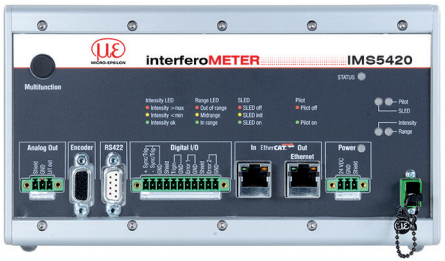
MICRO-EPSILON



Quick Manual
interferoMETER

IMS5420-TH
IMS5420MP-TH
IMS5420IP67-TH
IMS5420IP67MP-TH

Contents

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You can find further information about the measurement system in the operating instructions. They are available at:

https://www.micro-epsilon.com/download-file/man--interferometer-5420--en.pdf

General

Symbols used

The following symbols are used in this document:

⚠ 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.
`Measure`	Indicates hardware or a software button/menu.

Warnings

⚠ CAUTION

Avoid unnecessary laser radiation to be exposed to the human body.

➡ Switch off the controller for cleaning and maintenance.

➡ Switch off the controller for system maintenance and repair if the controller is integrated into a system.

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

Connect the power supply and the display/output device according to the safety regulations for electrical equipment.
> Risk of injury, damage to or destruction of the controller

NOTICE

The supply voltage must not exceed the specified limits.
> Damage to or destruction of the controller

NOTICE

Avoid shocks and impacts to the sensor and the controller.
> Damage to or destruction of the components

Never kink optical fibers or bend them in thight radii.
> Damage to or destruction of the optical fibers; failure of measurement device

Protect the ends of the optical fibers against contamination
> Failure of the measuring device

Protect the cable against damage.
> Failure of the measuring device

Intended Use

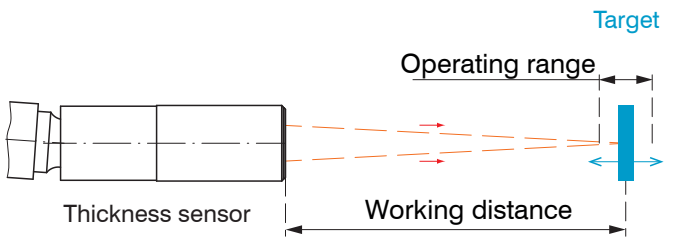
- The interferoMETER measuring system is designed for use in an industrial environments and domestic areas. It is used for measuring thickness and surface inspection, monitoring quality and checking dimensions.
- The measuring system must only be operated within the limits specified in the technical data, see operating instructions chap. 3.
- The measuring 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 controller.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

Proper Environment

Model		IMS5420-TH	IMS5420MP-TH	IMS5420IP67-TH	IMS5420IP67MP-TH
Protection class	Sensor	IP65 (optional IP67)			
	Controller	IP40		IP67	
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)			
	Operation Sensor	+10 … +50 °C (+50 ... +122 °F), front side		+10 … +60 °C (+50 ... +140 °F), front side	
	Operation Controller	+10 … +50 °C (+50 ... +122 °F)			
Humidity		5 – 95 % (non-condensing)			

Ambient pressure	Atmospheric pressure
EMV	According to EN 61000-6-3 / EN 61326-1 (Class B) and EN 61 000-6-2 / EN 61326-1

Glossary



You can find further information about the sensors in the operating instructions, chapter Technical Data.

Laser Safety

The following apply to the interferoMETER IMS5420, IMS5420MP, IMS5420IP67 and IMS5420IP67MP measuring systems:

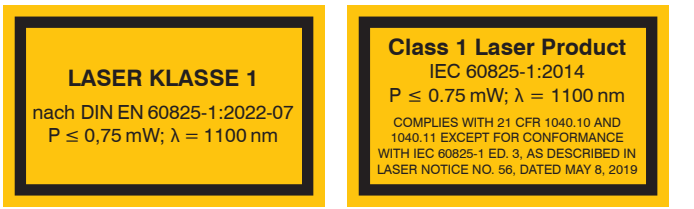
The measuring system works with a measuring laser of a wavelength of 1100 nm with a max. power of <0.75 mW.

The measuring system falls within laser class 1.

The accessible radiation is harmless under predictable conditions.

For class 1 laser devices, impairment of color vision and disturbances, e.g., from a glare effect, cannot be excluded.

An LED signalizes by illumination that laser radiation emits from the optical opening of the light source SLED.



Laser label measuring laser

The following apply to the interferoMETER IMS5420 and IMS5420MP measuring systems:

The measuring system works with a pilot laser of a wavelength of 635 nm (visible red) offering max. power of <0.2 mW.

The measuring system falls within laser class 1.

Laser label pilot laser

The accessible radiation is harmless under predictable conditions. For class 1 laser devices, impairment of color vision and disturbances, e.g., from a glare effect, cannot be excluded.

An LED signalizes by illumination that laser radiation emits from the optical opening of the light source `Pilot`.

Operating Modes

The interferoMETER measuring system provides highly accurate measurements of thicknesses for transparent layer materials, e.g. silicon wafers, at a wavelength of 1100 nm.

Silicon	0.05 ... 1.05 mm [1]
Air	0.2 ... 4 mm [2]

Measuring ranges for thickness measurements

The possible resolution here is in the nanometer range.

