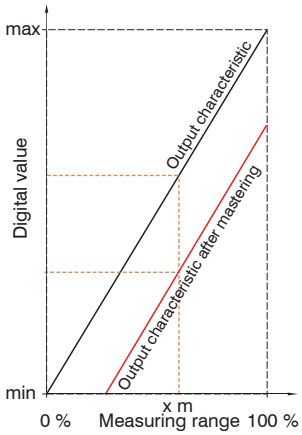


Fig. 6.16: Moving the characteristic during mastering

Zeroing/mastering sequence:

- Place measuring object and sensor into their desired positions to one another.
- Define the `Master value`, web interface/ASCII/EtherCAT.

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

The following two figures show the procedure for zeroing/mastering using the `Multifunction` button on the controller. This requires that these functions have been assigned to the `Multifunction` button beforehand, see Chap. 5.4.

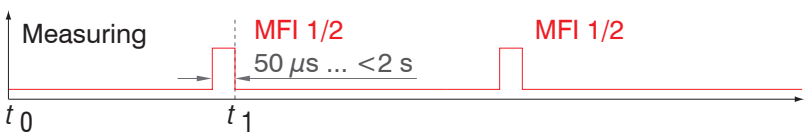


Fig. 6.17: Flowchart for zeroing, mastering (Multifunction button)

The Zeroing/Mastering function can be applied several times in a row.

Fig. 6.18: Flowchart for resetting Zeroing/Mastering (Multifunction button)

Fig. 6.19: Trigger mastering in the Measurement chart menu by mouse click (left), resetting mastering (right)

6.4.2 Statistics

The controller derives the following statistical values from the measurement result:

- Minimum,
- Peak-to-peak and
- Maximum

The statistical values are calculated from measured values within the region of interest.

The region of interest is reset with each new measurement value. The statistical values are displayed via the web interface in the Measurement chart, or are output via the interfaces.

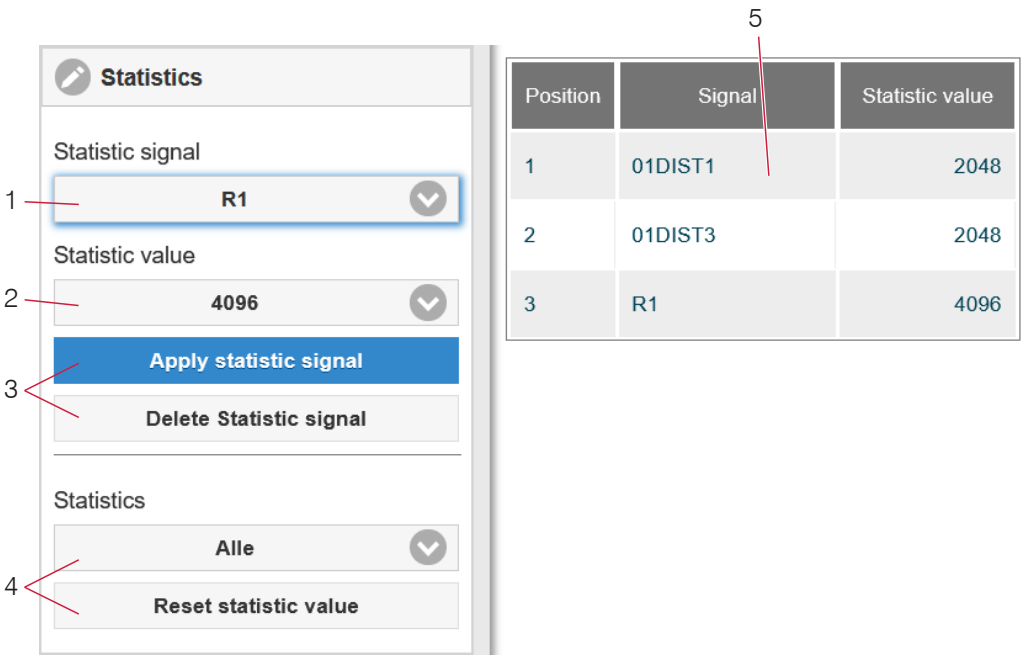


Fig. 6.20: Mastering dialog, overview of individual master values

1	Selects a signal for the function
2	Number of measurement values based on which minimum, maximum and peak-to-peak are determined for a signal. The range of values used for calculation can be between 2 and 16384 (in powers of 2).
3	Button for saving or deleting a signal.
4	The `Reset statistic value` button can be used to reset a specific signal or all statistics signals and thus initiate a new evaluation cycle (storage period). When a new cycle starts, previous statistical values are deleted.
5	Overview of signals for a statistical function have been set up, region of interest (statistical value)

Sequence for creating a statistical evaluation:

- Change to the tab `Settings > Postprocessing > Statistics`.
- Choose a signal (1) for which the statistical values should be calculated.
- Define the region of interest via the `Statistic value`.

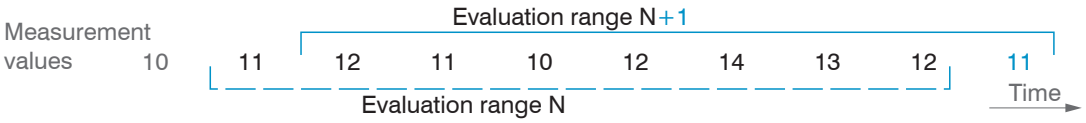


Fig. 6.21: Dynamic updating of the region of interest using measured values, statistical value = 8

6.4.3 Data reduction, output data rate

Data reduction	*value*	*Instructs the controller 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.*

You can reduce the measurement output in the controller if you set the output of every nth measured value. Data reductions causes only every nth measured value to be output. The other measurement values are discarded. 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 controller without having to reduce the measuring rate.

6.4.4 Error handling (hold last value)

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

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 value is displayed.*

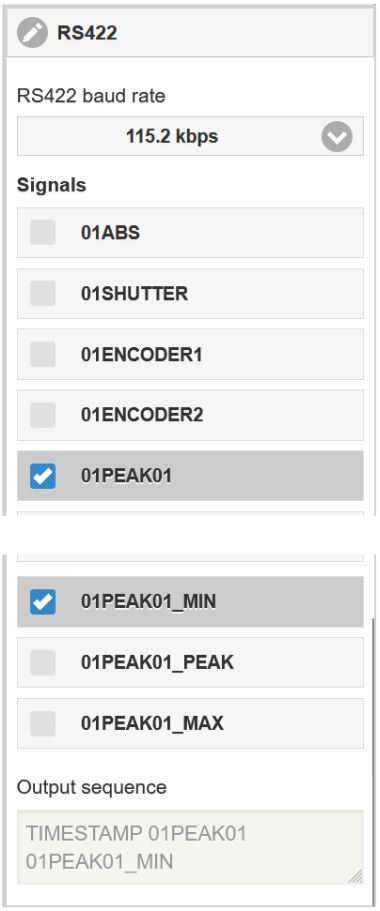
6.5 Outputs

6.5.1 General

A parallel data output via multiple channels is possible.

6.5.2 RS422

Output data are selected for both interfaces separately from all internally determined values and from the calculated values from the computing modules. These are issued in a fixed order.
Further details on data output via RS422 can be found here, see Chap. 8.



► Switch to the tab `Settings > Outputs > RS422`.

6.5.3 Ethernet data output

For Ethernet and RS422, output data are selected for the interfaces separately from all internally determined values and from the calculated values from the computing modules. This data is output sequentially in a fixed order. The selected values for Ethernet contain the signals for transmitting the measured values. However, this does not apply to the web diagram.
Measurement data can be output via Ethernet and RS422 and Ethernet in parallel.
Further details on data output via Ethernet can be found here, see Chap. 9.

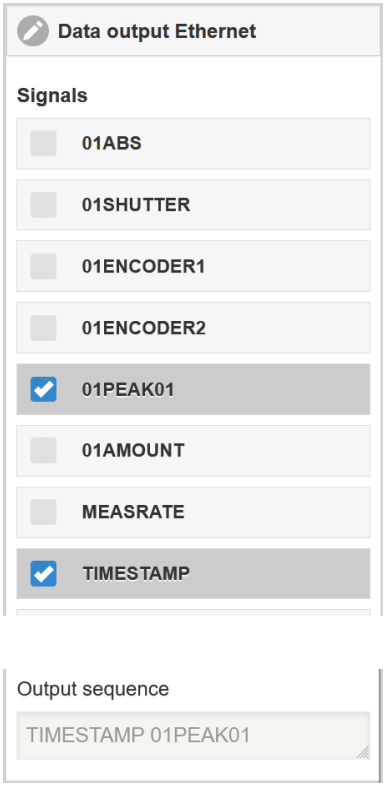


Fig. 6.22: Selection of output data for the Ethernet interface, depending on controller version

► Switch to the tab `Settings > Outputs > Ethernet data output`.

6.5.4 Analog output

6.5.4.1 Selection options, scaling

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

Output signal	*01PEAK01 / ... / 01PEAK14 Signal processing results*	*Only one value can be output at the analog output.*	
Output range	*4 ... 20 mA / 0 ... 5 V / 0 ... 10 V*	*Either the voltage or current output can be used on the controller.*	
Scaling	*Standard scaling*	*Scaling to 0 ... Measuring range*	
	Two-point scaling	Minimum value (in mm):	*value*
		Maximum value (in mm):	*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 allows for user-defined specification of the measuring range to be output. Here, switching the minimum and maximum range limits is permitted; this allows for a falling analog characteristic curve.

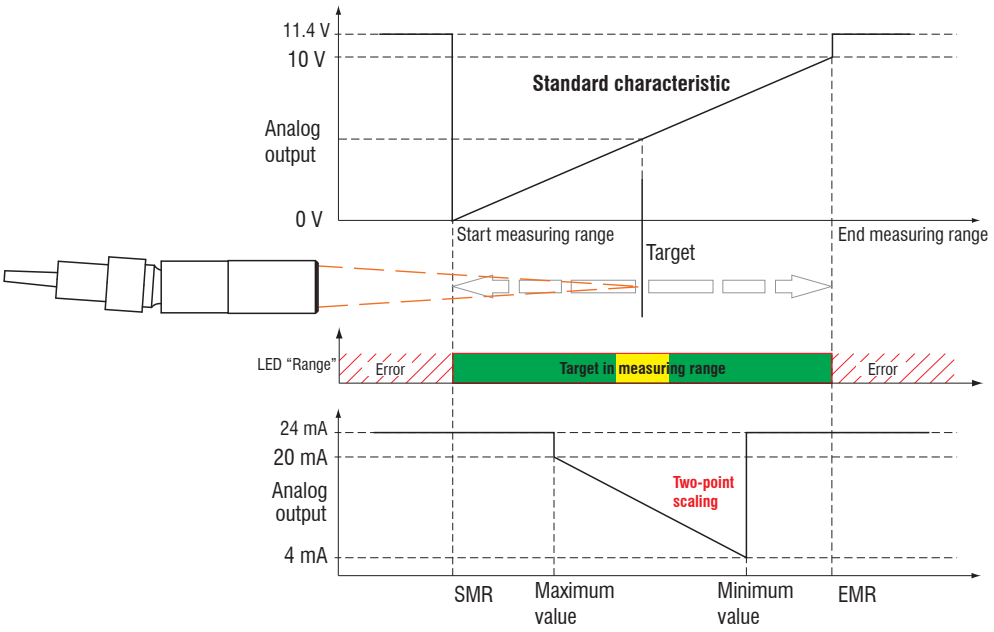


Fig. 6.23: Scaling of the analog signal

6.5.4.2 Calculation of the measured value from the current output

Current output (without mastering, without two-point scaling)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 4)}{16} * MR\ [mm]$
MR = Measuring range (thickness) in µm	{160[13] [14]	
d = Thickness in µm	[-0.01MR; 1.01MR]	

Current output (with two-point scaling)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\ [mm] = \frac{(I_{OUT}\ [mA] - 4)}{16} * \lvert n\ [mm] - m\ [mm] \rvert$
MR = Measuring range (thickness) in µm	{160[13] [14]	
m, n = Teach area in µm	[0; MR]	
d = Thickness in µm	[m; n]	

6.5.4.3 Calculation of the measured value from the voltage output

Voltage output (without mastering, without two-point scaling)		
Variables	**Value range**	**Formula**
V_{OUT} = voltage [V]	[-0.05; <0] SMR reserve [0; 5] Measuring range [>5; 5.05] EMR reserve	$d = \frac{V_{OUT}}{5} * MR$
	[-0.1; <0] SMR reserve [0; 10] Measuring range [>10; 10.1] EMR reserve	$d = \frac{V_{OUT}}{10} * MR$
MR = Measuring range thickness in µm	{160[13] [14]	
d = Thickness in µm	[-0.01*MR*; 1.01*MR*]	

[13] The measuring object must be within the operating range.

[14] Applies to an air gap measurement n~1. }

Current output (with two-point scaling)		
Variables	**Value range**	**Formula**
V_{OUT} = voltage [V]	[-0.05; <0] SMR reserve [0; 5] Measuring range [>5; 5.05] EMR reserve	$d = \frac{V_{OUT}}{5} * \lvert n - m \rvert$
	[-0.1; <0] SMR reserve [0; 10] Measuring range [>10; 10.1] EMR reserve	$d = \frac{V_{OUT}}{10} * \lvert n - m \rvert$
MR = Measuring range thickness in µm	{160[13] [14]	
m, n = Teach area in µm	[0; MR]	
d = Thickness in µm	[m; n]	

6.5.5 Switching Outputs, Limit Value Monitoring

Digital output 1 "Error 1" Digital output 2 "Error 2"	*01PEAK01*
Compare to	*lower / upper / both*
Min. limit value in mm	*value*
Max. limit value in mm	*value*
Switching level with error	*PNP / NPN / Push-Pull / Push-Pull negated*

Both switching outputs are activated if the target is located outside the measuring range.

Optionally, you can use the “Error 1” and “Error 2” switching outputs to monitor 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. Notes about switching behavior are available under Electrical Connections, see Chap. 4.4.

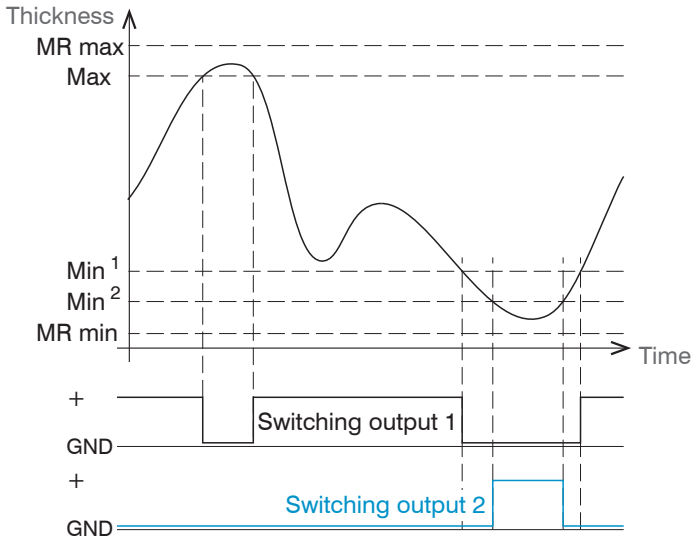


Fig. 6.24: Switching output 1 (both, NPN) and switching output 2 (bottom, PNP) with limit values

Range limits -21.47 ... +21.47
Max = Maximum
Min [1] = Minimum switching output 1
Min [2] = Minimum switching output 2
MR = measuring range, minimum and maximum

6.5.6 Data output, interface selection

The controller supports

- three digital interfaces that can be used in parallel for data output,
  - Ethernet: enables fast data transfer, but provides no real-time capabilities (packet-based data transfer). Both measurement and FFT data can be transferred. Data output via Ethernet is suitable for measuring value acquisition without direct process control, for subsequent analysis. Parameterization is carried out via the web interface or ASCII commands.

[13] The measuring object must be within the operating range.

[14] Applies to an air gap measurement n~1. }

- RS422: provides an interface capable of real-time output at a lower data rate.
- Switching/limit value output

- Analog output: outputs either voltage or current values.

► Switch to the `Settings > Outputs > Output interface` menu and select the desired output channels.

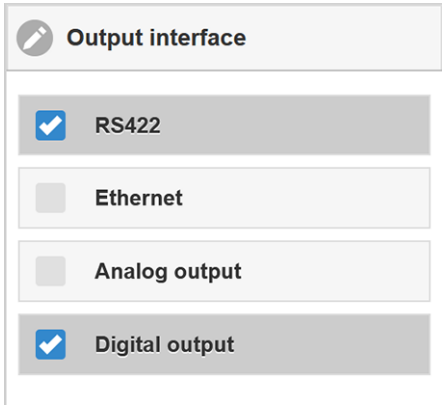


Fig. 6.25: Selecting the required interfaces for data output

6.5.7 Ethernet settings

Ethernet	IP settings of the basic device	*Static IP address / DHCP*	*Values for IP address / gateway / subnet mask. Only for static IP address*
	Ethernet measured value transfer settings	*Server TCP/IP* *Client TCP/IP* *Client UDP/IP*	*Value for the port*

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 controller is set at the factory to the static IP address 169.254.168.150.

The controller transmits the Ethernet packets at a transmission rate of 10 MBit/s or 100 MBit/s. The transmission rate is selected automatically depending on the connected network or PC.

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 bock.

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 explicit 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 thickness measurement values are transmitted as 32-bit signed integer values with a resolution of 10 pm.

Example: Output of the measured values 7835 = 7.853 * 10 $^{-5}$ mm.

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

6.6 System Settings

6.6.1 Web interface unit

Specifies the unit for display on the web page and for all input parameters related to units. You can select between mm and inches.

i Data output via Ethernet/analog output is not affected by this setting.

The web interface supports the unit 10^1 picometer when displaying measuring results.

6.6.2 Language Support

The web interface is available in German and English, among other languages. Switch the language in the menu bar.

The ASCII support is in English.

6.6.3 Keylock

The keylock prevents unauthorized or unintentional execution of the key functions. The keylock of the `Multifunction` button can be set individually.

Key lock	*Automatic*	value (1 ... 60 min)	*The button function will be blocked after a defined period of time has elapsed.*
	Active		*Keylock starts immediately.*
	Inactive		*No keylock*

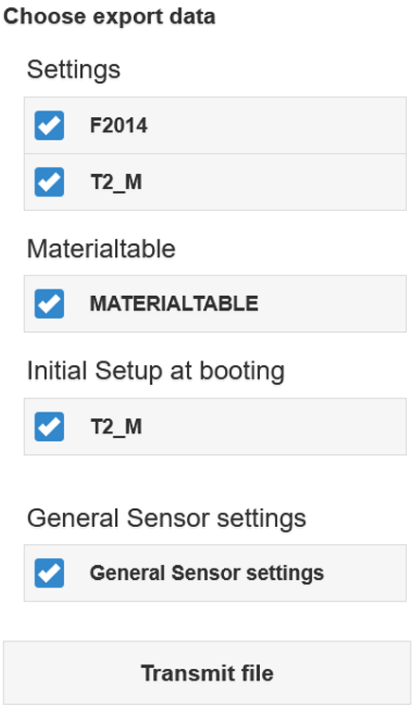
By default, the `Multifunction` button is not locked.

