More Precision

# interferoMETER IMS5420 // High precision inline wafer thickness measurement

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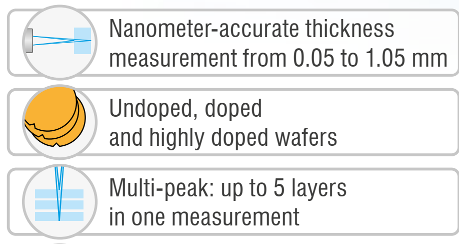
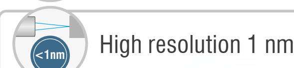
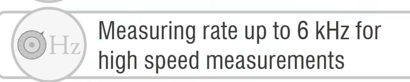


- Nanometer-accurate thickness measurement from 0.05 to 1.05 mm
- Undoped, doped and highly doped wafers
- Multi-peak: up to 5 layers in one measurement



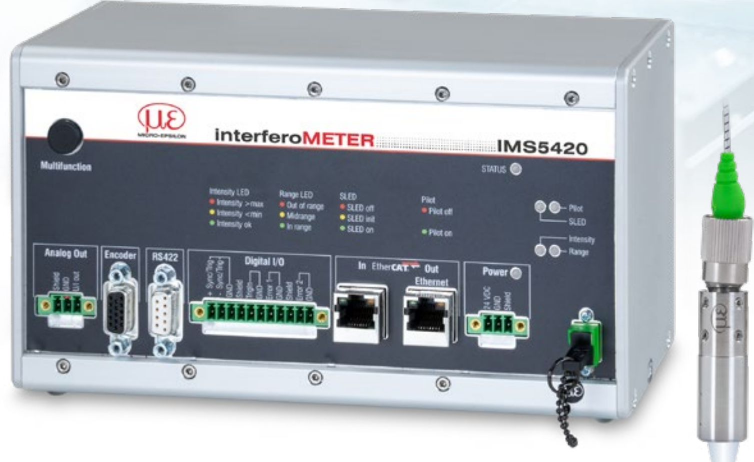
- High resolution 1 nm



- Measuring rate up to 6 kHz for high speed measurements

- Ethernet / EtherCAT / RS422 / PROFINET / EtherNet/IP

- Easy configuration via web interface




**Stable wafer thickness measurement in inline processes**

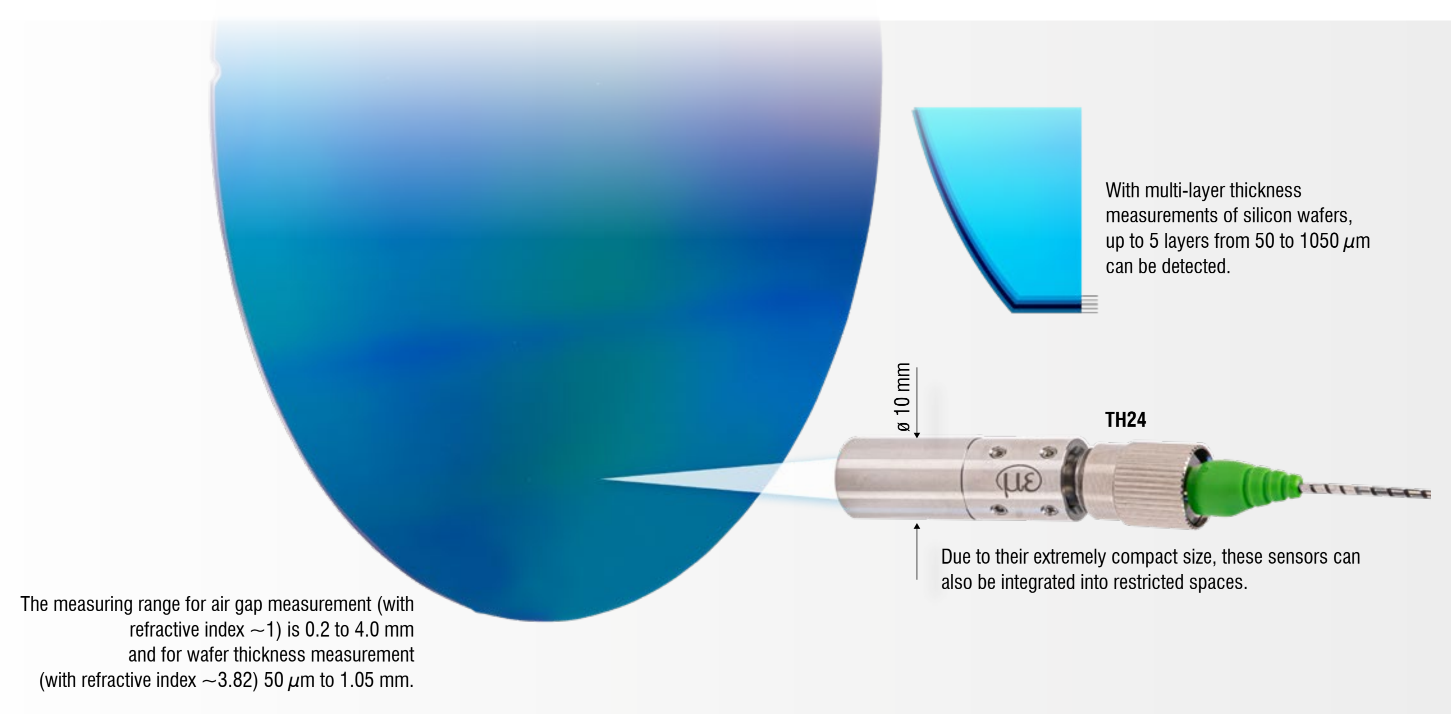
The IMS5420-TH white light interferometer opens up new perspectives in industrial thickness measurement of monocrystalline silicon wafers. Due to its broadband superluminescent diode (SLED), the IMS5420-TH can be used for undoped, doped and highly doped SI wafers. In wafer thickness measurements, the IMS5420-TH impresses with an excellent price/performance ratio.

The white light interferometer achieves a signal stability in the submicrometer range. The thickness can be measured from a distance of 24 mm. The measuring system is therefore ideally suited for inline measurements.

The measuring system is available as a thickness measuring system or as a multi-peak thickness measuring system. The multi-peak system measures thicknesses of up to five layers, e.g., wafer thickness, air gap, films and coatings.

In addition to silicon wafers, the IMS5420 also precisely detects the thickness of silicon carbide wafers.

For thickness measurements in harsh environmental conditions, the IMS5420/IP67 controller is available with IP67 and stainless steel housing.




With multi-layer thickness measurements of silicon wafers, up to 5 layers from 50 to 1050 µm can be detected.

Due to their extremely compact size, these sensors can also be integrated into restricted spaces.

The measuring range for air gap measurement (with refractive index ~1) is 0.2 to 4.0 mm and for wafer thickness measurement (with refractive index ~3.82) 50 µm to 1.05 mm.