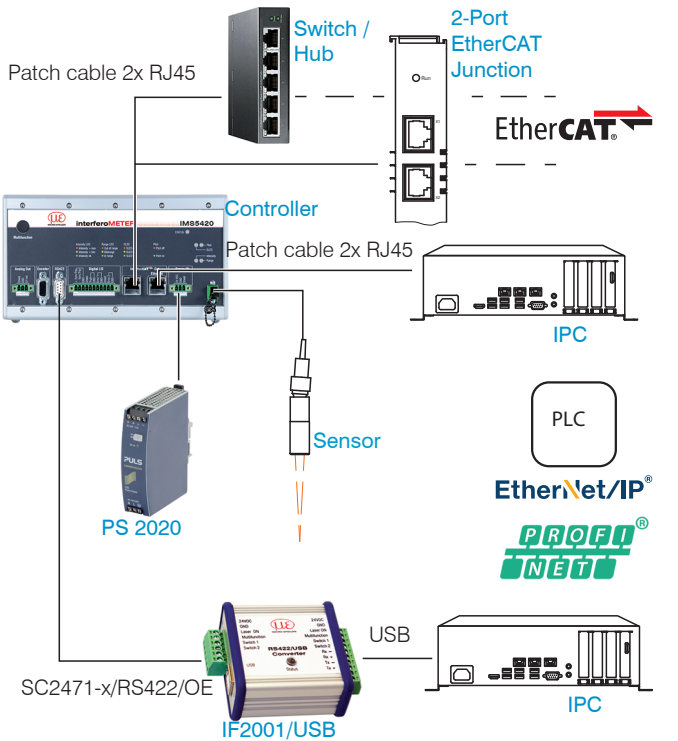
To get started quickly, it is recommended to use saved configurations (presets) for various target surfaces and applications, see instruction manual Chap. 6.6.

1) Measuring range at n=3.82 (silicon); measurable thickness depends on doping

2) For air gap measurement between two glass plates (n~1) the measuring range is 0.2 ... 4 mm. The measuring object must be within the working distance.

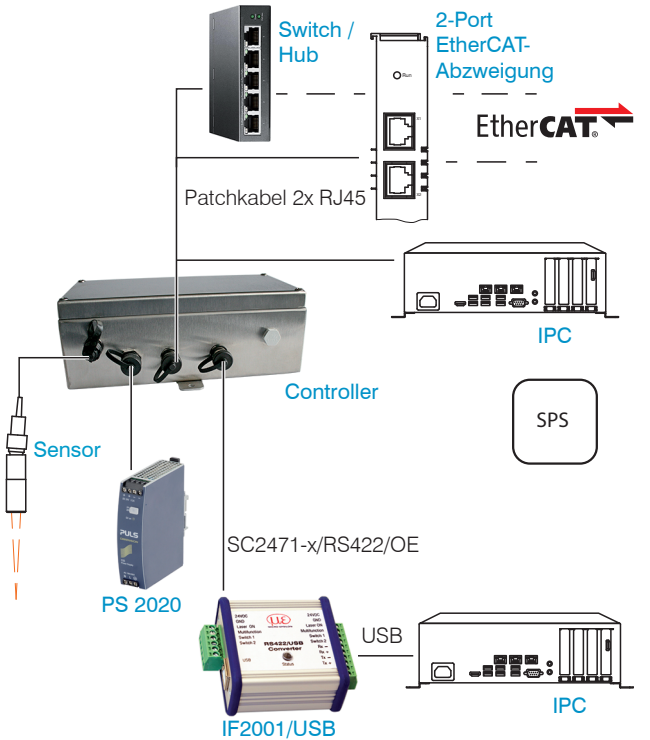
Setup, Connection Options

Connect the components together and mount the sensors into the clamps.



Connection examples on IMS5420, IMS5420MP

A more detailed description of the connection options is available in the operating instructions.

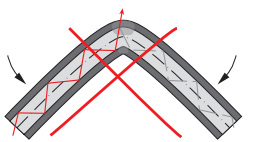


Connection examples on IMS5420IP67, IMS5420IP67MP

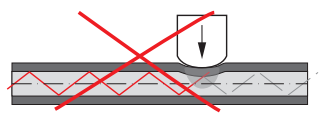
Sensor Cable

Sensor and controller are connected through an optical fiber.

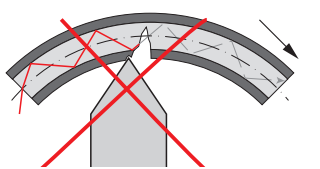
- Do not shorten or extend the optical fiber.
- Do not pull or hold the sensor on the optical fiber.



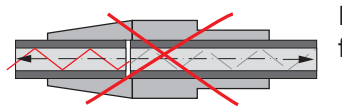
Do not kink the optical fiber.



Do not crush the optical fiber, do not fasten it using cable ties.



Please do not grind the optical fiber over sharp corners.



Do not pull the optical fiber.

Cleaning of the connectors requires the corresponding know-how.

General Rules

As a matter of principle, avoid:
- any contamination of the connector, e.g., dust or finger prints
- unnecessary mating cycles.
- any mechanical stress of the optical fiber (bending, crushing, pulling, twisting, 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 cable more tightly than the permissible bending radius.