6.6.4 Load and save

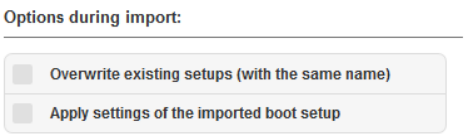
You can save device settings in the controller or activate saved settings. Details can be found in the section Load and save, see Chap. 5.9.

6.6.5 Import, export

A parameter set includes the current measurement and device settings (setups) and the initial setup during booting of the controller. The `Import & Export` menu allows you to easily exchange parameter sets with a PC/notebook.

Exchange of parameter sets with PC/notebook, possibilities		
Storing parameter set on PC		**Loading parameter set from PC**
`Import & Export` menu		`Import & Export` menu
Click on the button `Create a parameter set` with the left mouse button. The `Choose export data` dialog opens. Compose a parameter set by selecting/ deselecting the checkboxes. Click on the `Transmit file` button. A Windows dialog for data transfer opens. Confirm the dialog with `OK`. The operating system stores the parameter set in the `Download` area. The file name for the adjacent example is therefore `<...\Downloads\IMC5xxx_BASICSET-TINGS_MEASSETTINGS_... .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 parameter set` button. To do this, both the firmware version and the option number of the controller must match.

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



6.6.6 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. 6.5: Rights in the user hierarchy

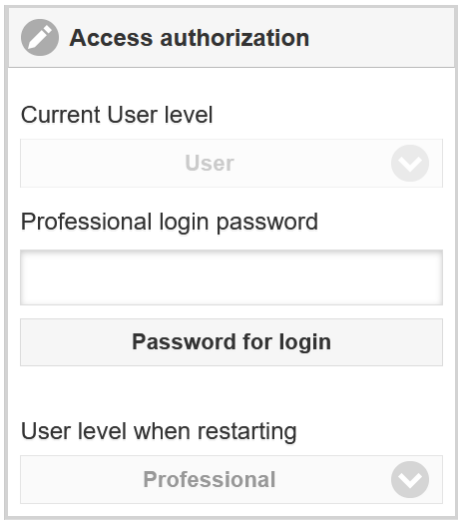


Fig. 6.26: Changing to Professional level

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.

6.6.7 Reset controller

You can reset individual settings to the factory setting in this menu area. This menu requires the Professional user level.

Measurement settings	*Resets the preset to Thickness measurement glass and all parameters (except interface settings) to the factory setting.*
Device settings	*Reset Ethernet interface to factory settings.*
Reset of the materials table	*Reset materials table to factory settings.*
Reset all	*Resets the device and measurement settings to factory settings.*
Reboot controller	*Starts the controller with the last saved settings*

6.6.8 Light source

You can switch the LED (light source) on or off.

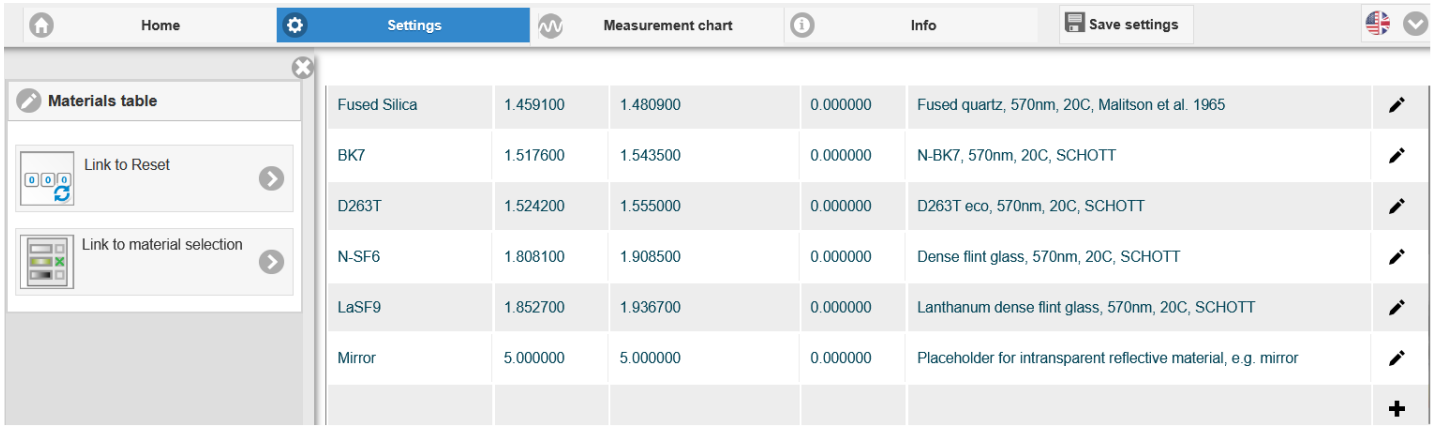
► Go to `Settings > System settings > Light source`.

Alternatively, you can assign the function to the `Multifunction` button on the controller and use it to switch the light source on or off.

6.6.9 Materials table

This menu item allows you to compare the settings of the listed materials or add a new material.

► Go to `Settings > System settings` and make the changes to the materials table.



The surface area of the following material is also required for calculating the distances and thicknesses.

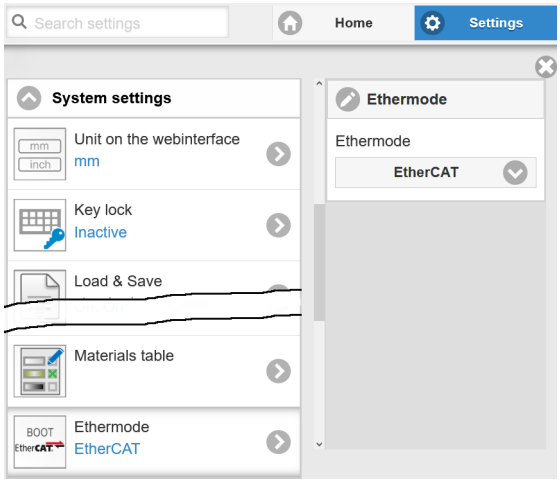
- ✎ Click the icon to change an existing entry.
- ✚ Click the icon to add another material.
- ✔ Click the icon to save another or changed material.
- ✖ Click the icon to cancel the operation without saving.
- ⦸ Click the icon to delete the entry.

6.6.10 Switching between Ethernet and EtherCAT

This setting defines the connection log when the controller is started. You can also switch between Ethernet and EtherCAT via an ASCII command or EtherCAT object.

Save the current settings before switching to EtherCAT.

► Switch to the `Settings > System settings` menu and select `EtherCAT` as the interface.



► Click on the `Save settings` button.

The switch becomes active only after the controller has been restarted. The web interface is not available in EtherCAT mode.

The RS422 interface for sending an ASCII command is available both in Ethernet mode and in EtherCAT mode.

7 Thickness measurement

7.1 Requirements

For one-sided thickness measurement of a transparent object, the controller evaluates the interference of the two reflected signals at the surfaces and thus determines the thickness.

- ► Align the sensor perpendicularly to the object to be measured. Make sure that the measuring object is close to the working distance.

i The light beam must strike the surface of the object at a perpendicular angle. Otherwise, measurements might be inaccurate.

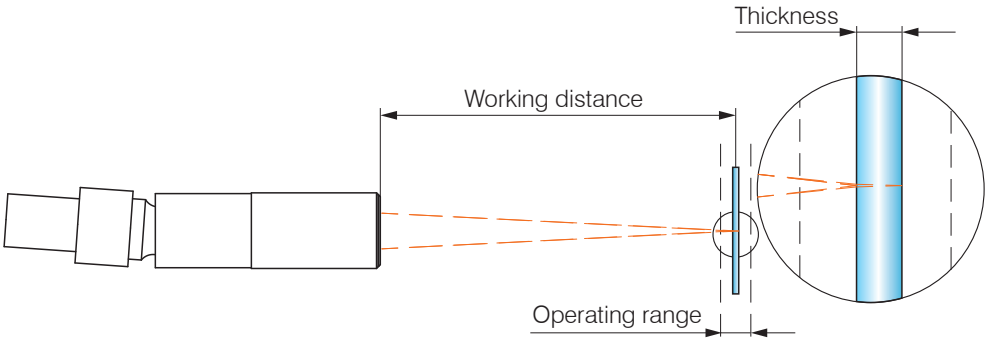


Fig. 7.1: One-sided thickness measurement on a transparent target

Minimum target thickness	1 µm (n = 1.5)
Maximum target thickness	100 µm (n = 1.5)
Minimum air thickness	1.5 µm
Maximum air thickness	150 µm

7.2 Selection of the sensor

Thickness measurement is only possible with sensors of the IMP-VIS-THxx series.

- ► Go to the `Settings > Sensor` menu.

7.3 Material selection

Specifying the material is essential for calculating a correct thickness value. For this, a phase index and group refractive index is required.

- ► Switch to the `Settings` > `Data recording` > `Material selection` menu.
- ► Select the material of the measurement object for `Layer 1` and any other layers.

7.4 FFT signal

If a surface of the target lies outside the measuring range, the controller will not provide any measurement value. This may also occur if a signal is below the detection threshold. Choose the detection threshold carefully.

Two boundary surfaces are active when the thickness of a transparent material is measured. However, only one peak is visible in the FFT signal.

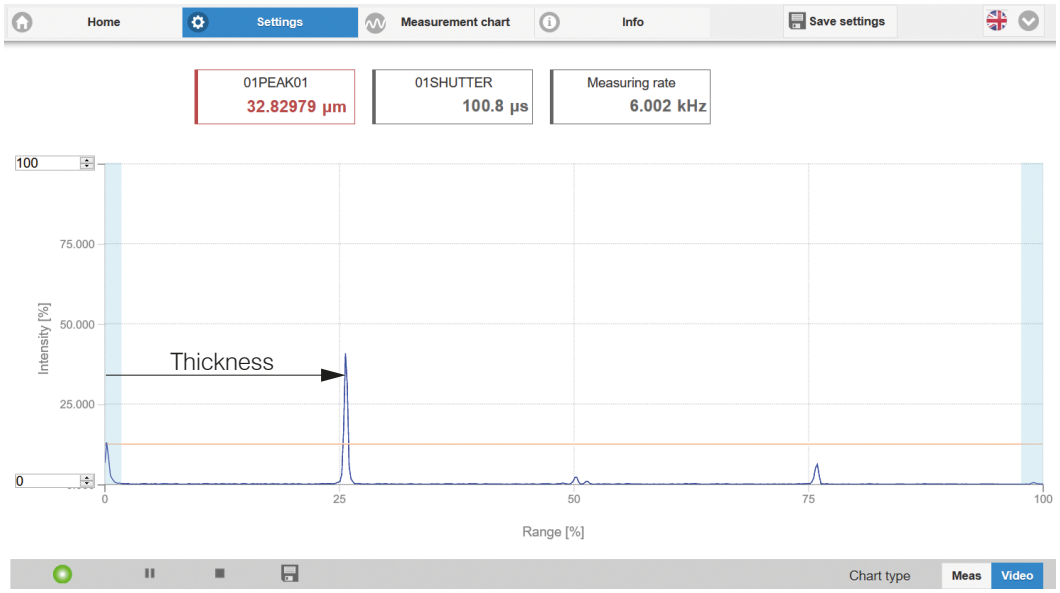


Fig. 7.2: Website FFT signal (thickness measurement)

- Switch to the `Measurement chart` tab and select `Mess` as the chart type.

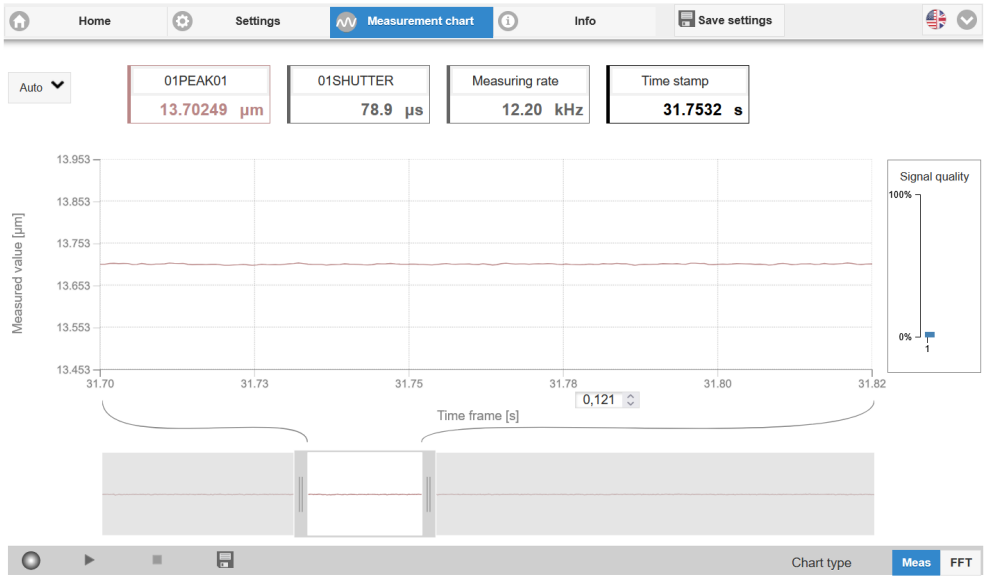


Fig. 7.3: Offline analysis of measured thickness results based on a one-sided thickness measurement

The thickness is displayed graphically and numerically on the web page.

8 Digital interface RS422

8.1 Measurement data format

8.1.1 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

8.1.2 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). This applies 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 frames were not transmitted between the current and the 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 frames 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.

The RS422 interface has a maximum baud rate of 4000 kBaud. The baud rate is set to 115.2 kBaud when the interface is delivered. Use ASCII commands or the web interface to configure.

The transmission settings of the controller and of the PC must match.

Data format: Binary. Interface parameters: 8 data bits, no parity, 1 stop bit (8N1). Selectable baud rate.

The maximum number of measured values that can be transmitted for a measuring point depends on the measuring rate of the controller and the transmission rate set for the RS422 interface. Use the maximum available transmission rate (baud rate) where possible.

Measurement data can be output via Ethernet and RS422 and Ethernet in parallel.

8.1.3 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

8.2 Output values, scaling

Signal name	min	max	scale	Unit
01ABS (2048 x 16Bit)	0	2047	Value / 2048 * 100	%
01SHUTTER	1	400000	Value / 40	µs
01ENCODER1	0	UINT32_MAX	Value	Encoder ticks
01ENCODER2	0	UINT32_MAX	Value	Encoder ticks
01ENCODER3	0	UINT32_MAX	Value	Encoder ticks
01AMOUNT[01..16]	0	UINT32_MAX	(value & 0xfffff) / 2048* // intensity value >>20 // Pixel of the center of gravity	% Pixels
MEASRATE	1666	400000	40000 / value	kHz
TIMESTAMP	0	UINT32_MAX	Value	µs

Signal name	min	max	scale	Unit
COUNTER	0	UINT32_MAX	Value	
STATE	0	UINT32_MAX	• Bit 0: Encoder 2 track index status • Bit 1: Encoder status 2 track B • Bit 2: Encoder status 2 track A • Bit 3: Encoder 1 track index status • Bit 4: Encoder status 1 track B • Bit 5: Encoder status 1 track A • Bit 7: TriggerIn status • Bit 8: Switching output 1 active • Bit 9: Status switching output 1 • Bit 10: Switching output 2 active • Bit 11: Status switching output 2 • Bit 12: Sync/Trig active • Bit 13: Status Sync/Trig • Bit 15: Triggered frame • Bit 16, 17: Intensity LED ◦ 00 - off ◦ 01 - green ◦ 10 - red ◦ 11 - yellow • Bit 18, 19: Range LED ◦ 00 - off ◦ 01 - green ◦ 10 - red ◦ 11 - yellow • Bit 20, 21: LED LED ◦ 00 - off ◦ 01 - green ◦ 10 - red ◦ 11 - yellow • Bit 24, 25: State LED ◦ 00 - off ◦ 01 - green ◦ 10 - red ◦ 11 - yellow • Bit 26: EtherCAT IN Link LED • Bit 27: EtherCAT IN Speed LED • Bit 28: Ethernet Link LED • Bit 29: Ethernet Speed LED	
01PEAK[01..16]	INT32_MIN	0x7ffffeff	Value / 1000000000 • 0x7fffff04 There is no peak present • 0x7fffff05 Peak is located in front of the measuring range (MR) • 0x7fffff06 Peak is located after the measuring range (MR) • 0x7fffff07 Measured value cannot be calculated • 0x7fffff08 Measurement value cannot be evaluated • 0x7fffff0E Hardware error	mm
USERNAMED VALUES	INT32_MIN	0x7ffffeff	as 01PEAK[01..16]	mm

9 Ethernet interface

9.1 Transmission of measured data to a measurement server via Ethernet

During the transmission of measured value data to a measurement server, the 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.

All distances and additional information intended for transmission that were captured at a certain time are consolidated into a measurement frame. Several measured value frames are consolidated into a measured value block, which is given a header and fits into a TCP/IP or UDP/IP packet. The header must be located at the start of a UDP or TCP packet. In the event of changes to the transmitted data or the frame rate, a new header is sent automatically.

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

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

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

Example: The data for Encoder 2, Thickness value, and Counter are transferred.