| Model | | IMS5420-TH24 | IMS5420MP-TH24 | IMS5420IP67-TH24 |
|---|---|---|---|---|
| Working distance | | 24 mm ±3.0 mm | | |
| Measuring range (thickness) | Silicon | 0.05 … 1.05 mm [1] | | |
| | Air | 0.2 … 4 mm [2] | | |
| Resolution [3] | | < 1 nm | | |
| Measuring rate | | continuously adjustable from 100 Hz to 6 kHz | | |
| Linearity [4] | | < ±100 nm | < ±100 nm with one layer<br>< ±200 nm for other layers | < ±100 nm |
| Temperature stability | | temperature compensated, stability < ±50 ppm between +10 ... +50 °C | | |
| Multi-peak measurement | | 1 layer | up to 5 layers | 1 layer |
| Light source | | NIR-SLED, wavelength 1100 nm<br>Pilot laser: laser LED, wavelength 635 nm | | NIR-SLED, wavelength 1100 nm |
| Laser safety class | | Class 1 in accordance with DIN EN 60825-1: 2022-07<br>Pilot laser: Class 1, power (< 0.2 mW) | | Class 1 in accordance with DIN EN 60825-1: 2022-07 |
| Light spot diameter [5] | | 20 µm | | |
| Max. tilt angle [6] | | ±1.5° | | |
| Supply voltage | | 24 VDC ±15 % | | |
| Power consumption | | approx. 10 W (24 V) | | |
| Signal input | | Sync in, trigger in, 2x encoders (A+, A-, B+, B-, index) | | - |
| Digital interface | | Ethernet / EtherCAT / RS422 / PROFINET [7] / EtherNet/IP [7] | | Ethernet / 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)<br>and FC socket (sensor);<br>standard length 1 m, 3 m and 5 m;<br>other cable lengths on request;<br>bending radius: static 30 mm, dynamic 40 mm | | pluggable optical fiber via IP9 SC socket (controller)<br>and FC socket (sensor);<br>standard length 1 m and 2 m;<br>other cable lengths on request;<br>bending radius: static 45 mm, dynamic 60 mm |
| | Electrical | 3-pin supply terminal strip;<br>encoder connection (15-pin, HD-sub socket, max. cable length 3 m,<br>30 m with external encoder supply);<br>RS422 connection socket (9-pin, Sub-D, max. cable length 30 m);<br>3-pin output terminal strip (max. cable length 30 m);<br>11-pin I/O terminal strip (max. cable length 30 m);<br>RJ45 socket for Ethernet (out) / EtherCAT (in/out) (max. cable length 100 m) | | 4-pin M12 connector for supply;<br>RS422 connector<br>(5-pin, M12, max. cable length 30 m);<br>RJ45 socket for Ethernet (out) /<br>EtherCAT (in/out) (max. cable length 100 m) |
| Mounting | Sensor | Clamping, mounting adapter (see accessories) | | |
| | Controller | Free-standing, DIN rail mounting | | Through bores |
| Temperature range | Storage | -20 … +70 °C | | |
| | Operation | Sensor: +10 … +50 °C (front);<br>Controller: +10 … +50 °C | | Sensor: +10 … +60 °C (front);<br>Controller: +10 … +50 °C |
| Shock (DIN EN 60068-2-29) | | 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 | IP67 | | |
| | Controller | IP40 | | IP67 |
| Vacuum | | Optional UHV (cable and sensor) | | |
| Material | Sensor | Stainless steel | | |
| | Controller | Aluminum housing, passive cooling | | Stainless steel housing |
| Control and indicator elements | | Multifunction button: two adjustable functions<br>and reset to factory settings after 10 s;<br>web interface for setup: selectable presets, freely selectable averaging,<br>data reduction, setup management;<br>6 x color LEDs for intensity, range, SLED, pilot laser, status and power;<br>pilot laser: can be switched on for sensor alignment | | web interface for setup: selectable presets,<br>freely selectable averaging possibilities,<br>data reduction, setup management;<br>Power LED |

All data at constant ambient temperature (22 ±3 °C)

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

[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.

[3] Measuring rate 0.5 kHz, moving average over 64 values, measured on an approx. 0.8 mm thick silicon (2 sigma) polished on both sides.

[4] Maximum thickness deviation when measuring on an approx. 0.8 mm thick silicon polished on both sides (n=3.8) when passing through the measuring range