Fixed:
R = 30 mm or more

Flexible:
R = 40 mm or more

Mounting, Mounting Adapter

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

i Ensure careful handling during installation and operation.

➡ Mount the sensors with an outer clamp. Use the MA5400-10 mounting adapter from the optional accessories.

This type of sensor installation ensures the highest level of reliability because the sensor's cylindrical cover is clamped over a relatively large area.

Electrical Connectors, IMS5420IP67

Supply Voltage

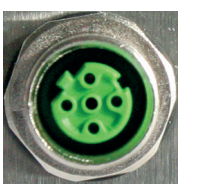
Pin	Color	Comment
1	Brown	$+U_B$ 24 VDC ± 15 %, I_{max} < 1 A
3	Blue	GND

4-pin M12 connector

Optional accessory: PC5420/IP67-x

Ethernet

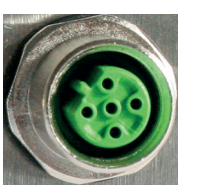
5-pin M12 female connector with D coding



Optional accessory:
shielded SC5420IP67-IE-x-RJ45 Ethernet cable

RS422

Pin	Color	Name
1	Yellow	RX -
2	Green	RX +
3	Grey	GND422
4	Pink	TX +
5	Brown	TX -

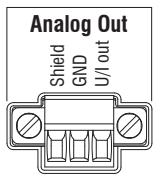
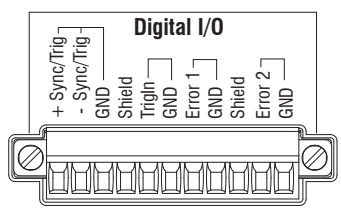
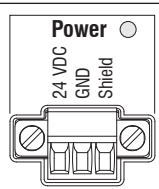


5-pol M12 Buchse

Optional accessory: SC5420IP67-OE-x

Wire colours correspond to the optional accessory cables.

Electrical Connectors, IMS5420

Pin	Description	Comments	
U/I out	Voltage output	0 ... 5 V; 0 ... 10 V; R_i appr. 50 Ohm 5.5 V / 10.9 V with error, outside measuring range	
	Current output	4 ... 20 mA; $R_L \leq$ 500 Ohm 23.7 mA with error, outside measuring range	
GND	Ground analog output	Galvanically connected with supply	
+Sync/Trig -Sync/Trig	Synchronization input/output, trigger input	RS422 level (EIA422)	
TrigIn	Trigger input	TTL or HTL level TTL: Low ≤ 0.8 V, High ≥ 2 V HTL: Low ≤ 3 V, High ≥ 8 V	
Error 1 / 2	Switch outputs	NPN, PNP or Push-Pull I_{max} = 100 mA, $U_{H\,max}$ = 30 V	
GND	Ground potentials	All GND conductors are interconnected with one another and to supply voltage ground.	
24 VDC	Supply voltage	± 15 %, I_{max} < 1 A	
GND	Supply voltage ground	GND is galvanically connected to GND of switching outputs, synchronization, analog and encoder input	
Shield	Shields to respective output/input, connector housing		

The plug-in screw terminals are designed for a conductor cross-section of 0.14 mm² up to 1.5 mm².

LEDs Controller

Power on	Green	Supply voltage available
Status	Off	No error
	If EtherCAT is active, meaning of the LED is conform with the Ether-CAT guide-lines.	
Intensity LED Intensity >max Intensity <min Intensity ok	Red	Signal in saturation
	Yellow	Signal too low
	Green	Signal ok
SLED SLED off SLED init SLED on	Red	SLED of
	Yellow	SLED warms up
	Green	SLED ready for operation
	Yellow flashing	SLED current outside the optimal value range [1]
Pilot Pilot off Pilot on	Red	Pilot laser off
	Green	Pilot laser on
	Green	Pilot laser is alternately turned on and off, if no target object or outside the measuring range

Range LED Out of range Midrange In range	Red	No target object, or target object outside the operating range. The expected number of peaks was not found or it was not possible to assign a thickness.
	Yellow	Target close to mid of working distance
	Green	Target within operating range The expected number of peaks was found. A valid thickness could be found for each peak.

1) When measuring outside the optimum current value of the SLED, the controller will measure, but the measurement accuracy may not be as specified.