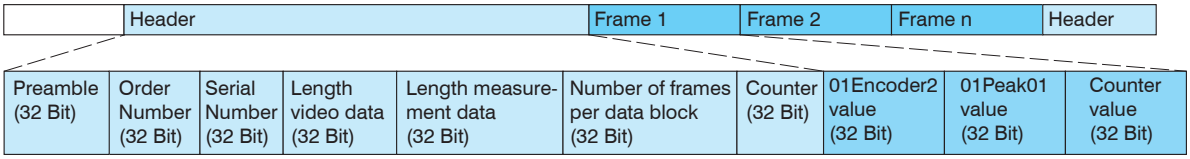


Fig. 9.1: interferometer Example Data Frame Ethernet 157x20 cmyk AI

9.2 Output values, scaling

Signal name	min	max	scale	Unit
01ABS (2048 x 16Bit)	0	2047	Value / 2048 * 100	%
01SHUTTER	1	400000	Value / 40	µs
01ENCODER1	0	UINT32_MAX	Value	Encoder ticks
01ENCODER2	0	UINT32_MAX	Value	Encoder ticks
01ENCODER3	0	UINT32_MAX	Value	Encoder ticks
01AMOUNT[01..16]	0	UINT32_MAX	(value & 0xfffff) / 2048* // intensity value >>20 // Pixel of the center of gravity	% Pixels
MEASRATE	1666	400000	40000 / value	kHz
TIMESTAMP	0	UINT32_MAX	Value	µs

Signal name	min	max	scale	Unit
COUNTER	0	UINT32_MAX	Value	
STATE	0	UINT32_MAX	• Bit 0: Encoder 2 track index status • Bit 1: Encoder status 2 track B • Bit 2: Encoder status 2 track A • Bit 3: Encoder 1 track index status • Bit 4: Encoder status 1 track B • Bit 5: Encoder status 1 track A • Bit 7: TriggerIn status • Bit 8: Switching output 1 active • Bit 9: Status switching output 1 • Bit 10: Switching output 2 active • Bit 11: Status switching output 2 • Bit 12: Sync/Trig active • Bit 13: Status Sync/Trig • Bit 15: Triggered frame • Bit 16, 17: Intensity LED ○ 00 - off ○ 01 - green ○ 10 - red ○ 11 - yellow • Bit 18, 19: Range LED ○ 00 - off ○ 01 - green ○ 10 - red ○ 11 - yellow • Bit 20, 21: LED LED ○ 00 - off ○ 01 - green ○ 10 - red ○ 11 - yellow • Bit 24, 25: State LED ○ 00 - off ○ 01 - green ○ 10 - red ○ 11 - yellow • Bit 26: EtherCAT IN Link LED • Bit 27: EtherCAT IN Speed LED • Bit 28: Ethernet Link LED • Bit 29: Ethernet Speed LED	
01PEAK[01..16]	INT32_MIN	0x7ffffeff	Value / 1000000000 • 0x7fffff04 There is no peak present • 0x7fffff05 Peak is located in front of the measuring range (MR) • 0x7fffff06 Peak is located after the measuring range (MR) • 0x7fffff07 Measured value cannot be calculated • 0x7fffff08 Measurement value cannot be evaluated • 0x7fffff0E Hardware error	mm
USERNAMED VALUES	INT32_MIN	0x7ffffeff	as 01PEAK[01..16]	mm

10 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/.

11 Service, repair

If the sensor, controller or sensor cable is defective:

- If possible, save the current sensor settings in a parameter set to reload them into the controller 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 measuring system to:

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

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

12 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.

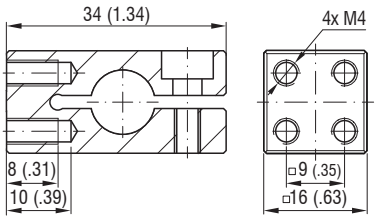
- Old devices can also be returned for disposal to Micro-Epsilon at the address given in the legal details at https://www.micro-epsilon.com/legal-details.

- 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.

13 Accessories, Services

Mounting adapter

MA5400-10		Mounting adapter for IMP-TH sensors

Other accessories

SC2471-3/IF2008ETH		Connection cable between controller and IF2008/ETH, length 3 m
SC2471-x/IF2008		Connection cable between controller and IF2008/PCIE or IF2004/USB, length 3 m or 10 m
SC2471-x/RS422/OE		Interface cable for IF2035 interface, length 3 m or 10 m
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
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
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)
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.
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

14 Factory settings

User group: Professional, password: "000"
Data output: web interface
RS422: 115.2 KBaud
Trigger mode: no trigger
Language: de
Synchronization: no synchronization
Key function 1: LED on/off

Measurement averaging: median, 3 values
Error handling: Error output, no measurement value
Ethernet: static IP, 169.254.168.150
Measuring rate: 1 kHz
Unit on the web interface: µm
Data reduction: no
Key function 2: Inactive

You can find an overview of all parameters in the `Info > System overview` menu.

Preset: Thickness measurement glass

15 ASCII communication with controller

15.1 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.

15.2 Commands overview

Group	Command	Brief information
General		
	HELP	Help
	GETINFO	Controller information
	ECHO	Reply type
	PRINT	Parameter overview
	SYNC	Synchronization
	TERMINATION	Termination resistor
	RESET	Boot sensor
	RESETCNT	Reset counter
User level		
	LOGIN	Change user level
	LOGOUT	Change to User level
	GETUSERLEVEL	User level query
	STDUSER	Set standard user
	PASSWD	Change password
Sensor		
	SENSORTABLE	Display of available sensors, linearization tables
	SENSORHEAD	Selection of the sensor
	SENSORINFO	Information on sensor
	LED	LED status
Triggering		

Group	Command	Brief information
	TRIGGERSOURCE	Trigger source
	TRIGGERAT	Effect of trigger input
	TRIGGERMODE	Trigger type
	TRIGGERLEVEL	Active level of trigger input
	TRIGGERSW	Generate a software trigger pulse
	TRIGGERCOUNT	Number of measured values to be output
	TRIGINLEVEL	Level for the TrigIn (TTL / HTL)
	TRIGGERENCMAX	Maximum encoder triggering
	TRIGGERENCMIN	Minimum encoder triggering
	TRIGGERENCSTEPSIZE	Step size encoder triggering
Encoder		
	ENCINTERPOLn	Set interpolation depth
	ENCREFn	Set reference track
	ENCVALUEn	Encoder value setting
	ENCSET	Set encoder value
	ENCRESET	Reset encoder value
	ENCMAXn	Set maximum encoder value
	ENCODER3	Encoder3 on/off
Interfaces		
	IPCONFIG	Ethernet settings
	MEASTRANSFER	Set the measurement server
	BAUDRATE	RS422 setting
	ETHERMODE	Switch Ethernet EtherCAT
	MEASCNT_ETH	Measurements per frame
	TCPKEEPALIVE	TCP on/off
Parameter management, load/save settings		
	BASICSETTINGS	Load connection settings
	CHANGESETTINGS	Show changed parameters
	EXPORT	Export parameter sets
	IMPORT command	Import parameter sets
	SETDEFAULT	Set factory settings
	MEASSETTINGS	Edit measurement settings
Measurement		
	MEASRATE	Measurement frequency
	ROI	Mask the region of interest (ROI)
	MIN_THRESHOLD	Minimum threshold peak detection
	CRITVAL	Read or update Critval value
	PEAKCOUNT	Number of Peaks
	MEASPEAK_SORT	Sorting of peaks
Materials database		

Group	Command	Brief information
	MATERIALTABLE	Materials table
	MATERIAL	Select material
	MATERIALINFO	Show material property
	MATERIALEDIT	Edit materials table
	MATERIALADD	Add material
	MATERIALMP	Determine material composition of target
	MATERIAL_INFRONT	Determine material or medium in front of the measuring object
	MATERIALDELETE	Delete material
	META_MATERIAL	Existing materials, material names
	META_MATERIAL_PROTECTED	Protected materials
Edit measured value		
	META_STATISTICSIGNAL	List of possible statistics signals
	STATISTICSIGNAL	Selection of statistics signal
	META_STATISTIC	List of all active statistics signals
	STATISTIC	Selection of statistics signal
	META_MASTERSIGNAL	List of possible signals to be parameterized
	MASTERSIGNAL	Parameterization of master signals
	META_MASTER	List of possible signals for mastering
	MASTER	Trigger mastering
	COMP	Calculation in channel
	META_COMP	List of possible calculation signals
Data output		
	OUTPUT	Digital output selection
	OUTREDUCEDEVICE	Output data rate
	OUTREDUCECOUNT	Reduction counter
	OUTHOLD	Error handling
Selection of measured values to be output via interfaces		
	OUT_ETH	Data selection for Ethernet
	META_OUT_ETH	List of possible signals Ethernet
	GETOUTINFO_ETH	List of selected signals, sequence via Ethernet
	GETOUTINFO_RS422	List of selected signals, sequence via RS422
	META_OUT_RS422	List of possible signals RS422
	OUT_RS422	Data selection for RS422
Switching outputs		
	ERROROUTn	Error switching output
	ERRORLIMITSIGNALn	Set signal to be evaluated
	META_ERRORLIMITSIGNAL	List of possible signals for error output
	ERRORLIMITCOMPARETOn	Set limit values
	ERRORLIMITVALUESn	Set value
	ERRORLEVELOUTn	Switching behavior of error outputs
Analog output		
	ANALOGOUT	Data selection for analog output
	META_ANALOGOUT	List of possible signals for analog output
	ANALOGRANGE	Set current/voltage range of the digital-to-analog converter (DAC)
	ANALOGSCALEMODE	Set scaling for DAC
	ANALOGSCALERANGE	Set scaling range

Group	Command	Brief information
System settings for key functions		
	KEYFUNC1	Activation of the Multifunction button
	KEYMASTERSIGNALSELECT	Signal selection
	KEYLOCK	Selection of the keylock

15.3 General commands

15.3.1 General

15.3.1.1 Help

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

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

15.3.1.2 Controller information

```
GETINFO
```

Request sensor information. Output see example below:

```
->GETINFO
Name:              IMC5200
Serial:            7241xxxxx
Option:            000
Article:           7311024
MAC-Address:       00-0C-12-01-B4-CE
Version:           009.005.034
Hardware-rev:      01
Boot-version:      004.003
BuildID:           136
Timestamp:         20250214_105301
```

Name:	Model name of controller / controller series
Serial:	Controller serial number
Option:	Controller option number
Article:	Controller article number
MAC address:	Address of network adapter
Version:	Version of the booted software
Hardware-rev:	Hardware revision used
Boot version:	Bootloader version
BuildID:	Identification number for generated software

15.3.1.3 Reply type

```
ECHO ON | OFF
```

The reply type describes the structure of a command reply.

ECHO ON:	The command name and the command reply or an error message is output.
ECHO OFF:	Only the command reply or an error message is returned.

15.3.1.4 Parameter overview

```
PRINT ALL
```

without parameters:	This command outputs a list of all setting parameters and their values.
ALL :	This command outputs a list of all setting parameters and their values, as well as information such as, e.g., the sensor table or GETINFO.

15.3.1.5 Synchronization

```
SYNC NONE | MASTER | SLAVE_SYNTRIG | SLAVE_TRIGIN
```

Set synchronization type:

- NONE: No synchronization
- MASTER: Controller is master, i.e., it outputs synchronization pulses at the Sync/Trig output
- SLAVE_SYNTRIG: With this setting, the controller is the slave and waits for synchronization impulses, e.g., from another controller or similar impulse source, at the Sync/Trig input.
- SLAVE_TRIGIN: Controller is slave and waits for synchronization pulses from a frequency generator at the TrigIn input.

Input	Behavior
Sync/Trig	Differential
TrigIn	TTL / HTL

Sync/Trig is alternatively an input or an output, i.e. it must be ensured that one of the controllers is always set to master and the others to slave.

The TrigIn input also serves as a trigger input for the trigger types edge and level triggering.

Command is mapped in the SDO 0x35B1.

15.3.1.6 Termination resistor at Sync/Trig

```
TERMINATION OFF | ON
```

Switching a terminating resistor into the synchronization line.

The terminating resistor at the Sync/Trig synchronization input is switched on or off to avoid reflections.

`OFF`: No terminating resistor

`ON`: With terminating resistor

15.3.1.7 Boot sensor

```
RESET
```

The controller is restarted.

15.3.1.8 Reset counter

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

The counter is reset after the selected trigger edge occurs.

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

15.3.2 User level

15.3.2.1 Change user level

```
LOGIN <Password>
```

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

- USER: Read access to all elements + use of web diagrams
- PROFESSIONAL: Read/write access to all elements

15.3.2.2 Switch to user level

```
LOGOUT
```

Set user level to USER.

15.3.2.3 User level query

```
GETUSERLEVEL
```

Queries the current user level.

Possible outputs, see Chap. 15.3.2.1, “Change User Level”.

15.3.2.4 Set standard user

```
STDUSER USER|PROFESSIONAL
```

Sets the standard user who is logged in after the system starts.

15.3.2.5 Change password

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

Change the password for the PROFESSIONAL user. The factory standard password is “000”.

For this, the old password must be entered and the new password must be entered twice. If the new passwords do not match, an error message will be output. The password function is case-sensitive. A password may only contain the letters A to Z and numbers without umlauts/special characters. The maximum length is limited to 31 characters.

15.3.3 Sensor

15.3.3.1 Information on linearization tables

```
SENSORTABLE
```

Output of all available sensors that have been taught in.

15.3.3.2 Sensor number

```
SENSORHEAD [<number>]
```

Selection of the current sensor based on its position in the sensor table.

15.3.3.3 Sensor information

```
SENSORINFO
```

Output of information about the sensor (name, measuring range and serial number).

```
->SENSORINFO
Position:                1
Sensor name:             IMP-VIS-TH26
Measurement range:       0.160 mm
Serial number:           12345678

Sensor Type:             Thickness
->
```

15.3.3.4 LED

```
LED [ON | OFF]
```

Indicates the current status of the LED, or switches the LED on or off.

15.3.4 Triggering

15.3.4.1 Trigger source

```
TRIGGERSOURCE [NONE | SYNCTRIG | TRIGIN | SOFTWARE | ENCODER1 | ENCODER2 | ENCODER3]
```

The trigger source triggers the triggering process.

- `NONE`: No trigger source used
- `SYNCTRIG`: Use input `Sync/Trig`
- `TRIGIN`: Use the input `TrigIn`
- `SOFTWARE`: Triggering is initiated by the command `TRIGGERSW`.
- `ENCODER1`/`ENCODER2`: Encoder triggering of encoder 1
- `ENCODER3`: Triggered by encoder3 (ENCODER3 must be switched on)

15.3.4.2 Output of triggered values, with/without averaging

`TRIGGERAT INPUT | OUTPUT`

- INPUT: Triggers data acquisition. Values measured immediately before the trigger event are not included in the average value calculation, but older measured values that were output during previous trigger events are included instead.
- OUTPUT: Triggers measured value output. Values measured immediately before the trigger event are included in the average value calculation.

15.3.4.3 Trigger type

`TRIGGERMODE EDGE | PULSE`

Selection of trigger type. Only enabled if `TRIGGERSOURCE` has been set to `SYNC` or `TRIGIN`.

- `PULSE`: Level triggering
- `EDGE`: Edge triggering

15.3.4.4 Active level of trigger input

`TRIGGERLEVEL HIGH | LOW`

- `HIGH`: Edge triggering: Rising edge, level triggering: High active
- `LOW`: Edge triggering: Falling edge, level triggering: Low active

15.3.4.5 Software trigger pulse

`TRIGGERSW`

Generates a software trigger pulse when the trigger source is set to software. At low measuring rates < 2.4 kHz and selected FFT signal, unreliable trigger information may occur.

15.3.4.6 Number of measurement values to be output

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

- `NONE`: Stop triggering
- `<n>`: Number of measured values to be output after a trigger pulse (with edge triggering or software triggering)
- `Infinite`: Start of an infinite measured value output after a trigger pulse (with edge triggering or software triggering)

15.3.4.7 Level selection trigger input TrigIn

`TRIGINLEVEL TTL | HTL`

The level selection only applies to the input `TrigIn`. The input `Sync/Trig` waits for a differential signal.

- `TTL`: Input waits for TTL signal.
- `HTL`: Input waits for HTL signal.

15.3.4.8 Maximale encoder triggering

`TRIGGERENCMAX [maximum value]`

Set maximum encoder value for triggering.

The value can be between 0 and 2^32-1.

15.3.4.9 Minimum encoder triggering

```
TRIGGERENCMIN [<minimum_value>]
```

Set minimum encoder value for triggering.

The value can be between 0 and 2^32-1.

15.3.4.10 Increment encoder triggering

```
TRIGGERENCSTEPSIZE [<value_of_step_size>]
```

Set step size between triggering events.

If the value is set to 0 and the encoder value is between minimum and maximum, all values are output. The value can be between 0 and 2^32-1.

15.3.4.11 Example

An encoder should cause triggering in the controller. For this purpose, the commands below were sent to the encoder:

TRIGGERENCMIN 5

TRIGGERENCMAX 35

TRIGGERSTEPSIZE 10

Result: The encoder starts triggering at counters 10, 20 and 30.

15.3.5 Encoder

15.3.5.1 Encoder interpolation depth

```
ENCINTERPOL1 1 | 2 | 4
ENCINTERPOL2 1 | 2 | 4
ENCINTERPOL3 1 | 2 | 4
```

Sets the interpolation depth of the respective encoder input.

15.3.5.2 Effect of reference track

```
ENCREF1 [NONE | ONE | EVER]
ENCREF2 [NONE | ONE | EVER]
```

Sets the effect of the encoder reference track.

- `NONE`: Reference mark of the encoder has no effect.
- `ONE`: One-time setting (the first time the reference marker is reached, the encoder value will be adopted).
- `EVER`: Setting for all markers (every time the reference marker is reached, the encoder value will be adopted).

15.3.5.3 Encoder value

```
ENCVALUE1 [<encoder value>]
ENCVALUE2 [<encoder value>]
ENCVALUE3 [<encoder value>]
```

Indicates the value which the corresponding encoder should be set to when a reference marker is reached (or via software).

The encoder value can be between 0 and 2^32-1.

Setting the `ENCVALUE` automatically resets the algorithm for recognizing the first reference marker.

15.3.5.4 Set encoder value via software

```
ENCSET 1 | 2 | 3
```

Set the encoder value, in the specified encoder via software (only possible with `ENCREF NONE` , otherwise the command immediately returns without an error message).

15.3.5.5 Reset detection of first reference marker

```
ENCRESET 1 | 2
```

Reset the detection of the first reference mark (only possible with `ENCREF ONE`, otherwise the command returns immediately without an error message).

15.3.5.6 Maximum encoder value

```
ENCMAX1 <encoder value>
ENCMAX2 <encoder value>
ENCMAX3 <encoder value>
```

Indicates the maximum value of the encoder after which the encoder jumps back to 0. Can be used for rotary encoders without reference track. Can be used for rotary encoders without a reference track, for example.

The encoder value can be between 0 and 2^{32}-1.

15.3.5.7 Encoder3 On/Off

```
ENCODER3 [ON | OFF]
```

If `Encoder3` is switched on, `ENCREF1` and `ENCREF2` are set to `NONE`.

15.3.6 Interfaces

15.3.6.1 Ethernet IP settings

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

Setting of the Ethernet interface.

- `DHCP`: IP address and gateway are automatically queried via DHCP. If no DHCP server is available, a link-local address is searched for after approx. 2 minutes.
- `STATIC`: Sets an IP address, the net mask and the gateway in the format xxx.xxx.xxx.xxx

If the IP address, netmask and/or gateway are not specified, their values remain unchanged.

15.3.6.2 Setting for Ethernet measurement value transmission

```
MEASTRANSFER [NONE | SERVER/TCP [<PORT>]|(CLIENT/TCP | CLIENT/UDP [<IP> [<Port>]])]
```

The controller can be operated as a server and client for measured value output via Ethernet.

- `NONE`: No measured values are transmitted via Ethernet.
- `SERVER/TCP`: The controller provides a server at the specified port via which measured values can be called. This is only possible via TCP/IP.
- `CLIENT/TCP`: The controller sends connection-oriented measured values to the specified server via TCP/IP. The IP address and port of the server must be specified, see Chap. 15.3.11.1.
- `CLIENT/UDP`: The controller sends measured values to the specified server without a connection via UDP/IP. Specifying the server's IP address and port is required.
- `IP`: IP address of the server to which the measured values are sent in client mode
- `Port`: Port on which the server is created in server mode or to which the measured values are sent in client mode (min: 1024, max: 65535).