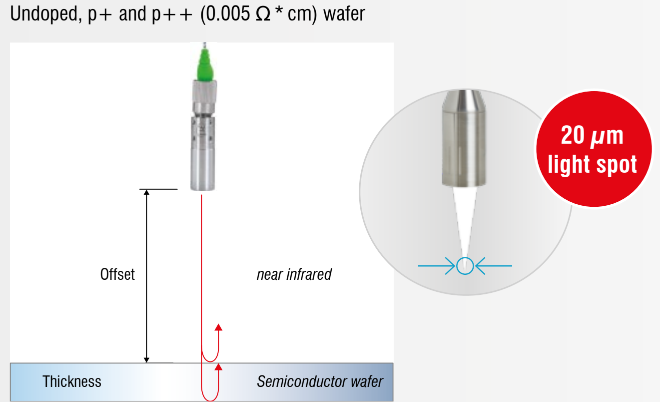
[5] With a working distance of 24 mm (TH-24) or 17.5 mm (204)

[6] Maximum sensor tilt angle that produces a usable signal on an approx. 0.8 mm thick silicon in the mid of the measuring range. The accuracy decreases when approaching the limit values.

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

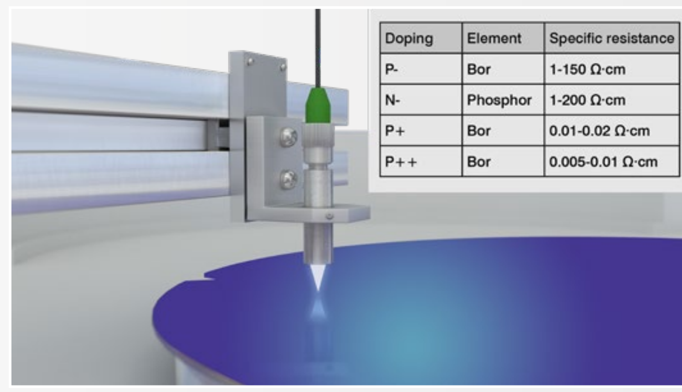
Features
# interferoMETER IMS5420

Undoped, p+ and p++ (0.005 Ω * cm) wafer




Due to the optical transparency of silicon wafers, interferometers can precisely detect the thickness in the wavelength range of 1.100 nm. At these wavelengths, both undoped silicon and doped wafers provide sufficient transparency. The transparency of silicon allows thickness measurement of wafers up to 1.05 mm. The measurable thickness of air gaps is even up to 4 mm.

The IMS5420 interferometer enables the thickness measurement of undoped, doped and highly doped silicon wafers and thus offers a wide range of applications. This wafer thickness measuring system is ideal for the measurement of monocrystalline silicon wafers with a geometric thickness of 50 to 1050 µm and a doping of up to 0.005 Ω*cm. Even for highly doped wafers with a specific resistance of 0.005 Ω*cm, thicknesses from 0.05 mm to 0.85 mm can be measured. This results in decreasing transparency with increasing doping.



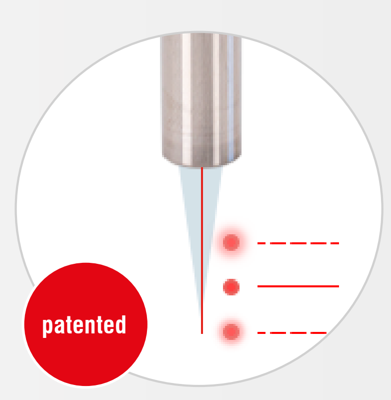
| Doping | Element | Specific resistance |
|---|---|---|
| P- | Bor | 1-150 Ω·cm |
| N- | Phosphor | 1-200 Ω·cm |
| P+ | Bor | 0.01-0.02 Ω·cm |
| P++ | Bor | 0.005-0.01 Ω·cm |