LED IMS5420IP67

Power on	Green

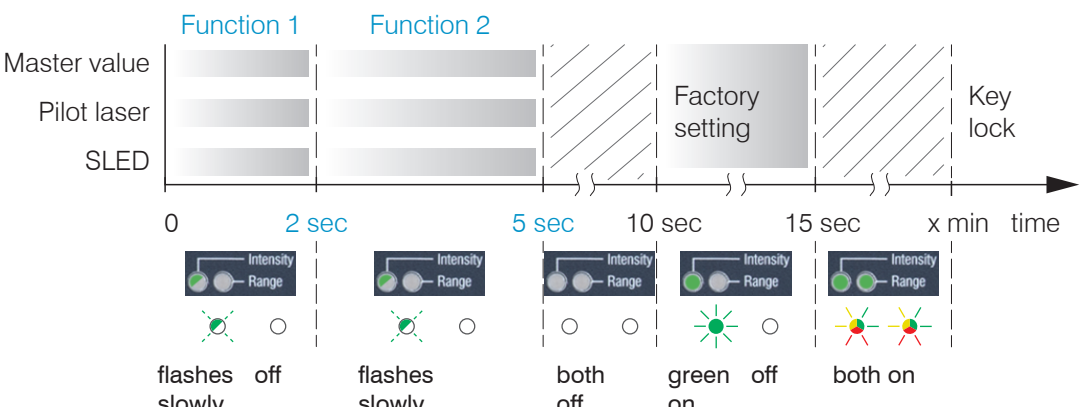
Supply voltage available

Button Multifunction, IMS5420

The `Multifunction` button of the controller has multiple functions. It enables, e.g., to operate the light source. The button is factory-set to the `Pilotlaser on/off` feature.

Key function 1 / 2	Set / reset master value	*Starts or stops the master measurement of the selected signals*
	Pilot laser	*Turns on/off the pilot laser*
	SLED	*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.



The `Intensity` and `Range` LEDs indicate the currently selected function.

Multifunction Button Actuation Time

Initial Operation

i 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.

The controller is factory set to the static IP address 169.254.168.150. Use this address for a direct connection with a browser.

The start screen of the controller software is now displayed in the web browser.

You can check the IP address of the controller, that are connected to a PC / network, with the sensorTOOL.exe program. This program is available online at https://www.micro-epsilon.com/download/software/sensorTOOL.exe.

➡ Start the program sensorTOOL and click the button 

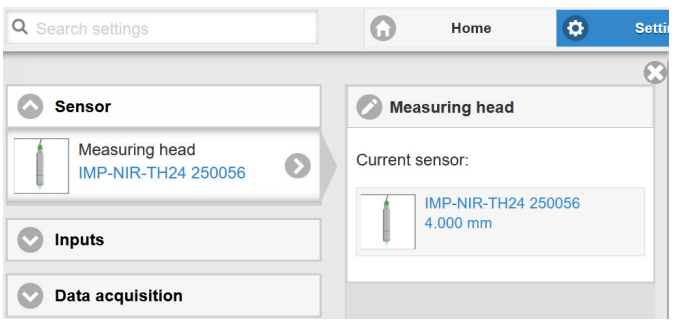
.

➡ Click the `Open Website` button to connect the controller to your default browser.

Select a Sensor

➡ Change to the `Settings` > `Sensor` menu.

➡ Select a sensor from the list.



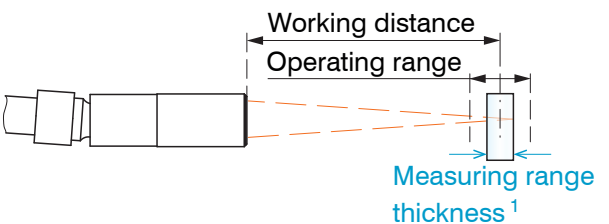
Positioning the Target, Thickness Measurement

The red-light pilot laser supports you in aligning the sensor to the target during commissioning.

Turn on or off the pilot laser in the menu `Settings` > `System settings`.

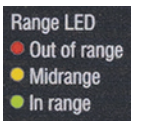
➡ Position the target (measurement object) as much as possible in the mid of the measuring range.

The peak positions remains stable in the FFT signal, even though the measurement target moves. The peak position depends on the target thickness.



Basics thickness measurement

The LED `Range` on the controller front indicates the position of the target in relation to the sensor.



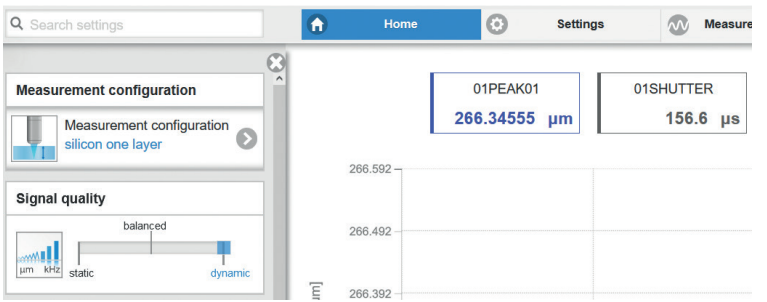
Red	No target or target outside the operating range
Yellow	Target close to the working distance
Green	Target within operating range

Green	Pilot laser is turned on and off alternately, if no target or outside the measuring range

1) The thickness measuring range is 0.05 ... 1.05 mm for n=3.82 (silicon); for air gap measurement between two glass plates (n~1) the measuring range is 0.2 ... 4.0 mm.

Presets, Measurement Configuration

Common measurement configurations (presets) for various target surfaces are stored on the controller. This allows you to quickly start with your individual measurement task. In a preset the basic features like peak or material selection and calculation functions are already set.



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

➡ Go to the `Home` > `Measurement configuration` menu and start the `Measurement configuration`.
Select a configuration.

Then, you can apply your own settings (setups).

When saving a modified preset, the web interface displays a dialog for entering a setup name. This prevents presets from being overwritten by accident. Data output only starts when the associated interface is activated.