15.3.6.3 Setting the RS422 baud rate

```
BAUDRATE <Baudrate>
```

Baud rates can be set in Bps for the RS422 interface:

9600, 115200, 230400, 460800, 691200, 921600, 2000000, 3000000, 4000000

15.3.6.4 Switching Ethernet / EtherCAT

`ETHERMODE [ETHERNET | ETHERCAT]`

Selection of whether the controller starts in Ethernet or EtherCAT mode.

The setting only becomes active after saving and restarting the controller.

15.3.6.5 Measurements per frame

`MEASCNT_ETH [0 | <count>]`

Set the maximum frame number per packet for transmission of measurements via Ethernet.

0: Automatic assignment of the frame number per packet

`count`: Maximum number of frames per packet (0 ... 350)

15.3.6.6 TCP On/Off

`TCPKEEPALIVE [ON|OFF]`

The parameter can have the following states:

- `ON`: Enables the function “tcp keep alive”
- `OFF`: Disables the use of “cp keep alive”

15.3.7 Parameter management, load/save settings

15.3.7.1 Load / save connection settings

`BASICSETTINGS READ | STORE`

- `READ`: Reads the connection settings from the controller flash.
- `STORE`: Saves the current connection settings from the controller RAM to the controller flash.

15.3.7.2 Show changed parameters

`CHANGESETTINGS`

Outputs all changed settings.

15.3.7.3 Export parameter sets to PC

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

Exporting the sensor settings.

- `MEASSETTINGS`: Only transmits measurement settings with the name <SettingName>.
- `BASICSETTINGS`: Only device settings are transmitted.
- `MEASSETTINGS_ALL`: All measurement settings are transmitted.
- `ALL`: All device and measurement settings are transmitted.

15.3.7.4 Import parameter sets from PC

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

Loads parameters from an external device, e.g. PC.

The import file is a JSON file previously saved with export.

- `FORCE`: Overwriting `Meassettings` with the same name, otherwise an error message is returned when the name is the same. When importing Meassettings or Basicsettings, Force must always be specified.
- `APPLY`: Apply the settings after importing and reading the initial settings.
- `ImportData`: Data in JSON format

15.3.7.5 Factory settings

`SETDEFAULT ALL | MEASSETTINGS | BASICSETTINGS | MATERIAL`

Set the default values (reset to factory settings), delete the corresponding settings in the flash.

- `ALL`: All setups are deleted and the default parameters are loaded. The current materials table is also overwritten by the standard materials table.
- `MEASSETTINGS`: Deletes all measurement settings
- `BASICSETTINGS`: Deletes all basic settings
- `MATERIAL`: Only overwrite the current materials table with the standard materials table.

15.3.7.6 Editing, storing, displaying, deleting measurement settings

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

Settings for measurement task. Moves application-dependent measurement settings between controller RAM and controller flash. Either the manufacturer-specific presets or the user-defined settings are used. Each preset can be used as a user-defined setting.

Subcommands:

`PRESETMODE <mode>`	Defines the preset dynamics.
`<mode> = NONE|STATIC|BALANCED|DYNAMIC`	With NONE, there is no selection for a preset.
`PRESETLIST`	Lists all existing presets (names): “Name1” “Name2” “…”
`READ <Name>`	Loads a basic setting or measurement setting/preset (specify name) from the controller flash.
`STORE <Name>`	Stores a basic setting or a measurement setting in the controller Flash. Enter name or it will be saved under the current name.
`DELETE <Name>`	Deletes the named measurement setting from the controller flash.
`RENAME <NameOld> <NameNew> [FORCE]`	Changes the name of a measurement setting in the controller flash. An existing measurement setting can be overwritten with FORCE.
`LIST`	Lists all stored measurement settings (names) "Name1" "Name2" "…". The order is based on the internal slot numbers, that is, not the order of saving.
`CURRENT`	Outputs the current measurement setting / preset (name)
`INITIAL AUTO`	When starting the controller, the settings which were saved last or the first preset are loaded if no setups exist.
`INITIAL <Name>`	Loads a named measurement setting upon starting the controller. Presets cannot be indicated.

15.3.8 Measurement

15.3.8.1 Measuring rate

```
MEASRATE <measuring rate>
```

Input of the measuring rate in kHz, value range 0.100 ... 24.000.

A maximum of three decimal places can be specified, e.g. 0.100 for 0.1 kHz.

15.3.8.2 Region of interest (ROI)

```
ROI <Start> <End>
```

Sets the "Region of interest" for the respective channel. Start and end must be between 0 and 2047. The entry is made in the unit pixels. The start value must be less than the end value.

15.3.8.3 Minimum threshold peak detection

```
MIN_THRESHOLD [<n>]
```

Sets the minimum detection threshold. A peak must be above this threshold for it to be recognized as peak.

It is entered in % and must be between 0.5 and 100. Precision can be specified with one decimal place.

15.3.8.4 Critval function

```
CRITVAL [<value> | DEFAULT]
```

Display or adjust critical value. Helps to detect a thickness peak and depends on the sensor used.

This dependency also applies to the standard determination of the default value based on the calibration data. If a value is set, this is used.

To deactivate the Critval function, the value must be set to 0. To reset the value to the value of the calibration data, it must be set to default.

Value range: 0 ... 1048573

Default: resets the value to the value of the calibration data

15.3.8.5 Number of Peaks

This command is only valid for the IMS5200 MP.

```
PEAKCOUNT [<Value>]
```

Determines or lists the number of peaks of the FFT signal used for evaluation in thickness measurements.

- `Value`: Specify number with 1 to max. 14 peaks

15.3.8.6 Sorting of peaks

```
MEASPEAK_SORT [HEIGHT | DISTANCE ]
```

Selection of the sorting of the peaks.

15.3.9 Materials database

15.3.9.1 Materials table

```
MATERIALTABLE
```

Output of the materials table saved in the controller.

```
-> MATERIALTABLE
Material,    n_group,    Description
„Vacuum“,    1.000000,   „Perfect vacuum“
„Water“,     1.363000,   „liquid water (H20) at 25C“
„Acrylic“,   14.97500,   „acrylic resin, adhesive, lacquer“
```

- `Name`: Material name
- `group index`: Group refractory index of the material
- `Description`: Brief description of the material

15.3.9.2 Select material

```
MATERIAL [<Material Name>]
```

for IMS5200 MP:

```
MATERIAL [<Material Name1> [<Material Name2> ... [<Material Name14>]]]
```

Selecting the material to be used for the thickness peak (thickness sensor).

The command supports case sensitive input.

15.3.9.3 Show material property

```
MATERIALINFO
```

Output of the material properties of the selected layer.

```
->MATERIALINFO
Name:                   Vacuum
group index:            1.000000
Description:            vacuum, air (approximately)
->
```

15.3.9.4 Edit materials table

`MATERIALEDIT <Material> <Phase_Index> <Group_Index> <Phase_Shift> <Description>`

Editing an existing material.

- `Material`: The name must start with an alphanumeric character and be between 2 and max. 31 characters long. Character range a-zA-Z0-9 ()-_.
- `Phase_Index`: The value range for the refractive index is between +1.000000 and +10.000000.
- `Group_Index`: The value range for the group break index is between +1.000000 and +10.000000.
- `Phase_Shift`: The value range for the phase index is between -3.141592 to +3.141592.
- `Description`: The description must start with an alphanumeric character and be between 2 and max. 63 characters long. Character range a-zA-Z0-9 (),;.:-_/.

The material table can include no more than 20 materials.

15.3.9.5 Add material

`MATERIALADD <Material> <Phase_Index> <Group_Index> <Phase_Shift> <Description>`

Adds a material.

- `Material`: The name must start with an alphanumeric character and be between 2 and max. 31 characters long. Character range a-zA-Z0-9 ()-_.
- `Phase_Index`: The value range for the refractive index is between +1.000000 and +10.000000.
- `Group_Index`: The value range for the group break index is between +1.000000 and +10.000000.
- `Phase_Shift`: The value range for the phase index is between -3.141592 to +3.141592.
- `Description`: The description must start with an alphanumeric character and be between 2 and max. 63 characters long. Character range a-zA-Z0-9 (),;.:-_/.

15.3.9.6 Determining the material composition of the target

This command is only valid for the IMS5200 MP.

`MATERIALMP [<Material Name 1> [<Material Name 2> ... [<Material Name 13 [<Material Name 14>]]]]`

Determines the layer composition of a target.

- `Material Name 1`: close to sensor
- `Material Name 14`: far from sensor

15.3.9.7 Defining a Medium in Front of the Target

`MATERIAL_INFRONT [<Name>]`

Defines or lists the medium between the sensor and the first layer of the target.

- Name: Name of the material or medium used, see Chap. 15.3.9.1.

15.3.9.8 Delete a material

`MATERIALDELETE <Name>`

Deletes a material.

- Name: Name of the material (length: max. 30 characters)

15.3.9.9 Existing material in controller

`META_MATERIAL`

Lists the material names already saved in the controller.

15.3.9.10 Protected materials in controller

`META_MATERIAL_PROTECTED`

Displays a list of all material names saved in the controller during calibration. These materials cannot be edited or deleted.

15.3.10 Edit measured value

15.3.10.1 List of possible statistics signals

`META_STATISTICSIGNAL`

Lists all possible signals that can be included in the statistics.

15.3.10.2 Generate statistical signals

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

- `<signal>`: Thickness signal for which the statistical values are to be calculated
- `NONE`: Ends statistical calculation for the corresponding thickness signal
- `INFINITE`: Uses all previous measurement values as evaluation range for the statistical calculation
- `<depth>`: Evaluation range for statistical calculation, 2|4|8|...|8192|16384

The statistics are created for the selected signal.

The controller generates new signals that can then be output via the interfaces.

- `<signal>_MIN`: Signal minimum
- `<signal>_MAX`: Signal maximum
- `<signal>_PEAK`: <signal>_max - <signal>_min

Command examples:

`STATISTICSIGNAL`	*returns the list of configured statistical signals*
`STATISTICSIGNAL <signal>`	*returns the configuration of the specified signal*

15.3.10.3 List of statistics signals

`META_STATISTIC`

Provides a list of the active statistics signals.

These signals were defined under `STATISTICSIGNAL`.

15.3.10.4 Reset statistical calculation

`STATISTIC ALL | <signal> RESET`

Resets the statistical data of the selected signal or of all signals (minimum, maximum, peak).

- `<signal>`: Resets the statistical data of the corresponding thickness signal
- `ALL`: Resets all statistical data

15.3.10.5 List of possible signals to be parameterized

`META_MASTERSIGNAL`

Lists all possible signals that can be used for mastering.

15.3.10.6 Parameterization of master signals

`MASTERSIGNAL [<signal>]`

`MASTERSIGNAL <signal> <master value>`

`MASTERSIGNAL <signal> NONE`

Defines the signal to be mastered.

The parameter `NONE` resets the signal. The function itself is triggered with MASTER.

- `<signal>`: Selecting a specific measured or calculated signal on which the master value should be set.
- `<master value>`: master value in mm, value range: -21.47 ... 21.47

15.3.10.7 List of possible signals for mastering

```
META_MASTER
```

Lists all defined master signals from the `MASTERSIGNAL` command. These can be used with the command `MASTER`.

15.3.10.8 Mastering / zeroing

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

There are up to 10 master signals in the controller.

This command sets or resets the mastering for the corresponding signal.

- `ALL`: use all signals for mastering
- `<signal>`: use a specific measured or calculated signal for mastering
- `SET|RESET`: Start or end function

If the master value is 0, the mastering function has the same functionality as zeroing.

The master command waits a maximum of 2 seconds for the next measured value and uses this as the master value. If no measured value was recorded within this time, in case of external triggering, for example, the command returns with the error “E32 Timeout”.

The master value is processed with six decimal places.

15.3.10.9 Calculation in channel

```
COMP [<channel> [<id>]]
COMP CH01 <id> MEDIAN <signal1> <median data count>
COMP CH01 <id> MOVING <signal1> <moving data count>
COMP CH01 <id> RECURSIVE <signal1> <recursive data count>
COMP CH01 <id> CALC <factor1> <signal1> <factor2> <signal2> <offset> <name>
COMP CH01 <id> THICKNESS <signal1> <signal2> <name>
COMP CH01 <id> COPY <signal1> <name>
COMP CH01 <id> NONE
```

These commands are only valid for the IMS5200 MP:

```
COMP CH01 <id> CALC <factor1> <signal1> <factor2> <signal2> <offset> <name>
COMP CH01 <id> THICKNESS <signal1> <signal2> <name>
```

This command defines all channel-specific as well as controller-specific calculations.

<id> 1...10	*Number of the calculation block, a maximum of 10 calculation blocks are possible. The ID is assigned in ascending order. The calculation blocks are processed sequentially. Feedback couplings (algebraic loops) over one or several blocks are not possible.*
<signal1>, <signal2>	*Measuring signal; you can query the available signals with the command META_COMP*
<median data count> 3|5|7|9	*Averaging depth Median*
<moving data count> 2|4|8|16|32 64|128|256|512|1024|2048|4096	*Averaging depth Moving average*

<recursive data count> 2 ... 32000	*Averaging depth Recursive average*
<factor1>, <factor2>	*-32768.0 .. 32767.0 (unit mm)*
<offset>	*-21.47 .. 21.47 (unit mm)*
<name>	*Name of calculation block; length min. 2 characters, max. 15 characters. Permitted characters a-zA-Z0-9, the name must start with a letter.* *Command names such as STATISTIC, MASTER, CALC, NONE, ALL are not permitted.*

You can use the `COMP` command to create new calculation blocks, modify or delete calculation blocks.

This provides the following functions:

- `MEDIAN`, `MOVING` and `RECURSIVE`: averaging functions
- CALC: Calculation function consisting of two summands (signal), sign/scaling (factor) and a constant (offset)
  Formula: CALC = (<factor1> * <signal>) + (<factor2> * <signal>) + <offset>
  The result of the calculation is written to a new variable <name>.
- THICKNESS: Thickness calculation (difference) from two peaks, `Signal1 > Signal2`;
  Formula: THICKNESS = <signal1> - <signal2>
  The result of the calculation is written to a new variable <name>.
- COPY: Duplicates a signal
- NONE: deletes a calculation block

15.3.10.10 List of possible calculation signals

```
META_COMP [CH01 <id>]
```

Lists all possible signals that can be used in the calculation.

<id> 1 ... 10

15.3.11 Data Output

15.3.11.1 Digital output selection

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

- `NONE`: No output of measured values
- `RS422`: Output of measured values via RS422
- `ETHERNET`: Output of measurement values via Ethernet
- `ANALOG`: Output of measured values via analog output
- `ERROROUT`: Error or status information via the error outputs

Command starts the output of measured values. The connection to the measured value server can already exist or can now be established.

15.3.11.2 Output data rate

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

The number of measured values is reduced using the selected interfaces.

- `NONE`: No reduction of output of measured values
- `RS422`: Reduction of output of measured values via RS422
- `ANALOG`: Reduction of measured values output via analog
- `ETHERNET`: Reduction of measured value output via Ethernet

15.3.11.3 Reduction counter for output of measured values

```
OUTREDUCECOUNT <count>
```

Reduction counter for output of measured values.

Only each nth measured value is output. The other measurement values are discarded.

- Number: 1...3000000 (1 means all frames)

15.3.11.4 Error handling

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

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

- `NONE`: Last measured value not held; error value output
- `INFINITE`: Last measured value held indefinitely
- `Number`: Holds the last measured value via measurement cycle count and then outputs the error value (maximum 1024)

15.3.12 Selecting the Measured Values to be Output

15.3.12.1 General

Setting the values to be output via the Ethernet and RS422 interfaces.

The maximum output frequency via the Ethernet interface depends on the number of measured values to be output.

15.3.12.2 Data selection for Ethernet

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

Selection of data to be output via this interface.

15.3.12.3 List of possible signals for Ethernet

`META_OUT_ETH [MEAS | VIDEO | CALC]`

List of possible data for Ethernet.

The Video parameter contains the FFT signal.

Additional activation using the `OUTPUT` command is required.

15.3.12.4 List of selected signals, sequence via Ethernet

`GETOUTINFO_ETH`

Returns the order of the signals via this interface.

15.3.12.5 List of selected signals, sequence via RS422

`GETOUTINFO_RS422`

Returns the order of the signals via this interface.

15.3.12.6 Data selection for RS422

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

Selection of data to be output via this interface.

15.3.12.7 List of possible signals for RS422

`META_OUT_RS422`

List of possible data for the RS422.

15.3.13 Switching output

15.3.13.1 Error switching outputs

`ERROROUT1 [01ER1|01ER2|01ER12|ERRORLIMIT]`

```
ERROROUT2 [01ER1|01ER2|01ER12|ERRORLIMIT]
```

Setting the error switching outputs.

- 01ER1: Switching output is switched in the event of an intensity error
- 01ER2: Switching output is switched in the event of a measuring range error
- 01ER12: Switching output is switched in the event of an intensity error or a measuring range error
- ERRORLIMIT: Switching output is switched when the measured value is outside the limit values; the basis is formed by the settings for ERRORLIMITSIGNAL1/2, ERRORLIMITCOMPARETO1/2 and ERRORLIMITVALUES1/2.

15.3.13.2 Set signal to be evaluated

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

Selection of the signal to be used for the limit value analysis.

The setting is applied to the Digital I/O Error 1/2.

The META_ERRORLIMITSIGNAL command, see Chap. 15.3.13.3, lists all available signals that can be used here.

15.3.13.3 List of possible signals for error output

```
META_ERRORLIMITSIGNAL1
META_ERRORLIMITSIGNAL2
```

List of all signals that are possible for the `ERRORLIMITSIGNALn` command.

15.3.13.4 Set limit values

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

Specifies whether the output should activate upon

- LOWER --> shortfall
- UPPER --> exceedance
- BOTH --> undershot or exceeded

15.3.13.5 Set value

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

Sets the values for Lower and Upper limit values.

The setting is applied to the Digital I/O Error 1/2.

See ERRORLIMITCOMPEARETOn command, see Chap. 15.3.13.4, which defines whether the lower limit value, the upper limit value or both the lower limit value and the upper limit value are applied.

- <lower limit [mm]> = - 2.14 ... 2.14
- <upper limit [mm]> = - 2.14 ... 2.14

15.3.13.6 Switching behavior of error outputs

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

Switching behavior of error outputs Error 1 and Error 2.

- PNP: Switching output is High in the case of an error and open without error
- NPN: Switching output is Low in the case of an error and open without error
- PUSHPULL: Switching output is High in the case of an error and Low without error
- PUSHPULLNEG: Switching output is Low in the case of an error and High without error

15.3.14 Analog output

15.3.14.1 Data selection

`ANALOGOUT [<Signal>]`

Selection of the signal to be output via the analog output. The signal is specified as a parameter. A list with the possible signals can be shown with META_ANALOGOUT.