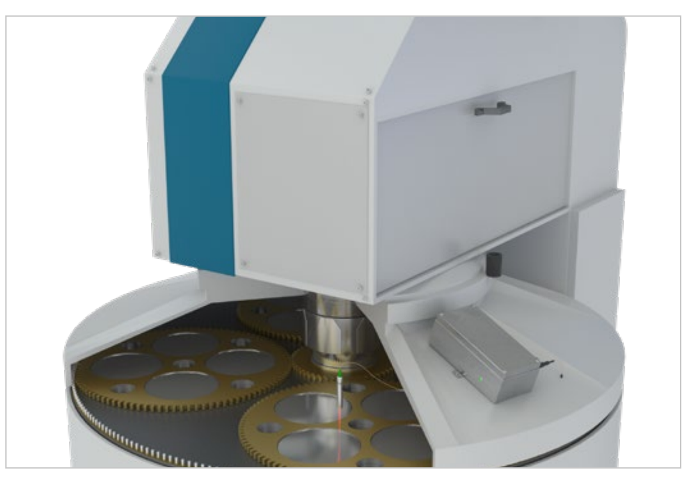
## User-friendly web interface for easy operation

The entire configuration of the measuring system is performed without additional software via a user-friendly web interface. The web interface is accessed via an Ethernet connection and allows quick and easy setting of e.g. averaging, measuring rate or presets and offers a material table for stable thickness measurements.

## Pilot laser for exact visualization of the measuring point

White light interferometers work with infrared, non-visible light (approx. 1100 nm wavelength), which means that the measurement position cannot be seen directly. To visualize the measuring position, the sensors are equipped with a pilot laser which projects a light spot onto the measuring position. In addition, the pilot laser uses a patented method to provide feedback on the distance in addition to the measurement position. If the measuring object is at the correct distance and within the measuring range, a constant glow is emitted by the pilot laser. If the measuring object is outside the measuring range, the pilot laser flashes.



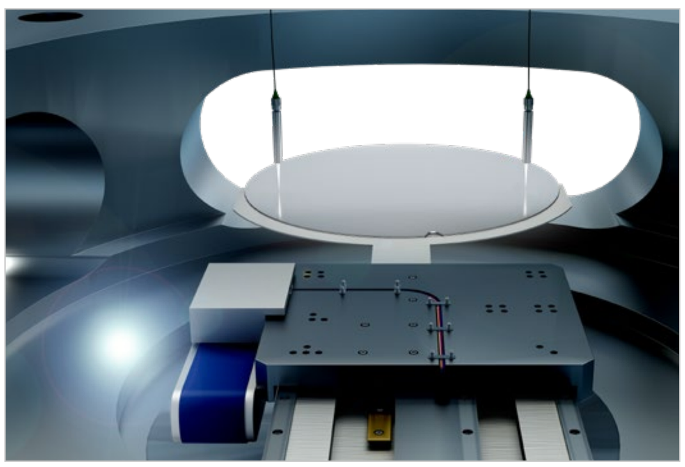


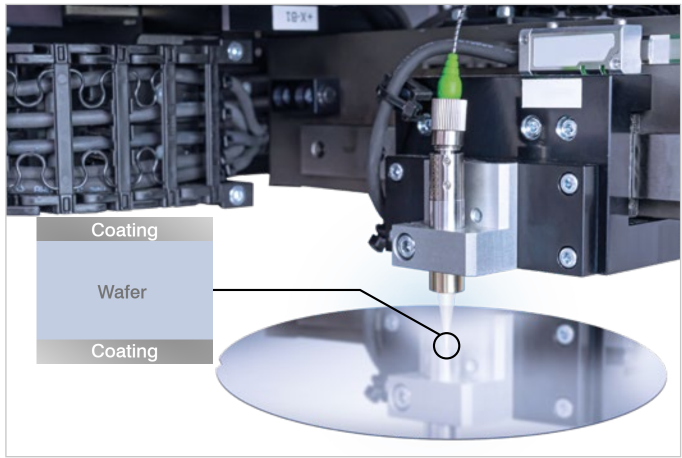
**IMS5420/IP67 controller with robust design for challenging environments**

The special design with IP67 protection and a protective housing made of stainless steel was specially designed for inline thickness measurements in challenging environments, e.g. during grinding and lapping of wafers. The measuring system and the sensor specially adapted to this measurement task achieve optimum measurement performance.