Preset	IMS5420 IMS5420IP67	IMS5420MP IMS5420IP67MP
silicon one layer	•	•
silicon p plus plus	•	•
silicon two layers		•
multilayer silicon air		•
multilayer paste silicon		•

• possible preset

Overview possible presets

Signal Quality

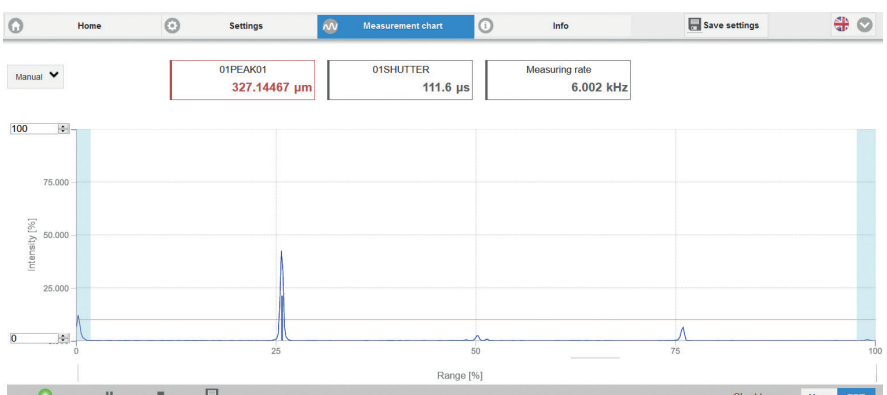
Using the `Signal quality` function, you can influence the measuring rate and the respective averaging. Averaging with the `Median` function is specified by the preset. The subsequent moving averaging is specified by the `Signal quality` function.

Averaging	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.

FFT Signal Check

Go to the `Measurement chart` menu. Show FFT signal display with `FFT`. The signal in the chart window shows the target thickness. Left 0 % (small thickness) and right 100 % (large thickness). The corresponding measured value is marked by a vertical line (peak marking). The diagram starts automatically when the website is called.



Number of Peaks

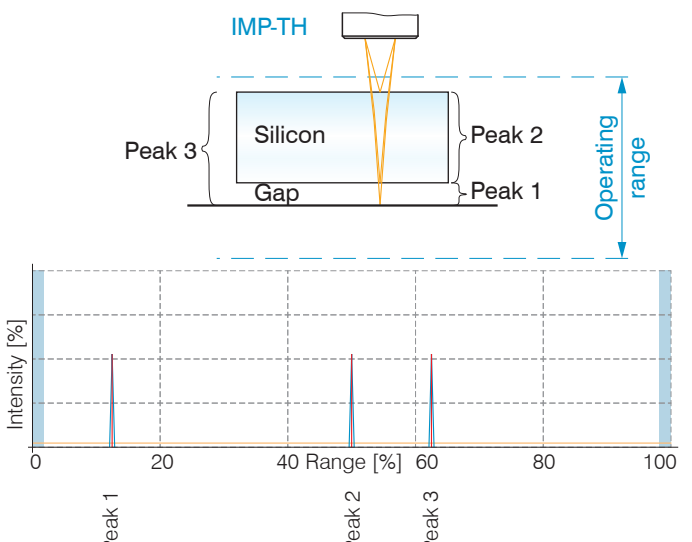
Number of peaks of the FFT signal used for evaluation in thickness measurement. The number of peaks can be selected in the `Settings` > `Data recording` > `Number of peaks`.

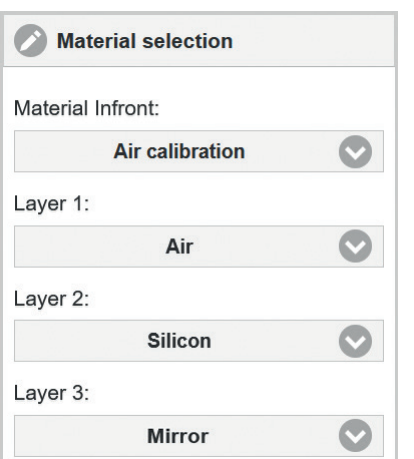
This function is possible for the following systems:
- IMS5420MP and IMS5420IP67MP: max. 5 layers

Make sure to count the peaks in the correct manner, see Chap. Peak Sorting.

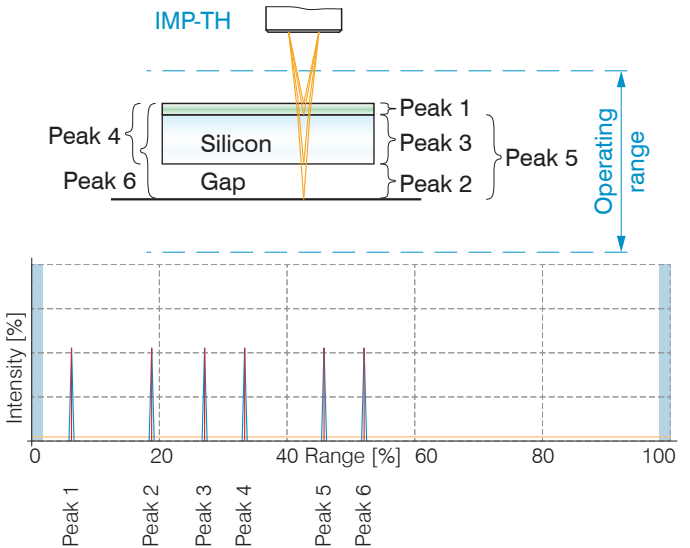
The material selection for a thickness measurement starts with the thinnest layer (layer 1) independent of the physical arrangement in the measuring object.