Additional activation using the OUTPUT command is required, see Chap. 15.3.11.1.

15.3.14.2 List of possible signals for analog output

`META_ANALOGOUT`

Lists all signals that can be connected to the analog output.

15.3.14.3 Output range

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

- 0-5 V: The analog output provides a voltage of 0 to 5 volts.
- 0-10 V: The analog output provides a voltage of 0 to 10 volts.
- 4-20mA: The analog output puts out a current of 4 to 20 milliamperes.

15.3.14.4 Set scaling for DAC

`ANALOGSCALEMODE [STANDARD | TWOPOINT]`

Selects whether to use one-point or two-point scaling of the analog output.

- `STANDARD` --> One-point scaling
- `TWOPOINT` --> Two-point scaling

The standard scaling is designed for distances -MR/2 to MR/2 and for thickness measurement from 0 to 2 MR (MR = measuring range).

Minimum and maximum measured values must be specified in millimeters. The available output range of the analog output is then spread between the minimum and maximum measured values. The minimum and maximum measured values must be between -21.47 and 21.47.

The minimum and maximum measured values are processed with three decimal places.

Unit in mm

15.3.14.5 Set scaling range

`ANALOGSCALERANGE [<lower_limit> < upper_limit>]`

`<lower_limit>` and `<upper_limit>` must be between -21.47 and 24.47 and cannot be identical.

Unit in mm

15.3.15 Key function

15.3.15.1 Multifunction button

`KEYFUNC1 [NONE|MASTERSET|MASTERRESET|LED]`

Configuring the button for the actuation time 1 (0 ... 2 s)

- `NONE`: No function
- `MASTERSET`: The `MASTER SET` command is triggered (see command `Master`) for signals that have been defined by `KEYMASTERSIGNALSELECT`.
- `MASTERRESET`: The `MASTER RESET` command is executed (set command `MASTER`) for signals that have been defined by `KEYMASTERSIGNALSELECT`.
- `LED`: The button is used to switch the LED on/off.

`KEYFUNC2 [NONE|MASTERSET|MASTERRESET|LED]`

Configuring the button for the actuation time 2 (2 ... 5 s)

- NONE: No function
- MASTERSET: The MASTER SET command is triggered (see command Master) for signals that have been defined by KEYMASTERSIGNALSELECT.
- MASTERRESET: The MASTER RESET command is executed (set command MASTER) for signals that have been defined by KEYMASTERSIGNALSELECT.
- LED: The button is used to switch the LED on/off.

15.3.15.2 Signal selection for mastering with multifunction button

```
KEYMASTERSIGNALSELECT [ALL | NONE | <signal> [<signal2> [...]]]
```

Selection of measuring data signals for the master via the button (see KEYFUNC1 and KEYFUNC2). A list of available signals is provided by the META_MASTER command. The signals are configured using the MASTERSIGNAL command.

15.3.15.3 Keylock

```
KEYLOCK [NONE | ACTIVE | (AUTO [<timeout period>])]
```

Selection of the keylock.

- NONE: Key always functions; no keylock
- ACTIVE: Keylock is activated immediately after restart
- AUTO: Keylock is only activated <timeout period> minutes after reboot

  <timeout period> minutes (1 ... 60)

15.4 Measured value format, structure

The structure of measured value frames depends on the selection of the measured values. In the following overview, you will find a summary of commands which you can use to query the available measured values via RS422 and Ethernet.

OUT_RS422	OUT_ETH	Data selection for RS422, Ethernet
META_OUT_RS422	META_OUT_ETH	List of possible signals RS422, Ethernet
GETOUTINFO_RS422	GETOUTINFO_ETH	List of selected signals, sequence via RS422, Ethernet

Examples of the structure of a data block, query with Tera Term for RS422:

Preset Thickness measurement glass	Preset 2 layers
->META_OUT_RS422 META_OUT_RS422 01ABS 01SHUTTER 01ENCODER1 01ENCODER2 01PEAK01 01AMOUNT MEASRATE TIMESTAMP COUNTER STATE ->	->META_OUT_RS422 META_OUT_RS422 01ABS 01SHUTTER 01ENCODER1 01ENCODER2 01PEAK01 01PEAK02 01PEAK03 01AMOUNT COUNTER STATE
->GETOUTINFO_RS422 GETOUTINFO_RS422 PEAK01 ->	->GETOUTINFO_RS422 GETOUTINFO_RS422 01PEAK01 01PEAK02 01OEAK03

A measured value frame is built dynamically, i.e., values not selected are not transmitted.

15.5 Warning and error messages

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
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
E262	Active signal transfer, please stop before
E270	No signals selected
E272	Invalid combination of signal parameters, please check measure mode and signal selection
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
E285	Name is too long
E286	Names must begin with an alphabetic character, and be 2 to 15 characters long. Permitted characters are: a-zA-Z0-9_
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
E360	Name already exists or not allowed
E361	Name begins or ends with spaces or is empty
E362	Storage region is full
E363	Setting name not found
E364	Setting is invalid
E500	Materials table is empty
E502	Materials table is full
E504	Material name not found
E600	ROI begin must be less than ROI end
E602	Master value is out of range
E603	One or more values were out of range
E610	Encoder: minimum is greater than maximum

E611	Encoder‘s start value must be less than the maximum value
E615	Synchronization as slave and triggering at level or edge are not possible at the same time
E616	Software triggering is not active
E618	Sensor head not available
E621	The entry already exists
E622	The requested dataset/table does not exist.
E623	Not available in EtherCAT mode
E624	Not allowed when EtherCAT SYNC0 synchronization is active
W505	Refractivity correction deactivated, vacuum is used as material
W526	Output signal selection modified by the system
W528	The shutter time has been changed to match the measurement rate and the system requirements.
W530	The IP settings has been changed.

16 EtherCAT documentation

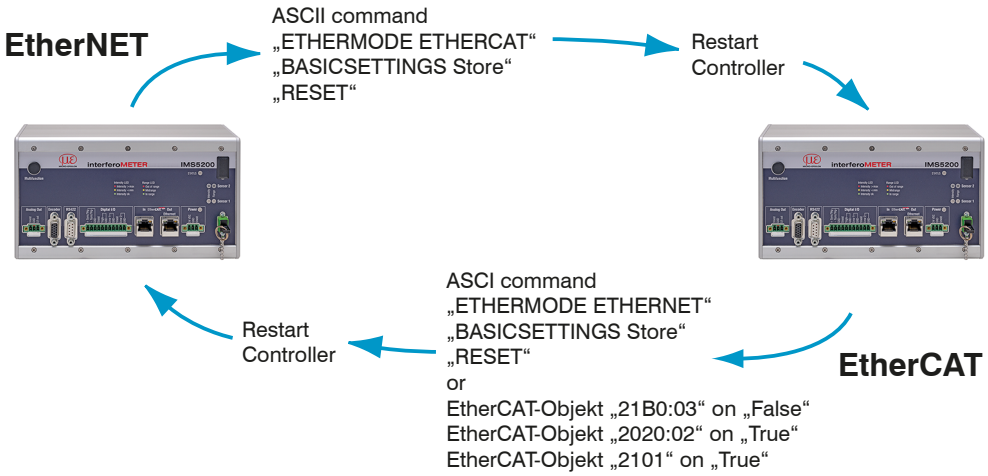
16.1 General

From an Ethernet point of view, EtherCAT® is an individual large Ethernet device that sends and receives Ethernet telegrams. An EtherCAT system like this consists of an EtherCAT master and up to 65535 EtherCAT slaves.

Master and slaves communicate via standard Ethernet cabling. On-the-fly processing hardware is used in each slave. The incoming Ethernet frames are processed by the hardware directly. The relevant data is extracted from the frame or inserted. The frame is then sent on to the next EtherCAT® slave device. The fully processed frame is returned from the last slave device. Various protocols can be used at the application level. CANopen over EtherCAT technology (CoE) is supported here. An object dictionary structure with service data objects (SDO) and process data objects (PDO) is used to manage the data in the CANopen protocol. Further information can be obtained from ® Technology Group (www.ethercat.org) or Beckhoff GmbH, (www.beckhoff.com).

16.2 Switching between Ethernet and EtherCAT

Switching between Ethernet and EtherCAT is possible via an ASCII command, see Chap. 15.3.6.4, the web interface, see Chap. 6.6.10 or an EtherCAT object, see Chap. 16.4.2.18. Save the current settings before switching to EtherCAT. The switch becomes active only after the controller has been restarted.



The RS422 interface for sending an ASCII command is available both in Ethernet mode and in EtherCAT mode.

16.3 Introduction

16.3.1 Structure of EtherCAT® Frames

The data in Ethernet frames is transmitted with a special Ether type (0x88A4). An EtherCAT® frame like this consists of one or more EtherCAT® telegrams, each of which is addressed to individual slaves / storage areas. The telegrams are transmitted either directly in the data area of the Ethernet frame or in the data area of the UDP datagram. An EtherCAT® telegram consists of an EtherCAT® header, the data area and the work counter (WC). The work counter is incremented by each addressed EtherCAT® slave that has exchanged the associated data.

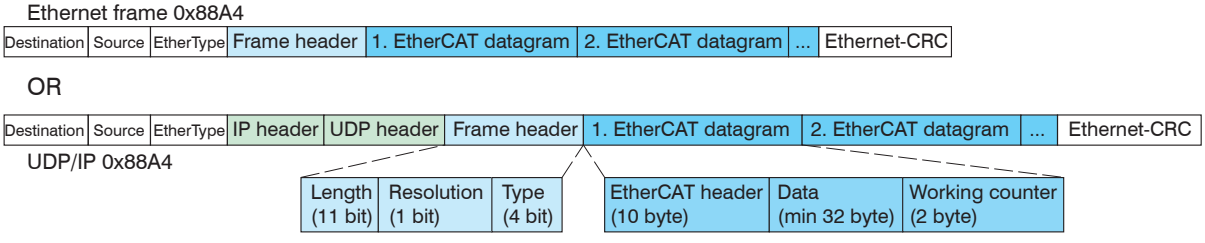


Fig. 16.1: Structure of EtherCAT frames

16.3.2 EtherCAT® services

In EtherCAT®, services are specified for reading and writing data in the physical memory within the slave hardware. The following EtherCAT® services are supported by the slave hardware:

- APRD (Autoincrement physical read, reading of a physical area with auto-increment addressing)
- APWR (Auto-Increment Physical Write, writing of a physical area with auto-increment addressing)
- APRW (Auto-Increment Physical Read Write, reading and writing of a physical area with auto-increment addressing)
- FPRD (Configured Address Read, reading of a physical area with fixed addressing)
- FPWR (Configured Address Write, writing of a physical area with fixed addressing)
- FPRW (Configured Address Read Write, reading and writing of a physical area with fixed addressing)
- BRD (Broadcast Read, broadcast-reading of a physical area for all slaves)
- BWR (Broadcast Write, broadcast-writing of a physical area for all slaves)
- LRD (Logical Read, reading of a logical storage area)
- LWR (Logical Write, writing of a logical storage area)
- LRW (Logical Read Write, reading and writing of a logical storage area)
- ARMW (Auto-Increment Physical Read Multiple Write, reading of a physical area with auto-increment addressing, multiple writing)
- FRMW (Configured Address Read Multiple Write, reading of a physical area with fixed addressing, multiple writing)

16.3.3 Addressing and FMMUs

In order to address a slave in the EtherCAT® system, various methods from the master can be used. The sensor/controller supports as full slave:

- Position addressing

  The slave device is addressed via its physical position in the EtherCAT® segment. The services used for this are APRD, APWR, APRW.
- Node addressing

  The slave device is addressed via a configured node address that was assigned by the master during the commissioning phase. The services used for this are FPRD, FPWR and FPRW.
- Logical addressing

  The slaves are not addressed individually; instead, a section of the segment-wide logical 4 GB address is addressed. This segment can be used by a number of slaves. The services used for this are LRD, LWR and LRW.

The local assignment of physical slave memory addresses and logical segment-wide addresses is implemented via the Field Bus Memory Management Units (FMMUs). The configuration of the slave FMMUs is implemented by the master. The FMMU configuration contains a start address of the physical memory in the slave, a logical start address in the global address space, length and type of the data, as well as the direction (input or output) of the process data.

16.3.4 Sync manager

Sync Managers serve the data consistency during the data exchange between EtherCAT® master and slaves. Each Sync Manager channel defines an area of the application memory. The sensor/controller has four channels.

- Sync manager channel 0: Sync manager 0 is used for mailbox write transfers (mailbox from master to slave).
- Sync manager channel 1: Sync manager 1 is used for mailbox read transfers (mailbox from slave to master).
- Sync Manager channel 2: Sync Manager 2 is normally used for process output data. Not used.
- Sync Manager channel 3: Sync Manager 3 is used for process input data. It contains the Tx PDOs that are specified by the PDO assignment object 0x1C13 (hex.).

16.3.5 EtherCAT state machine

The EtherCAT® state machine is implemented in each EtherCAT®. Immediately after switching on the sensor/controller, the state machine is in the "Initialization" state. In this state, the master has access to the DLL information register of the slave hardware. The mailbox is not yet initialized, i.e. communication with the application (controller software) is not yet possible. During the transition to the pre-operational state, the Sync Manager channels are configured for the mailbox communication. In the “Pre-Operational” state, communication via the mailbox is possible, and it can access the object

directory and its objects. In this state, no process data communication occurs. During the transition to the “Safe-Operational” state, the process-data mapping, the Sync Manager channel of the process inputs and the corresponding FMMU are configured by the master. Mailbox communication continues to be possible in the “Safe-Operational” state. The process data communication runs for the inputs. The outputs are in the “safe” state. In the “Operational” state, process data communication runs for both the inputs and the outputs.

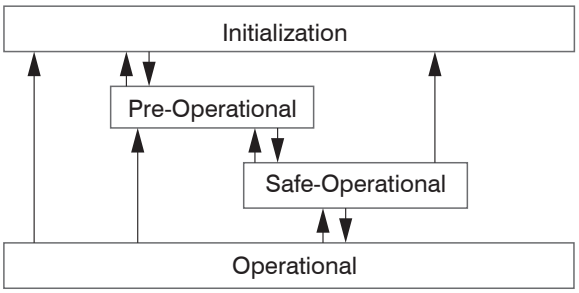


Fig. 16.2: EtherCAT state machine

16.3.6 CANopen over EtherCAT

The application layer communication protocol in EtherCAT is based on the CANopen DS 301 communication profile. This is called "CANopen over EtherCAT" or CoE. The protocol specifies the object directory in the controller, as well as the communication objects for the exchange of process data and acyclic messages. The controller uses the following message types:

- Process Data Object (PDO). The PDO is used for the cyclic I/O communication, therefore for process data.
- Service Data Object (SDO). The SDO is used for acyclic data transmission.

The object directory is described in chapter "CoE object directory".

16.3.7 Process Data Object Mapping (PDO Mapping)

Process Data Objects (PDOs) are used for the exchange of time-critical process data between master and slaves.

To transmit data from the slave to the master, Tx PDOs are used (inputs). Rx PDOs are used to transfer data from the master to the slave (outputs); this concept is not used in the interferoMETER. The PDO mapping defines which application objects (measurement data) are transmitted into a PDO.

With the interferoMETER, you can choose from a range of Tx PDO map objects, see Chap. 16.4.1.7.

In EtherCAT, the PDOs are transported in objects of the Sync Manager channel. The controller uses the Sync Manager channel SM3 for input data (Tx data). The PDO assignments of the Sync Manager can only be changed in the “Pre-Operational” state.

Note: Sub-index 0x00 of the object 0x1A00 contains the number of valid entries within the mapping report. This number also represents the number of application variables (parameters) that should be transmitted/received with the corresponding PDO. The sub-indices from 1h up to the number of objects contain information about the depicted application variables. The mapping values in the CANopen objects are coded in hexadecimal form. The following table contains an example of the entry structure of the PDO mapping:

MSB ... LSB		
31 ... 16	15 ... 8	7 ... 0
Index e.g. 0x6000 (16 bits)	Sub-index e.g. 0x01	Object length in bits, e.g. 20h = 32 bits

Tab. 16.1: Entry structure of the PDO mapping, example

16.3.8 Service data SDO service

Service Data Objects (SDOs) are primarily used for the transmission of data that is not time critical, e.g. parameter values.

EtherCAT specifies

- SDO services: these make possible the read/write access to entries in the CoE object directory of the device.
- SDO information services make it possible to read the object directory itself and to access the properties of the objects.

All parameters of the measuring device can be read or changed in this way, or measurements can be transmitted. A desired parameter is addressed via index and subindex within the object directory.

16.4 CoE object directory

16.4.1 Communication-specific standard objects

16.4.1.1 Overview

The CoE object directory (CANopen over EtherCAT) contains all the configuration data of the controller. The objects in CoE object directory can be accessed using the SDO services. Each object is addressed using a 16-bit index.

Index (h)	Name	Description
1000	Device type	Device type
1008	Device name	Manufacturer device name
1009	Hardware version	Hardware version
100 A	Software version	Software version
1018	Identity	Device identification
1A00 ... 1BAB		TxPDO mapping, see Chap. 16.4.1.7 PDO mapping objects may contain merged process data (mappable objects).
1C00	Sync. manager type	Synchronous manager type
1C12	RxPDO assign	
1C13	TxPDO assign	TxPDO assign
1C33	Sync manager input parameter	Synchronous mode parameter (DC)

Tab. 16.2: Overview of standard objects

16.4.1.2 Object 1000h: Device type

1000	VAR	Device type	0x00000000	Uint32	ro

Provides information about the device profile and the device type used.

16.4.1.3 Object 1008h: Manufacturer device name

1008	VAR	Device name	IMC5x00	Visible string	ro

16.4.1.4 Object 1009h: Hardware version

1009	VAR	Hardware version	xx	Visible string	ro

16.4.1.5 Object 100Ah: Software version

100 A	VAR	Software version	xxx.xxx	Visible string	ro

16.4.1.6 Object 1018h: Device identification

1018	RECORD	Identity			

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Vendor ID	0x00000607	Uint32	ro
2	VAR	Product code	0x0024E555	Uint32	ro
3	VAR	Revision	0x00010000	Uint32	ro
4	VAR	Serial number	0x009A4435	Uint32	ro

The article number is stored in the `Product-Code` and the serial number of the controller in `Serial number`.

16.4.1.7 TxPDO mapping

1A00	01Peak1 TxPDOMap			
	01Peak1 0x6000			
1AB0	Shutter TxPDOMap			
	CH01SHUTTER 0x6030			
1AC0	Encoder1 und Encoder2 TxPDOMap			
	ENCODER1 0x6050	**ENCODER2** 0x6051		
1AD0	Encoder3 TxPDOMap			
	Encoder3 0x6052			
1AE0	Counter TxPDOMap			
	COUNTER 0x7000			
1AE8	States TxPDOMap			
	TIMESTAMP 0x7001			
1AF0	Measrate TxPDOMap			
	MEASRATE 0x7002			
1AF8	State TxPDOMap			
	State 0x7003			
1B00	UserCalc01 TxPDOMap			
	UserCalcOutput01 0x7C00			
1B08	UserCalc02 TxPDOMap			
	UserCalcOutput02 0x7C01			
1B10	UserCalc03 TxPDOMap			
	UserCalcOutput03 0x7C02			
1B18	UserCalc04 TxPDOMap			
	UserCalcOutput04 0x7C03			
1B20	UserCalc05 and 06 TxPDOMap			
	UserCalcOutput05 0x7C04	**UserCalcOutput06** 0x7C05		
...	...			
	...	...		

1B58	UserCalc19 and 20 TxPDOMap			
	UserCalcOutput 19 0x7C12	**UserCalcOutput20** 0x7C13		
1B60	UserCalc21 to 24 TxPDOMap			
	UserCalcOutput21 0x7C14	**UserCalcOutput22** 0x7C15	**UserCalcOutput23** 0x7C16	**UserCalcOutput24** 0x7C17
...	...			
	...	...	...	...
1BA8	UserCalc57 to 60 TxPDOMap			
	UserCalcOutput57 0x7C38	**UserCalcOutput58** 0x7C39	**UserCalcOutput59** 0x7C3A	**UserCalcOutput60** 0x7C3B

Tab. 16.3: PDO-Map objects

In object 0x1C13, it is selected which PDOs are to be transferred. The PDO mapping objects are selected. The selection process takes place before switching from PreOP to SafeOP mode.

Example 1: Startup procedure to output thickness 1 from channel 1 (01PEAK01):

- The thickness 1 is expressed in 0x6000. In order to transfer 0x6000 in the PDO, PDO mapping object 0x1A00 must be selected in 0x1C13.

Object	value	Description
0x1C13:00	0x00 (0)	clear sm pdos (0x1C13)
0x1C13:01	0x1A00 (6656)	download pdo 0x1C13:01 index
0x1C13:00	0x01 (1)	download pdo 0x1C13 count

Example 2: Startup procedure to output thickness 1, signal quality 1, exposure time, encoder 1 and encoder 2 of channel 1 (01PEAK1, 01SHUTTER, 01ENCODER1, 01ENCODER2).

- The thickness 1 is expressed in 0x6000. In order to transfer 0x6000 in the PDO, PDO mapping object 0x1A00 must be selected in 0x1C13.
- The signal quality 1 is expressed in 0x6010. To transmit 0x6010 in the PDO, PDO map object 0x1A30 must be selected in 0x1C13.
- Shutter is output in 0x6010, encoder 1 in 0x6050 and encoder 2 in 0x6051. The four process data are summarized in 0x1A70, for transmission in the PDO it must be selected in 0x1C13.

Object	value	Description
0x1C13:00	0x00 (0)	clear sm pdos (0x1C13)
0x1C13:01	0x1A00 (6656)	download pdo 0x1C13:01 index
0x1C13:02	0x1A70 (6768)	download pdo 0x1C13:03 index
0x1C13:00	0x02 (2)	download pdo 0x1C13 count

16.4.1.8 Object 1C00h: Synchronous Manager Type

1C00	RECORD	Sync manager type			ro

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Sync manager 1	0x01	Uint8	ro
2	VAR	Sync manager 2	0x02	Uint8	ro
3	VAR	Sync manager 3	0x03	Uint8	ro
4	VAR	Sync manager 4	0x04	Uint8	ro

16.4.1.9 Object 1C12h: RxPDO Assign

1C12	ARRAY	RxPDO assign			rw

Sub-indices

0	VAR	Number of entries	0	Uint8	ro

No RxPDOs can be selected because none are present. The object is implemented as a dummy to enable the EtherCAT master to set the RxPDOs to 0.

16.4.1.10 Object 1C13h: TxPDO Assign

1C13	ARRAY	TxPDO-Assign			rw

Sub-indices

0	VAR	Number of entries	n	Uint8	rw
1	VAR	Sub-index 001	0x1A00	Uint16	rw
2	VAR	Sub-index 002		Uint16	rw
...					rw
n	VAR	Sub-index n		Uint16	rw

Object for selecting the PDOs (TxPDO maps), see Chap. 16.3.7.

16.4.1.11 Object 1C33h: Sync manager input parameters

1C33	RECORD	SM input parameter			ro

Sub-indices

0	VAR	Number of entries	9	Uint8	ro
1	VAR	Synchronization type	x	Uint16	ro
2	VAR	Cycle time	x	Uint32	ro
4	VAR	Supported synchronization types	0x4005	Uint16	ro
5	VAR	Minimum cycle time	1000000	Uint32	ro
6	VAR	Calc and copy time	x	Uint32	ro
8	VAR	Get cycle time	x	Uint16	rw
9	VAR	Delay time		Uint32	ro
12	VAR	Cycle time too small		Uint16	ro

- Synchronization Type: currently specified synchronization
  - 0: Freerun,
  - 2: Distributed Clock Sync0 Synchronization
- Cycle time: cycle time currently set in µs
  - Free run, the cycle time derived from the measuring rate,
  - Sync0 synchronization, the Sync0 cycle time set by the master.

The minimum cycle time is derived from the maximum measuring rate and is 41.7 µs.

- Synchronization types supported: Freerun and Sync0 synchronization is supported
- Calc and Copy Time , Get Cycle Time: if Get Cycle Time is set to 1, the Calc and Copy time is measured and output in the entry of the same name (only with Sync0 synchronization)
- Delay time: SYNC0 pulse triggers sampling, so this value is always 0.

16.4.2 Manufacturer-specific objects

16.4.2.1 Overview

Index (h)	Name	Description
2001	User level	Login, logout, change password
2005	Controller info	Controller information (more)
2020	Basic settings	Load, save, factory setting
2021	Preset	Signal quality
2022	Meassettings	Measurement settings
203F	Sensor error	Sensor error
2101	Reset	Restart controller
2105	Factory reset	Reset to factory settings
2107	Counter reset	Reset counter
2133	LED on/off	Switching the light source on/off
2141	Video signal	Request FFT signal
2142	Video signal enable	Output FFT signal
2150	Sensor	Sensor information
2152	Select sensor	Select sensor
2156	Multilayer options	Number of peaks for multilayer materials
2162	Peak options	Detection threshold
2163	Peak selection	Measpeak sorting
21B0	Digital interfaces	Digital interfaces
21B1	Enable output	Interface selection
21C0	Ethernet	Ethernet, IP configuration
21D0	Analog output	Analog output, scaling
21F3	Switching output 1	Switching output 1/2
21F4	Switching output 2	
2250	Shutter mode	Exposure mode
2251	Measuring rate	Measuring rate
24A0	Keylock	Locking the multifunction button on the controller
24A2	Keyfunc	Multifunction button function
25A0	Encoder 1, 2	Reference signal, interpolation, start and maximum value
25A1	Encoder 3	
2711	Range of interest	Masks the region of interest
2800	Material info and edit	Material information
2802	Material table edit	Edit materials table
2803	Materials table	Materials present in the materials table
2804	Material selection	Select material
2805	Material infront	Material between sensor and first layer
2A00-2A09	Master y	Master value, mastering
2A10-2A19	Statistic	Statistics
2C00-2C09	Comp y	Calculation of measured values
2E00	User calc	User signals

i Reading and writing the manufacturer-specific objects can cause an error if invalid entries are made. These errors are listed in the SDO abort codes, see Chap. 16.6.
If an error occurs while writing a value, you may be able to retrieve error details in object 203F.

16.4.2.2 Object 2001h: User level

2001	RECORD	User level			

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Actual user	x	Uint8	ro
2	VAR	Login		Visible string	wo
3	VAR	Logout	FALSE	BOOL	rw
4	VAR	Default user	x	Uint8	rw
5	VAR	Old password		Visible string	wo
6	VAR	New password		Visible string	wo
7	VAR	Repeat password		Visible string	wo

Further details can be found at Login, see Chap. 6.6.5 and User level, see Chap. 15.3.2.

Actual user, standard user:

- 0 - User
- 1 - Professional

Modifying the user level will also change the access rights for objects. At the User level, after logging out, all RW objects are read-only (= ro), and all write-only objects (= wo) are no longer available.

To change the password, you need to complete the three passwords fields (Old, New and Repeat) in this particular order. The maximum password length is 31 characters.

16.4.2.3 Object 2005h: Controller information (more)

2005	RECORD	Controller info			ro

Sub-indices

0	VAR	Number of entries	8	Uint8	ro
1	VAR	Name	IMS5x00	Visible string	ro
5	VAR	Serial No	xxxxxxxx	Visible string	ro
6	VAR	Option No	xxx	Visible string	ro
8	VAR	Article No	xxxxxxx	Visible string	ro

Further details can be found in the Controller information, see Chap. 15.3.1.2.

16.4.2.4 Object 2020h: Load, save, factory setting

2020	RECORD	Basic settings			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	READ		BOOL	wo
2	VAR	STORE		BOOL	wo
3	VAR	SETDEFAULT		BOOL	wo

- `READ`: Loading the last basic settings saved

- `STORE`: Saves the current settings
- `SETDEFAULT`: Resets the basic settings to factory settings

16.4.2.5 Object 2021h: Preset

2021	RECORD	Preset			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	Mode	x	Uint8	rw
2	VAR	List		Visible string	ro
3	VAR	Named read		Visible string	rw

Mode:

- 0 – `STATIC`
- 1 – `BALANCED`
- 2 – `DYNAMIC`

Further details can be found at Measurement settings, see Chap. 16.4.2.6.

16.4.2.6 Object 2022h: Measurement settings

2022	RECORD	Meassettings			ro

Sub-indices

0	VAR	Number of entries	7	Uint8	
1	VAR	Current		Visible string	ro
2	VAR	Named read		Visible string	wo
3	VAR	Named store		Visible string	wo
4	VAR	Named delete		Visible string	wo
5	VAR	Initial meassettings		Visible string	rw
6	VAR	List		Visible string	ro
7	VAR	Set default		BOOL	wo

- Current: Current measurement settings (`MEASSETTINGS CURRENT`)
- Named read: Loads a measurement setting from the `List`/sub-index 6 (`MEASSETTINGS READ`)
- Named store: Stores the current measurement setting. You can assign a name or number (`MEASSETTINGS STORE`)
- Named delete: Deletes a measurement setting from the `List`/sub-index 6 (`MEASSETTINGS DELETE`)
- Initial meas. settings: Measurement setting that is initially loaded during a controller reset (`MEASSETTINGS INITIAL`)
- List: List with stored measurement settings (`MEASSETTINGS LIST`)
- Set default: Corresponds to the `SETDEFAULT MEASSETTINGS` command

Further details can be found in the Measurement settings, see Chap. 15.3.7.6 section.

16.4.2.7 Object 203Fh: Sensor error

203F	RECORD	Sensor error			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Sensor error number	x	Uint16	ro
2	VAR	Sensor error description	x	Visible string	ro

For more information, please refer to the Error Messages section.

- Sensor error number: Output of the sensor error during communication
- Sensor error description: Sensor error as plain text

16.4.2.8 Object 2101h: Reset

2101	RECORD	Reset	FALSE	BOOL	rw

The controller is restarted.

16.4.2.9 Object 2105h: Factory settings

2105	RECORD	Factory reset		BOOL	ro

Reset to factory defaults. Corresponds to the `SETDEFAULT ALL` command.

16.4.2.10 Object 2107h: Counter reset

2107	RECORD	Counter reset			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Reset timestamp		BOOL	wo
2	VAR	Reset counter		BOOL	wo

If subindex 1 is set to 1, the time stamp (0x7001) is reset.

Setting subindex 2 to 1 resets the measured value counter (0x7000).

16.4.2.11 Object 2141h: Request FFT signal

2141	RECORD	Video signal			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
2	VAR	New frame request		BOOL	wo

If output of an FFT signal is enabled, a new image can be triggered by using this entry.

16.4.2.12 Object 2142h: Enable FFT signal

2142	RECORD	Video signal enable			ro

Sub-indices

0	VAR	Number of entries	1	Uint8	ro
1	VAR	Enable signal		BOOL	rw

Permits output of the FFT signal.

16.4.2.13 Object 2150h: Sensor

2150	RECORD	Sensor			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	Sensor info	IMPxxxx	Visible string	ro
2	VAR	Sensor range	xx.xxxxxx	FLOAT32	ro
3	VAR	Sensor serial no.	xxxxxxxx	Visible string	ro

Further details can be found in Sensor, see Chap. 15.3.3.

16.4.2.14 Object 2152h: Sensor selection

2152	RECORD	Select sensor			ro

Sub-indices

0	VAR	Number of entries	1	Uint8	ro
1	VAR	Number of sensor	x	Uint8	rw

Further details can be found at Select sensor, see Chap. 15.3.3 and Sensor number, see Chap. 15.3.3.2.

16.4.2.15 Object 2156h: Number of peaks multilayer materials

2156	RECORD	Multilayer options			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Peak count	x	FLOAT32	rw

- Peak count: Indicates how many peaks are to be evaluated.

16.4.2.16 Object 2162h: Peak options

2162	RECORD	Peak options			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Min threshold		FLOAT32	rw

- Min threshold: Peak detection threshold, corresponds to the `MIN_THRESHOLD (_CH0x)` command.

16.4.2.17 Object 2163h: Peak selection

2163	RECORD	Peak selection			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Measpeak sort		Uint8	rw

- MEASPEAK_SORT [HEIGHT=0|DISTANCE=1]
  Determines the selection of peaks: `HEIGHT` (use the highest peaks), `DISTANCE` (use the first peaks).

16.4.2.18 Object 21B0h: Digital interfaces

21B0	RECORD	Digital interfaces			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
2	VAR	RS422 baud rate	x	Uint32	rw
4	VAR	Ethermode		Uint8	rw

Sub-index 2 is equivalent to the `BAUDRATE` command. Only the preset baud rates can be specified: 9600, 115200, 230400, 460800, 691200, 921600, 1500000, 2000000, 3500000, 4000000.

Subindex 3 is equivalent to the `ETHERMODE` command and specifies whether the controller starts in Ethernet or EtherCAT mode. Changes only become effective after Basicsettings store and a restart.

- 0 - Ethernet
- 1 - EtherCAT

16.4.2.19 Object 21B1h: Interface selection

21B1	RECORD	Enable output			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	RS422	x	BOOL	rw
3	VAR	Analog out		BOOL	rw
4	VAR	Switching Outputs		BOOL	rw

Corresponds to the `OUTPUT` command. Parallel output of measured values via the respective interface can be switched on and off.

16.4.2.20 Object 21C0h: Ethernet

21C0	RECORD	Ethernet			ro

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	IP address	xxx.xxx.xxx.xxx	Visible string	rw
2	VAR	Subnet mask	xxx.xxx.xxx.xxx	Visible string	rw
3	VAR	Gateway	xxx.xxx.xxx.xxx	Visible string	rw
4	VAR	DHCP	FALSE	BOOL	rw

Further details can be found in the Ethernet IP settings section, see Chap. 15.3.6.1.

DHCP:

- 0 - Static IP address
- 1 - DHCP

16.4.2.21 Object 21D0h: Analog output

21D0	RECORD	Analog output			ro

Sub-indices

0	VAR	Number of entries	6	Uint8	ro
1	VAR	Analog output	x	Uint8	rw
2	VAR	Signal	x	Visible string	rw
3	VAR	Available signals		Visible string	ro
4	VAR	Type of scaling	x	Uint8	rw
5	VAR	Start two-point scaling	x.x	FLOAT32	rw
6	VAR	End two-point scaling	x.x	FLOAT32	rw

Further details can be found at Analog output, see Chap. 15.3.14.

Analog output:

- 0 - voltage 0 … 5 V
- 1 - voltage 0 … 10 V
- 7 - current 4 … 20 mA

- Signal: Data can only be selected in accordance with the selected measuring program

You can, for example, select 01PEAK1. `Available signals` lists the available signals.

Type of scaling:

- 0 - Standard scaling
- 1 - Two-point scaling

16.4.2.22 Object 21F3h: Switching output 1

21F3	RECORD	Analog output			ro

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Output level		Uint8	rw
2	VAR	Error out		Uint8	rw
3	VAR	Limit signal		Visible string	rw
4	VAR	Available signal		Visible string	ro
5	VAR	Lower limit value		FLOAT32	rw
6	VAR	Upper limit value		FLOAT32	rw
7	VAR	Compare to		Uint8	rw

Further details can be found in the Switching output section, see Chap. 15.3.13.

Output level:

- 0 - PNP
- 1 - NPN
- 2 - Push-pull
- 3 - Push-pull, negated

Error out:

- 1 - 01ER1
- 2 - 01ER2
- 3 - 01ER12
- 4 - 02ER1
- 5 - 02ER2
- 6 - 02ER12

- 7 - 0102ER12
- 8 - ERRORLIMIT

Use `Limit signal` to select a measured value signal that will be used for the comparison.

`Available signals` contains a list of the available signals.

Compare to:

- 1 - Lower
- 2 - Upper
- 3 - Both

16.4.2.23 Object 21F4h: Switching output 2

Details can be found under 21F3h.

16.4.2.24 Object 2251h: Measuring rate

2251	RECORD	Measuring rate	FLOAT32	rw

Further details can be found at Measuring rate.

16.4.2.25 Object 24A0h: Keylock

24A0	RECORD	Keylock			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Mode	0	Uint8	rw
2	VAR	Delay	0	Uint16	rw

For more information, please refer to the Keylock section, see Chap. 15.3.15.3.

Mode:

- 0 - Inactive
- 1 - Active
- 2 - Automatic mode / Active after delay

16.4.2.26 Object 24A2h: Multifunction button

24A2	RECORD	Keyfunc			ro

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Function 1	0	Uint8	rw
2	VAR	Function 2	0	Uint8	rw

Function 1 and 2:

- 0 - Key has no function
- 4 - Triggering the master (MASTERSET)
- 5 - Resetting the master (MASTERRESET)
- 6 - Switching the light source on and off

Subindex 4 in the KEYFUNC command corresponds to the "Signal".

When mastering via the (Function = 4) button, this entry specifies which signal is to be used for mastering.

16.4.2.27 Object 25A0h: Encoder 1, 2

25A0	RECORD	Encoder			ro

Sub-indices

0	VAR	Number of entries	10	Uint8	ro
1	VAR	Encoder 1 reference signal	x	Uint8	rw
2	VAR	Encoder 1 interpolation	x	Uint8	rw
3	VAR	Encoder 1 initial value	x	Uint32	rw
4	VAR	Encoder 1 maximum value	x	Uint32	rw
5	VAR	Encoder 1 set value	FALSE	BOOL	wo
6	VAR	Encoder 2 reference signal	x	Uint8	rw
7	VAR	Encoder 2 interpolation	x	Uint8	rw
8	VAR	Encoder 2 initial value	x	Uint32	rw
9	VAR	Encoder 2 maximum value	x	Uint32	rw
10	VAR	Encoder 2 set value	FALSE	BOOL	wo

Further details can be found in the section Encoder inputs, see Chap. 4.4.11 and Encoders, see Chap. 15.3.5.