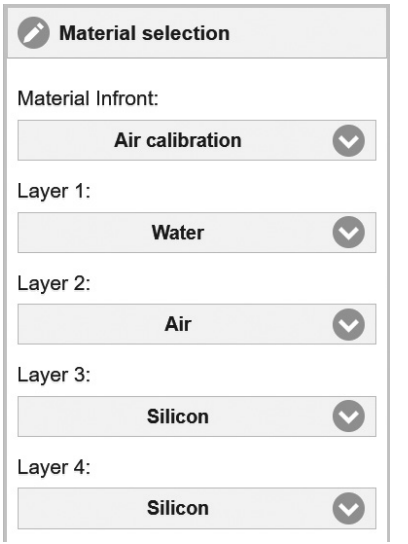
Example of a layer of silicon and gap, measpeak sorting: First, corresponding material selection





Example of silicon with paste and gap, measurement peak sorting: First, selected material





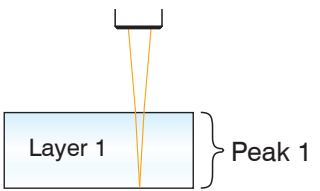
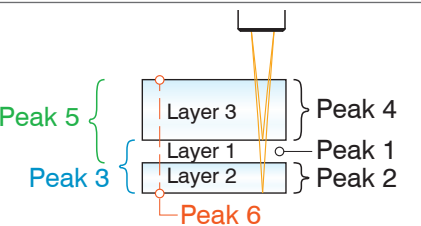
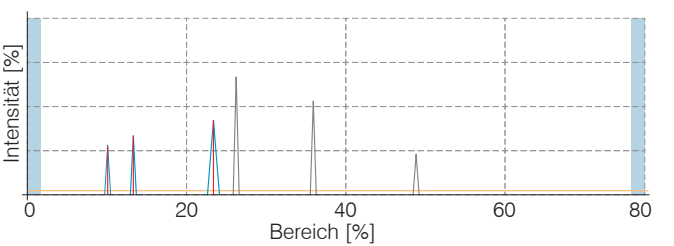
The IMS5420MP and IMS5420IP67MP controllers can also measure the thickness of combined layers of the same material.

A material does not necessarily have to be selected for layer 4. Peak 4 stands for a combination layer of paste and silicon. The controller evaluates this layer; however, the result has no significance in the measurement.

Peak Sorting

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

- Switch to material selection by going to `Settings` > `Data recording`.
- Switch to the chart type `FFT`.
- Choose between `First peak` and `Highest peak`.

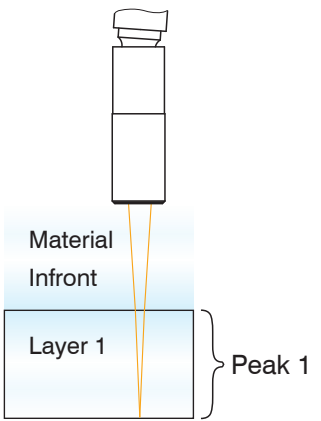
IMS5420 and IMS5420IP67	IMS5420MP and IMS5420IP67MP
	
The IMS5420 and IMS5420IP67 evaluates one layer. The peak in the FFT signal already corresponds to the thickness. It is not necessary to decide between the first and highest peak.	 *Evaluation starts with the first peak, e.g. 3 out of 4 peaks*
	The IMS5420MP and IMS5420IP67MP evaluates up to five layers. 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.

In the case of a target consisting of several transparent layers, the material must be assigned for each layer. 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. Material Selection.

The number of peaks of the FFT signal that are used for evaluation are to be determined separately, see Chap. Number of Peaks.

Material Selection

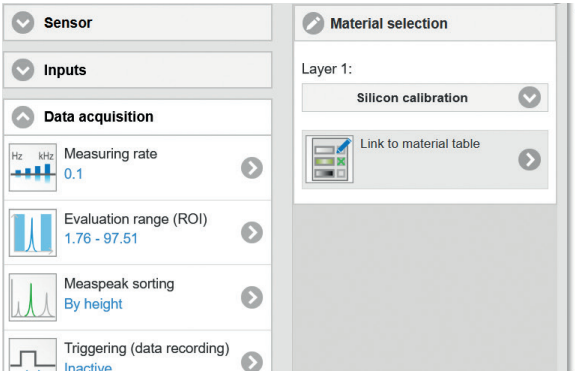
The refractive index needs to be corrected in the controller for an exact thickness measurement. Only air may be present between the sensor face and the measuring object (`Material Infront`); other media such as water or alcohol are not permissible.

	➡ Switch to material selection by going to `Settings` > `Data recording`. ➡ 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.

➡ Switch to the `Settings` > `Data recording` > `Link to material table` menu.