Encoder reference signal:

- 0 - None, the encoder’s reference marker has no effect
- 1 - One, specified once
- 3 - Ever, set for all markers

Encoder interpolation:

- 1 - Single interpolation
- 2 - Dual interpolation
- 3 - Quadruple interpolation

Encoder initial value:

0 … 2^{32}-1

Encoder maximal value:

0 … 2^{32}-1

16.4.2.28 Object 25A1h: Encoder 3

Sub-indices

0	VAR	Number of entries	5	Uint8	ro
1	VAR	Encoder3 enable	x	BOOL	rw
2	VAR	Encoder3 interpolation	x	Uint8	rw
3	VAR	Encoder3 initial value	x	Uint32	ro
4	VAR	Encoder3 maximum value	x	Uint32	ro
5	VAR	Encoder3 set value	FALSE	BOOL	ro

16.4.2.29 Object 2711h: Masking the region of interest

2711	RECORD	Range of interest			

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Range of interest start	x	Uint16	rw
2	VAR	Range of interest end	x	Uint16	rw

Further details can be found in the section Masking the region of interest, see Chap. 6.2.2, see Chap. 15.3.8.2.

16.4.2.30 Object 2800h: Material information

2800	RECORD	Material info and edit			

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Material name	xxxxx	Visible string	rw
2	VAR	Material description	xxxxxx	Visible string	rw
3	VAR	Group index	x.xxxx	FLOAT32	rw

Further details can be found in the section Materials database, see Chap. 15.3.9.

- Material name: Currently selected material for a thickness measurement
- Material description: Description of the currently selected material
- Group index: Refractive indices of the currently selected material at 845 nm

In Professional mode, the current material can also be edited here. Specified settings are saved immediately.

16.4.2.31 Object 2802h: Edit materials table

2802	RECORD	Materials table edit			

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Material delete	x	Visible string	wo
2	VAR	Reset materials	x	BOOL	wo
3	VAR	New material	x	BOOL	wo
4	VAR	Select material for edit	x	Visible string	wo

- Material delete: Specify the name of a material to be deleted from the materials table
- Reset materials: Resets the materials table to the factory settings
- New material: Creates a new material in the materials table. The newly created material (`NewMaterial`”) is edited in object 2800h “Material info”.

Sub-index 4 selects the material that is to be edited in object 0x2800.

16.4.2.32 Object 2803h: Existing materials

2803	RECORD	Materials table			

Sub-indices

0	VAR	Number of entries	1	Uint8	ro
1	VAR	Material names list	„xx“ „xx“ ...	Visible string	ro

Here you will find a list of all available materials: Air calibration / Air / BK7 / D263T / Ethanol / Fused Silica / LaSF9 / Mirror / N-SF6 / PC / PMMA / PS / Vacuum.

16.4.2.33 Object 2804h: Select material

2804	RECORD	Material selection			

Sub-indices

0	VAR	Number of entries	5	Uint8	ro
1	VAR	Material 1	xx	Visible string	rw
...					
E	VAR	Material	xx	Visible string	rw

Specification of the material whose characteristics are included in the measured values.

The selected material must be present in the materials table.

16.4.2.34 Object 2805h: Material between sensor and 1st layer

2805	RECORD	Material in front			

Sub-indices

0	VAR	Number of entries	1	Uint8	ro
1	VAR	Material	xx	Visible string	rw

Indication of the material located between the sensor front face and the first layer of the target.

16.4.2.35 Object 2A00h: Mastering

2A00	RECORD	Master 1			

Sub-indices

0	VAR	Number of entries	5	Uint8	ro
1	VAR	Enable	xx	BOOL	rw
2	VAR	Signal	xx	Visible string	rw
3	VAR	Available signals	xx	Visible string	ro
4	VAR	Set/reset	xx	BOOL	rw
5	VAR	value	xx	FLOAT32	rw

Mastering or zeroing a signal; there are 10 such objects (2A00h to 2A09h). Reference to the `MASTERSIGNAL` command. The sub-index specifies which signal is to be mastered. Subindex 3 corresponds to the `META_MASTERSIGNAL` command.

Sub-index 4 corresponds to the `MASTER` command.

16.4.2.36 Object 2A10h: Statistics

2A10	RECORD	Statistic 1			

Sub-indices

0	VAR	Number of entries	6	Uint8	ro
1	VAR	Enable		BOOL	rw
2	VAR	Signal		Visible string	rw
3	VAR	Available signals		Visible string	ro
4	VAR	Infinite		BOOL	rw
5	VAR	Depth		Uint32	rw
6	VAR	Resetting		BOOL	rw

The objects 2A10h to 2A19h generate 10 statistics signals.

Sub-index 3 corresponds to the command `META_STATISTICSIGNAL`.

Subindex 6 corresponds to the `STATISTIC` command.

3 signals are generated for each activated statistics object. These signals are listed in object 0x2E00. The statistics function can also be applied to user signals.

Example: You want Thickness 1 (channel 1) to output the minimum and the maximum measured values using all previous thickness values.

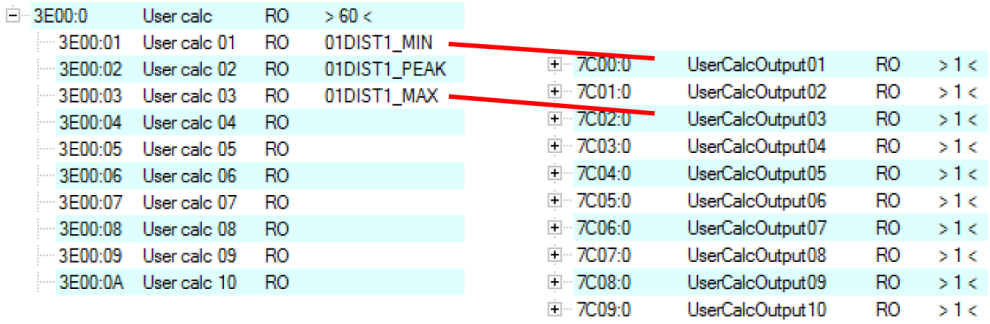
- Activating a statistics object

  2A10:01(Enable) to TRUE. Thickness 1 (01PEAK1) is selected as signal by default. If you would like to display statistics for a different signal, you will need to select the required signal in sub-index 2.
- Settings for all previous thickness values

  2A10:04 (Infinite) to True (STATISTICSIGNAL – INFINITE)

Assigning a user-defined signal to the PDO

The newly generated signal names appear in object 0x2E00h:



The minimum thickness is output in 0x7C00h and the maximum thickness in 0x7C02h.

Select PDO

UserCalcOutput01 – 0x7C00h is selected with object 1B00h, and 0x7C02h is output with object 1B10h.

1B00	UserCalc01 TxPDOMap	
	UserCalcOutput01	0x7C00
1B08	UserCalc02 TxPDOMap	
	UserCalcOutput02	0x7C01
1B10	UserCalc03 TxPDOMap	
	UserCalcOutput03	0x7C02

Extract with TxPDO Mapping, see Chap. 16.4.1.7

Before switching from PreOp to SafeOp, 0x1C13h, 0x1B00h and 0x1B10h must therefore be selected:

0x00 (0)1B00	clear sm pdos (0x1C13)
0x1B00 (6912)	download pdo 0x1C13:01 index
0x1B10 (6928)	download pdo 0x1C13:02 index
0x02 (2)	download pdo 0x1C13 count

16.4.2.37 Object 2C00h: Measured value calculation

2C00	RECORD	Comp y			

Sub-indices

0	VAR	Number of entries	6	Uint8	ro
1	VAR	Type		Uint16	rw
2	VAR	Name1		Visible string	rw
4	VAR	Signal1		Visible string	rw
5	VAR	Signal2		Visible string	rw
12	VAR	Available signals		Visible string	ro

13	VAR	Factor1		FLOAT32	rw
14	VAR	Factor2		FLOAT32	rw
17	VAR	Offset		Integer32	rw
18	VAR	Param1		Uint32	rw

Objects 2C00h to 2C09h include 10 calculation modules.

Type:

- 0 - None
- 1 - Moving average (`MOVING`)
- 2 - Recursive average (`RECURSIVE`)
- 3 - Median (`MEDIAN`)
- 4 - Calculation (`CALC`)
- 8 - Thickness calculation (`THICKNESS`)
- 9 - Copy

As soon as the type is changed, default settings are loaded for the selected type. You can only select signals from the corresponding channel.

Depending on the type, all other object entries have different meanings:

- Moving average (`MOVING`):

4	Signal1	Signal to which the filter is applied (default value 01PEAK1)
18	Param1	Averaging value (default: 2)

Value range for Param1: 2|4|8|16|32|64|128|256|512|1024|2048|4096

- Recursive average (`RECURSIVE`):

4	Signal1	Signal to which the filter is applied (default value 01PEAK1)
18	Param1	Averaging value (default: 2)

Value range for Param1: 2 ... 32000

- Median (`MEDIAN`):

4	Signal1	Signal to which the filter is applied (default value 01PEAK1)
18	Param1	Averaging value (default: 3)

Value range for Param1: 3|5|7|9

- Calculation (`CALC`), consisting of two summands (signal), sign/scaling (factor) and a constant (offset);
  Formula: CALC = (<factor1> * <signal1>) + (<factor2> * <signal2>) + <offset>
  The result of the calculation is written to a new variable <name>.

4, 5	Signal1 Signal2	Signal to be used for the calculation
13, 14	Factor1 Factor2	Value range *-32768.0 ... 32767.0 (unit mm)*
17	Offset	Value range *-21.47 ... 21.47 (unit mm)*
2	Name	*Name of calculation block; length min. 2 characters, max. 15 characters. Permitted characters a-zA-Z0-9, the name must start with a letter. Command names – e.g. STATISTIC, MASTER, NONE, ALL – are not permitted.*

- THICKNESS: Thickness calculation (difference) from two peaks;
  Formula: THICKNESS = <signal1> - <signal2>
  The result of the calculation is written to a new variable <name>.

4, 5	Signal1 Signal2	Signal to be used for the thickness calculation; signal1 > signal2
2	Name	*Name of calculation block; length min. 2 characters, max. 15 characters. Permitted characters a-zA-Z0-9, the name must start with a letter. Command names – e.g. STATISTIC, MASTER, NONE, ALL – are not permitted.*

- `COPY`: duplicates a signal
- `NONE`: deletes a calculation block

Subindex 12 `Available signals` lists the possible signals for the measured value calculation.

> i The object index determines the order of processing.
> Corresponds to the ID parameter of the ASCII command.

Example: Signal 01PEAK1 is to be filtered using a median filter and an average value filter; the sequence is median filter first, then average value filter.

1	Type	3 (Median)
4	Signal1	01PEAK1
18	Param1	<Averaging value>

Tab. 16.4: 0x2C00

1	Type	2 (recursive average)
4	Signal1	01PEAK1
18	Param1	<Averaging value>

Tab. 16.5: 0x2C01

Filters can also be applied to user signals.

16.4.2.38 Object 2E00h: User signals

2E00	RECORD	User calc			

Sub-indices

0	VAR	Number of entries	60	Uint8	ro
1	VAR	User calc 01		Visible string	ro
2	VAR	User calc 02		Visible string	ro
...					
3C	VAR	User calc 60		Visible string	ro

Names of the user signals that are output in the 0x7C0xh objects. The sequence specifies the order of the PDO data. The PDOs are selected via the 0x1B0xh objects.

16.5 Mappable objects - process data

Displays all individually available process data.

The objects 0x600x, 0x680x, 0x700x and 0x7C0x are structured as follows:

[INDEX]	[NAME]			
0	Sub-index 0	Int8	READ	1 (fixed)
1	Sub-index 1	[DATA TYPE]	READ	-

Objects 0x6000: Process data for channel 1.

Objects 0x7000: System process data (process data that are not available per channel).

Objects 0x7C00: Calculated process data.

i After switching on, the process data for the objects is not yet available. Only a successful change of status from PreOP to SafeOP makes the process data available which were selected through object 0x1C13h or the mapping objects for the PDO output. If the status is changed from SafeOP to OP, all previously selected process data will still be available.

INDEX	NAME	Data type / value range	Scaling	Unit
6000	01PEAK1 (thickness value)	INT32 -2^32-1 ... +2^32-1	10	pm
6030	SHUTTER	UINT32 10 ... 100000	value / 10	µs
6050	ENCODER1	UINT32 0 ... 2^32-1		Ticks
6051	ENCODER2	UINT32 0 ... 2^32-1		Ticks
6052	ENCODER3	UINT32 0 ... 2^32-1		Ticks
7000	COUNTER	UINT32 0 …2 ^32-1		
7001	TIMESTAMP	UINT32 0 … 2^32-1	value / 1000000	s
7002	FREQUENCY	UINT32 1538 ... 100000	10*1000 / value	kHz
7C00	UserCalcOutput01	INT32 -2^32-1 ... +2^32-1	10	pm
7C01	UserCalcOutput02	INT32 -2^32-1 ... +2^32-1	10	pm
...	...	...		
7C3B	UserCalcOutput60	INT32 -2^32-1 ... +2^32-1	10	pm

Tab. 16.6: Mappable objects

16.6 Error codes for SDO services

If an SDO requirement is evaluated as negative, a corresponding error code is added to the “Abort SDO Transfer Protocol”.

Error code hexadecimal	Meaning
0503 0000	Toggle bit did not change.
0504 0000	SDO protocol timeout expired
0504 0001	Invalid command entered
0504 0005	Insufficient memory
0601 0000	Access to object (parameter) not supported
0601 0001	Attempt to read a “write-only parameter”
0601 0002	Attempt to write a “read-only parameter”
0602 0000	Object (parameter) is not listed in the object directory
0604 0041	Object (parameter) cannot be mapped to PDO
0604 0042	Number or length of objects to be transmitted exceeds PDO length.
0604 0043	General parameter incompatibility
0604 0047	General internal device incompatibility
0606 0000	Access denied due to a hardware error

Error code hexadecimal	Meaning
0607 0010	Incorrect data type or length of the service parameter does not match
0607 0012	Incorrect data type or the service parameter is too long
0607 0013	Incorrect data type or the service parameter is too short
0609 0011	Sub-index does not exist.
0609 0030	Invalid value for the parameter (only for write access)
0609 0031	Value of parameter too high
0609 0032	Value of parameter too low
0609 0036	Maximum value is below minimum value.
0800 0000	General error
0800 0020	Unable to transfer data to the application or unable to save data
0800 0021	Unable to transfer data to the application or unable to save data. Cause: local control
0800 0022	Data cannot be transferred or saved in application due to device status.
0800 0023	Dynamic generation of the object directory failed or no object directory available

16.7 Oversampling

In operation without oversampling, the last measured value data set is transferred to the EtherCAT master with each fieldbus cycle, see Chap. 16.4.1.7. Therefore, many data records with measured values are not available for long fieldbus cycle periods. Configurable oversampling ensures that all (or selected) measurement data records are gathered and transmitted together to the master during the next fieldbus cycle.

The oversampling factor specifies how many samples are transmitted per bus cycle. An oversampling factor of 2, for example, means that 2 samples are transmitted per bus cycle.

With TxPDO mapping, the base index of the PDO mapping objects is included with oversampling factor 1. The following list is used to determine the index for selecting a different oversampling factor:

- Base index + 1: Oversampling factor 2
- Base index + 2: Oversampling factor 4
- Base index + 3: Oversampling factor 8

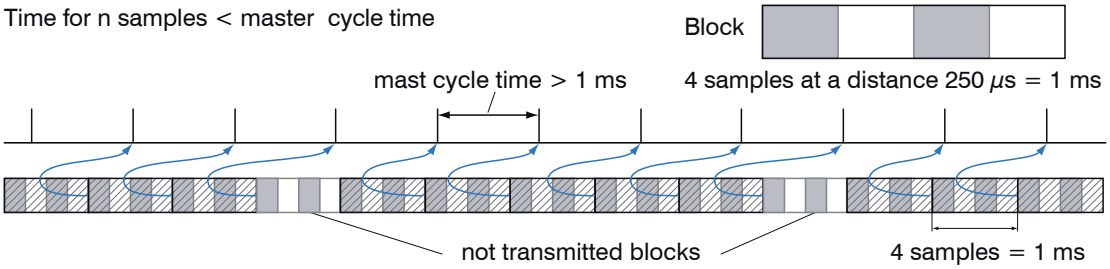
You can only select mapping objects with the same oversampling factor in 0x1C13h.

Example:

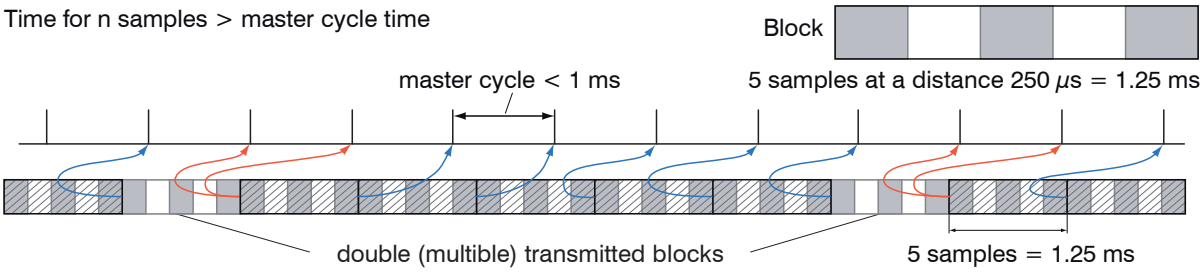
- The fieldbus/EtherCAT master operates at a cycle time of 1 ms because the higher-level PLC works with a cycle time of 1 ms. This means that an EtherCAT frame is sent to the interferoMETER every 1 ms to retrieve the process data.

  If the measurement frequency is set to 4 kHz, an oversampling of 4 must be set.
- Startup procedure to output the thickness value 1 (01PEAK1) with an oversampling factor of 4.
  - Set the object peak count 2156:01h to 1 in order to obtain a thickness.
  - Thickness 1 is output in object 6000h. In order to transfer this object in the PDO, the PDO mapping object 0x1A00 must be selected in object 0x1C13:01h. However, 0x1A02 (base index 0x1A00 + 2) must be selected for the 4-fold oversampling.

To ensure that no samples are lost due to the asynchronous nature between the master cycle and slave cycle, the master cycle time should always be less than the time for building a block from n samples. An entire block with the specified samples is only made available to the EtherCAT side after all specified samples have been written to the block. If the time for filling a block is less than the master cycle time, individual blocks will not be transferred. It can indeed happen that the next block is already being filled with samples before the previously filled block is picked up in a master cycle.



But if you select a number of samples sufficiently large that the time for filling a block is greater than the master cycle time, each block will be picked up in a master cycle. However, individual blocks (and therefore samples) will be transferred two or more times. This can be detected on the master side by transferring the timestamp or counter (see object 0x7000).



16.8 Calculation

Set a filter or a function, see Chap. 16.4.2.38.