➡ Assign the material according to the target used.



material name	phase index	Group refractive index	phase shift	description
Air calibration	1.000259	1.000262	0.000000	Calibration material
Vacuum calibration	1.000000	1.000000	0.000000	Calibration material
Silicon calibration	3.545000	3.820000	0.000000	1100 nm, laboratory conditions, Schinke et al. 2015
Vacuum	1.000000	1.000000	0.000000	Perfect vacuum
Air	1.000274	1.000276	0.000000	1100 nm, laboratory conditions, Ciddor et al. 1996
Silicon	3.545000	3.820000	0.000000	1100 nm, laboratory conditions, Schinke et al. 2015
Water	1.324000	1.340500	0.000000	1100 nm, 20degC, Daimon and Mesura et al. 2007

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

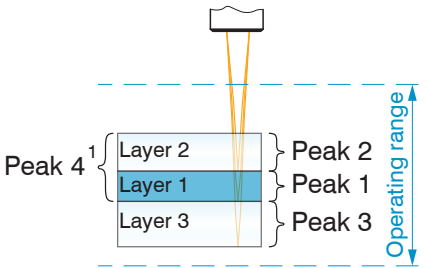
Click the icon to change an existing entry.

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.

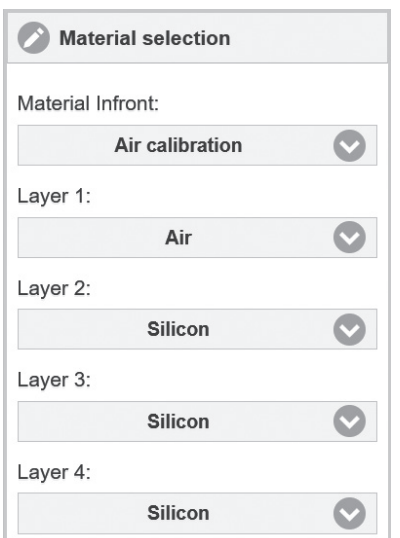


- Switch to material selection by going to `Settings` > `Data recording`.
- Assign the materials to the individual layers according to the target used.

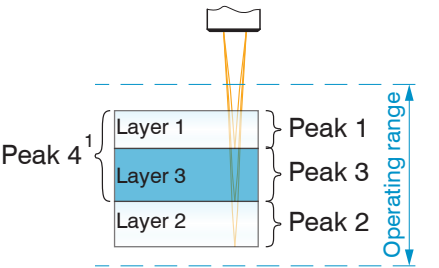
Compared to the example on the left, the thickness of the middle layer (blue) has increased and is greater than the top and bottom layers. The material selection must be adjusted for this case.

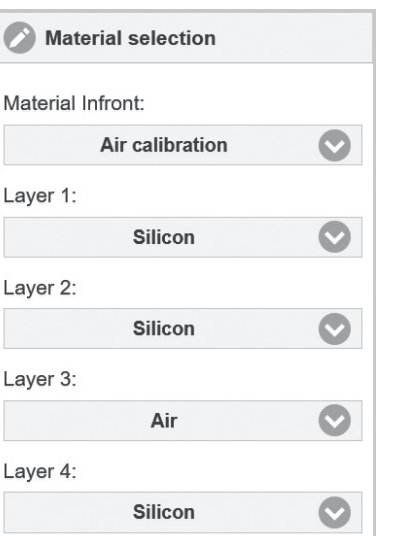
In the FFT signal, peak 1 up to peak 3 change places, see Chap. Peak Sorting.

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



1) The IMS5420MP and IMS5420IP67MP controllers also evaluate combined thicknesses of different layers. A material does not necessarily have to be selected for layer 4. Peak 4 stands for a combination layer of the two upper layers. The controller evaluates this layer; however, the result has no significance in the measurement.





Output Values

Output value	Description	Min	Max	Scaling	Unit
01ABS (2048 x 16Bit)	FFT signal	0	2047	value / 2048 * 100	%
01SHUTTER	Exposure time	1	100000	value / 10	µs
01ENCODER1	Encoder	0	UINT32_MAX	value	Encoder ticks
01ENCODER2	Encoder	0	UINT32_MAX	value	Encoder ticks
01ENCODER3	Encoder	0	UINT32_MAX	value	Encoder ticks
01AMOUNT[01..16]	Intensity	0	UINT32_MAX	(value & 0xfffff) / 2048 * 100	%
MEASRATE	Sample rate	1666	100000	10000 / value	kHz
TIMESTAMP	Time information	0	UINT32_MAX	value	µs
COUNTER	Frame counter	0	UINT32_MAX	value	
STATE	State word	0	UINT32_MAX	see instruction manual for details	
01PEAK[01..16]	Thickness value	INT32_MIN	see below	value * 10	pm
USERNAMED VALUES	Calculation result	INT32_MIN	0x7ffffeff	wie 01PEAK[01..16]	pm

Output values with RS422 and Ethernet

01PEAK[01..16]	0x7fffff04	There is no peak present
	0x7fffff05	Peak is located in front of the operating range
	0x7fffff06	Peak is located behind of the operating range
	0x7fffff07	Measuring value cannot be calculated
	0x7fffff08	Measuring value cannot be evaluated
	0x7fffff0E	Hardware error

Thickness Measurement, Web Page Display

- Align the sensor vertically to the target object.
- Then, move the sensor (or the target) closer, until you more or less reach the working distance for your sensor.

Once the object is within the sensor's measuring range, the `Range` LED (green or yellow) on the front of the controller will light up. Or, observe the FFT signal.

`Measurement` *web page (thickness measurement)*

1 Changes only take effect after clicking the `Save settings` button.

2 In the window on the left, the signals can be enabled or disabled both during and after the measurement. Inactive graphs are gray. Click on the check mark to add them. The changes take effect when saving the settings. Use the eye symbols to show and hide the single signals. The calculation continues in the background.
   - 01PEAK01: Chronological sequence of displacement signal

3 `Auto` (= automatic scaling) or `Manual` (= manual setting) allow for scaling the measurement axis (Y axis) of the graphic.

4 The current values for distance, exposure time, current measuring rate and time stamp are displayed in the text boxes above the graphic. Errors are displayed as well.

5 Mouseover feature. When moving the mouse over the graph, curve points are highlighted with a circle symbol while the corresponding values are displayed in the text boxes above the graph.

6 X axis scaling: The total signal is zoomable with the slider on the left side during running measurement. The time range can be defined in the input field below the time axis. If the diagram is stopped, you can also use the right slider. The zoom window can also be moved with the mouse in the center of the zoom window (arrow cross).

7 The LED visualizes the status of the transmission of measured values:
   - green: transmission of measured values is running.
   - yellow: waiting for data in trigger mode
   - gray: transmission of measured values stopped

   Data queries are controlled by using the `Play/Pause/Stop/Save` buttons of the measured values that were transmitted. `Stop` stops the diagram; data selection and zoom function are still possible. `Pause` interrupts recording. `Save` opens the Windows selection dialog for file name and storage location to save the FFT signals resp. measurement values in a CSV file (separation with semicolon).

   ➡ Click the button ▶ (Start), for starting the display of the measurement results.

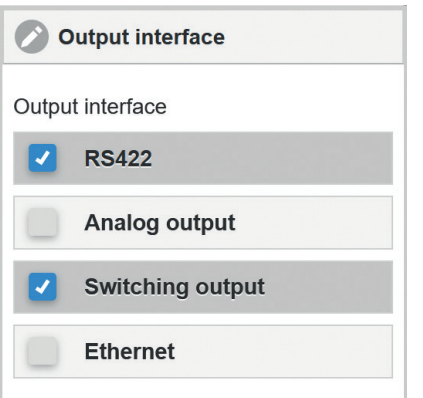
8 The two buttons allow to switch between FFT signal and measurement representation.

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. For measurement value detection without direct process control, for subsequent analysis. Parameterization is provided through the web interface or ASCII commands.
  - 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.



Selecting the required interfaces for data output

Ethernet

The controller transmits TCP/IP or UDP/IP packages with an Ethernet transfer rate of 10 Mbit/s or 100 Mbit/s. The transfer rate is selected automatically depending on the connected network or PC.

When transmitting measurement data to a measurement server, following successful connection (TCP or UDP), the sensor sends each measurement to the measurement server or to the connected client. No explicit request is necessary for this.

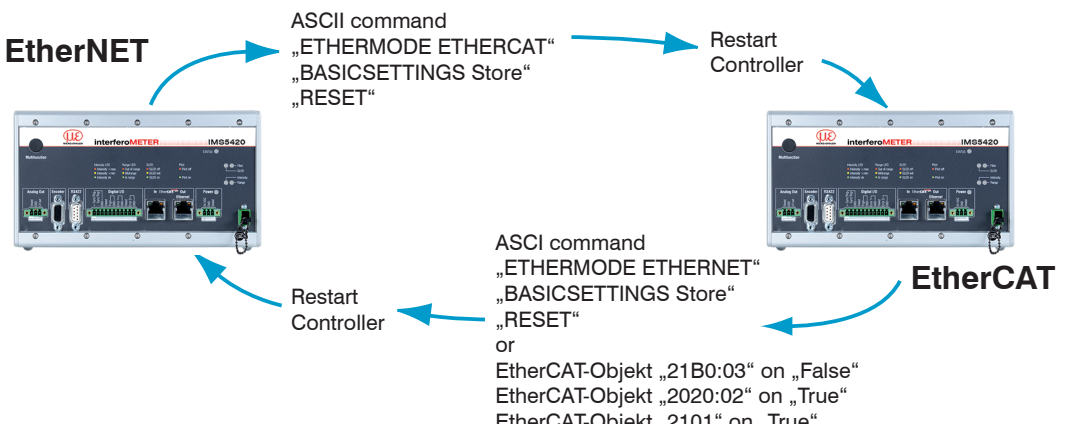
Thickness values are transmitted as 32 bit signed integer value with 10 pm resolution.

Set IP Address

- Change to the menu `Settings > Outputs > Ethernet Settings` and enter the new IP address.
- Click on `Apply settings` to confirm.
- Start the web interface with the new IP address.
- Save the new device settings. Click on `Save settings`.

Switching between Ethernet and EtherCAT

You can switch between Ethernet and EtherCAT using an ASCII command, the web interface or an EtherCAT object. 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.

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 and 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/.

For translations into other languages, the German version shall prevail.

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