16.9 Operating modes

16.9.1 Free run

No synchronization. The PDOs are updated according to the internal measuring rate. The measuring rate is set using object 0x2251h.

Use the measured value counter in 0x7000h or 0x1AE0h so that measured values are not evaluated twice due to the lack of synchronization.

16.9.2 Distributed clocks SYNC0 synchronization

The measuring rate is specified by the SYNC0 cycle time. In this mode, an EtherCAT master can synchronize the measurement acquisition for the EtherCAT cycle time and the measurement acquisition of multiple controllers.

Predefined SYNC0 cycle times are available in the ESI-XML file.

However, any cycle time between 41,667 ns (measuring rate = 24 kHz) and 10,000,000 ns (measuring rate = 0.1 kHz) can be set.

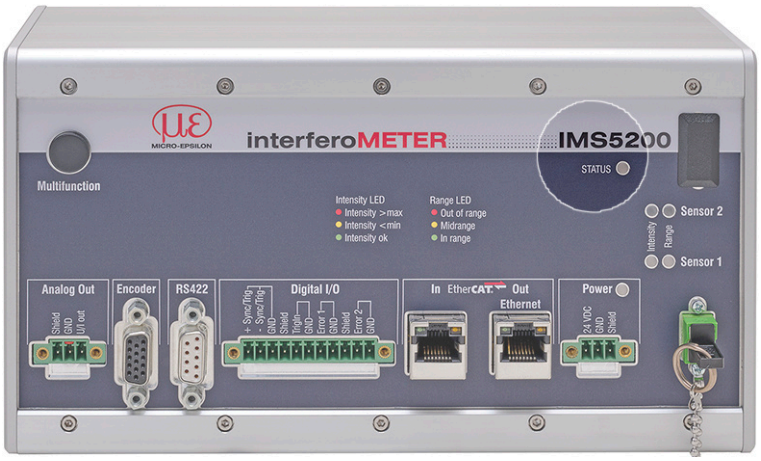
16.10 FFT signal via SDO

The output of the FFT signal is activated via object 0x2142:1h.

Each time an FFT image is triggered via object 0x2141:2h, the data of the new image is stored in object 0x8000h (channel 1) and 0x8800 (channel 2). The data is provided as a 1024 byte octet string. On the EtherCAT master side, the data must be interpreted as a vector of 16-bit unsigned integers.

The FFT signal can be output in parallel with the PDO output of process data. However, the process data in objects 0x6000h to 0x7FFFh are no longer updated cyclically as soon as an FFT signal is activated, but when an FFT image is triggered. This ensures that the thickness value calculated for this image can be assigned to each FFT image.

16.11 Meaning of the STATUS LED in EtherCAT operation



Status LED	**Green state:**	
	Green off	INIT state
	Green flashing 2.5 Hz	PRE-OP condition
	Green single flash, 200 ms ON / 1000 ms OFF	SAFE-OP state
	Green on	OP condition
	Red faults (displayed during the pauses of the green LED):	
	Red on	No interference
	Red flashing 2.5 Hz	invalid configuration
	Red single flash, 200 ms ON / 1000 ms OFF	Status change not requested
	Red double flash, 200 ms ON / 200 ms OFF 200 ms ON 400 ms OFF	Watchdog timeout
	Red flashing 10 Hz	Error during initialization

16.12 EtherCAT Configuration with the Beckhoff TwinCAT© Manager

The Beckhoff TwinCAT Manager can be used as EtherCAT master on the PC.

i Before you can use EtherCAT on the controller, the controller must be programmed for operation with EtherCAT, see Chap. 16.2.

► Copy the device description file (EtherCAT® slave information) to the `TwinCAT\3.1\ Config\Io\EtherCAT` directory before the measuring device can be configured with EtherCAT®.

IMS5200-TH <Micro-Epsilon_interferometer_5200.xml>
IMS5200MP-TH

The current device description file is available here: IMC5200_EtherCAT_XML.zip

► Delete any older files that may exist.

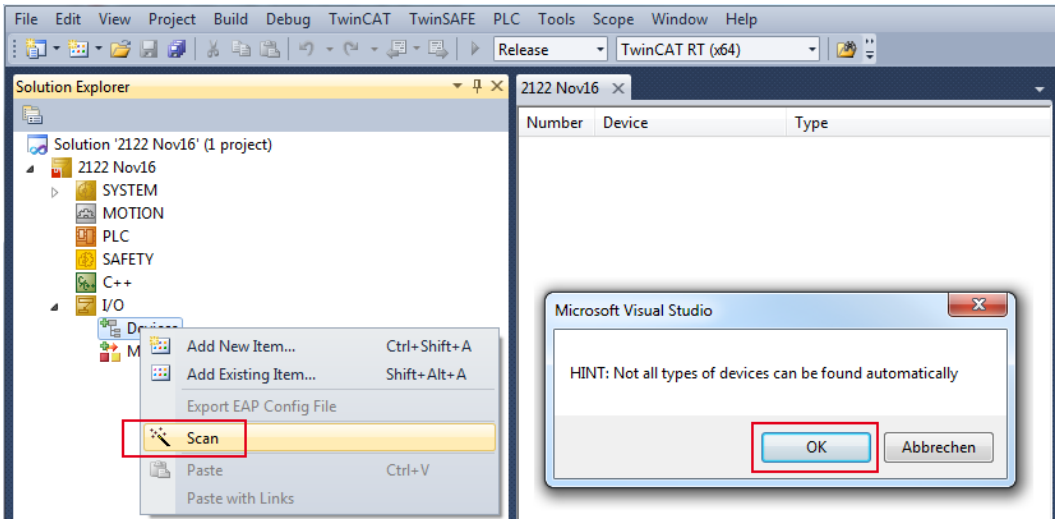
EtherCAT® slave information files are XML files which specify the characteristics of the slave device for the EtherCAT® Master and contain information on the communication objects supported.

► Restart the TwinCAT Manager after copying.

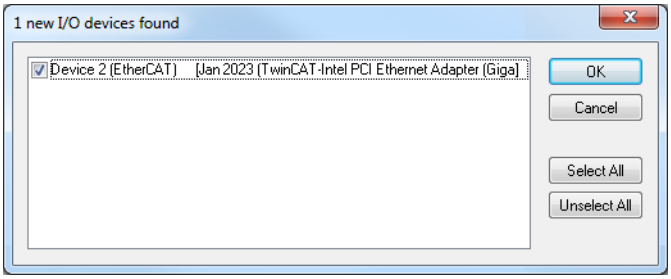
Search for a device:

► Select the `I/O Devices` tab and then `Scan`.

- Confirm with `OK`.

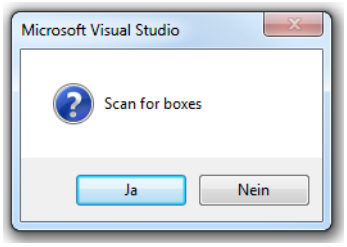


- Select a network card on which to search for EtherCAT® slaves.
- Confirm with `OK`.



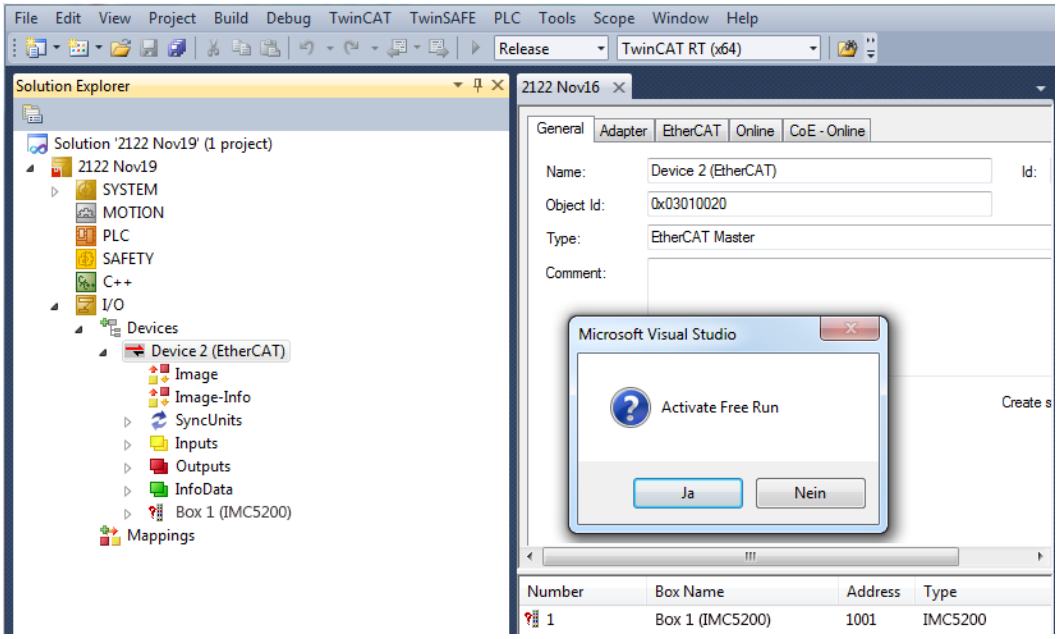
The "`Scan for boxes`" window appears (EtherCAT® slaves).

- Confirm with `Yes`.

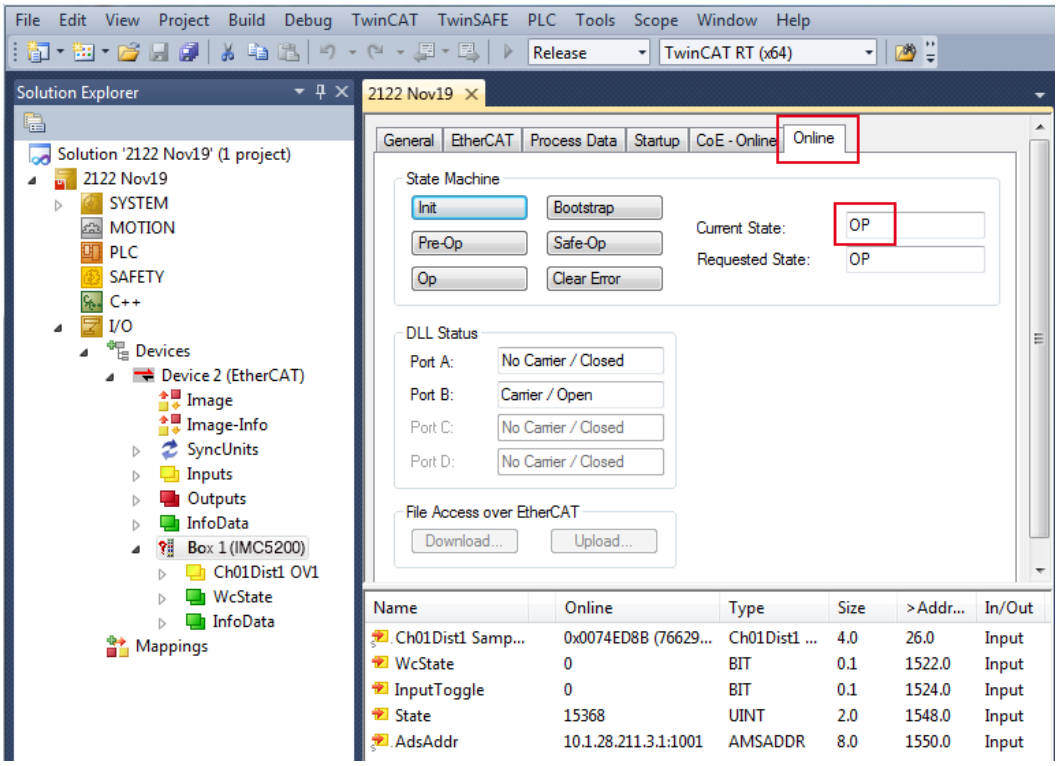


The interferoMETER is now listed in a list.

► Now confirm the `Activate Free Run` window with `Yes`.



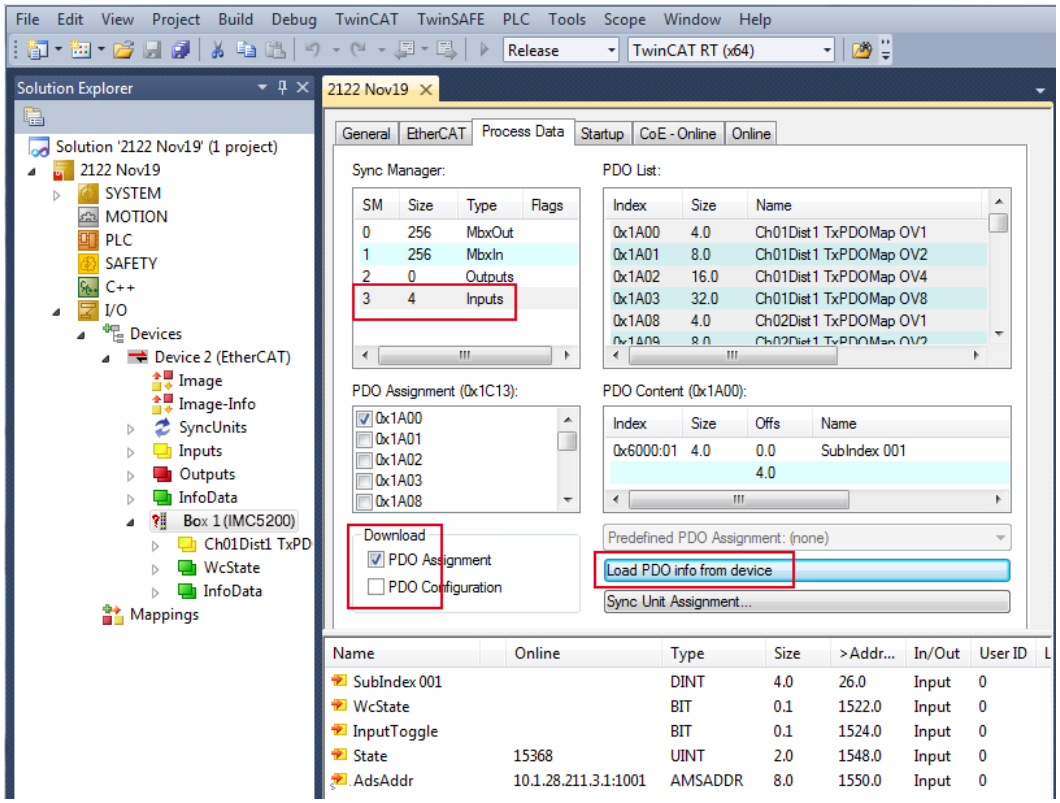
The current status should be at least `PREOP`, `SAFEOP` or `OP` on the `Online` page.



If `Current State ERR PREOP` appears, the cause is reported in the message window. This will be the case if the settings for the PDO mapping in the controller are different from the settings in the ESI file.

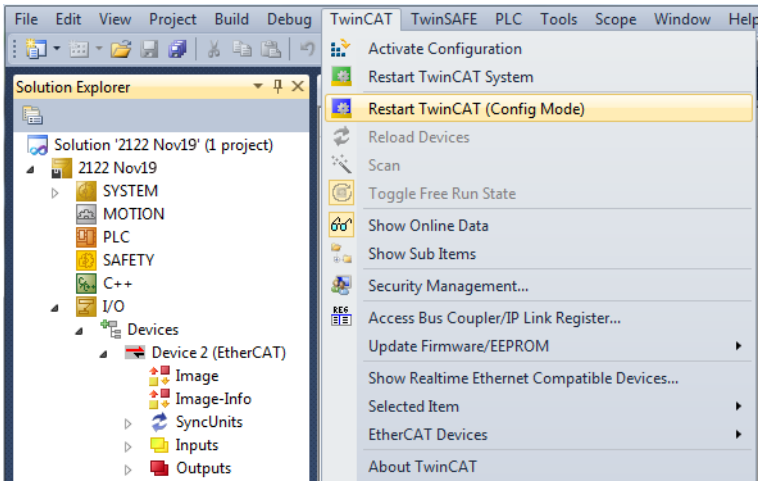
In the delivery state for the measuring device, only one measured value (thickness 1) is set as the output variable (both in the controller and in the ESI file).

Further data can be selected in the Process Data tab.



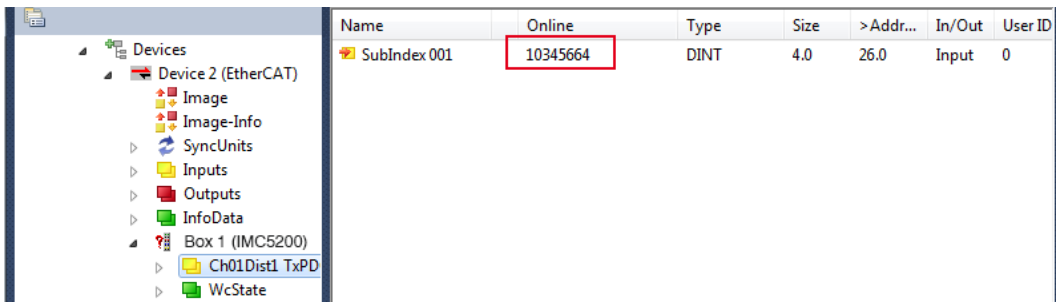
You can now view the scope of the available process data and the assignment of the sync managers.

- From the `TwinCAT` menu select the `Restart TwinCAT (Config Mode)` tab.



The configuration is now complete.

In `SAFEOP` and `OP` status, the selected measurement values are transferred as process data.



17 Telnet

17.1 General

The Telnet service allows you to communicate with the IMS5x00 from your PC. To communicate with Telnet, you will need

- an existing Ethernet connection between IMS5x00 and your PC,
- the ASCII commands, see Chap. 15.

17.2 Establishing the connection

► Start the `Telnet.exe` program via `Start > Run`.
► Enter the command `o 169.254.168.150` or the IP address of the controller.

```
->o 169.254.168.150

   .----------.
  /         ___ \
 / |    | /     )\
|  |    | \___   |
|  |    | /      |
\  |\_/ |/\___)/
       ,|
Connected with the MICRO-OPTRONIC terminal server.
Your IP 169.254.168.1, your local port number 51719. You
are connected to port number 23.
```

Fig. 17.1: Telnet start screen

A command always consists of the command name and zero or several parameters that are separated with a space. The currently set parameter value is reset if a command is invoked without parameters.

The output format is:

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

The returned command can be used again without changes for setting the password. 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.

> i If no connection is confirmed after sending the IP address, send a c to close the connection. Now send the command `o 169.254.168.150` again to establish the connection.

17.3 Error messages

The following error messages may appear:

- E01 Unknown command: An unknown parameter ID was submitted.
- E06 Access denied: This parameter cannot be accessed at the present time. The controller may not be in Professional mode or the parameter may not be visible due to other settings.
- E08 Unknown parameter: Not enough parameters were submitted.
- E11 The input value is outside the validity range, or the format is invalid: The submitted value is outside the validity range.

The text in the error messages depends on the set language. The error message identifier (Exx) is the same for every language.

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