**Precise thickness measurement during lapping**

In wafer fabrication, a crystalline silicon ingot is cut into thin slices of about 1 mm. The discs are then ground and lapped to obtain the desired thickness and surface finish. To achieve high process stability, interferoMETERs are used for inline thickness measurement in lapping and grinding machines. Due to its compact design, the sensor can also be integrated in confined installation spaces. The thickness values are used for machine control as well as for quality control of the wafer.






**Inline wafer inspection EOL**

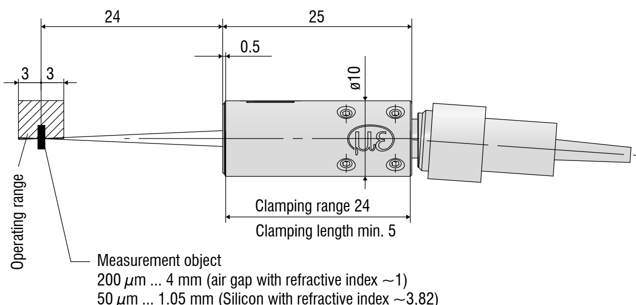
In the semiconductor production, highest precision is essential. High throughput, optimized process operating costs, simple and comprehensive process control, and consistent coating results play an important role in end-of-line quality control of silicon wafers. The white light interferometer from Micro-Epsilon inspects the thickness and/or layer thickness in the nanometer range without contact before the packaging process.

**Layer thickness control of coated wafers in inspection machines**

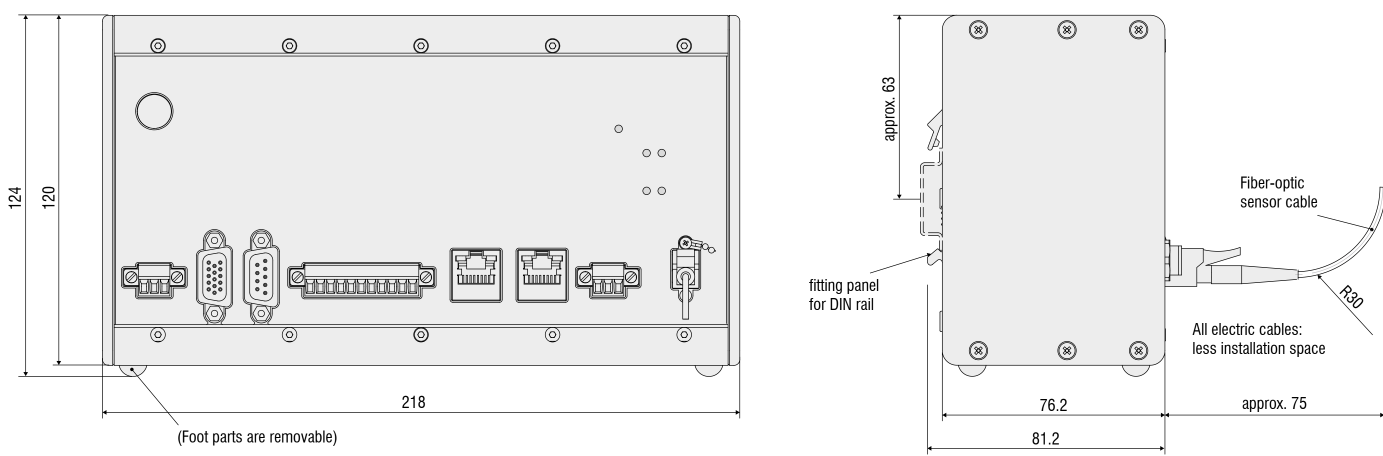
Wafers for semiconductor production consist of many individual layers. A complex and precise procedure is used for the application of each layer. Before a new layer is applied, the freshly applied layer must be checked for possible defects. A deviating layer thickness can affect the chip performance. If defects are not detected immediately after the layer buildup, they may not be discovered until the final inspection. With this measurement, the thickness of each individual layer and unwanted deviations are detected precisely.

# Dimensions
# interferoMETER IMS5420

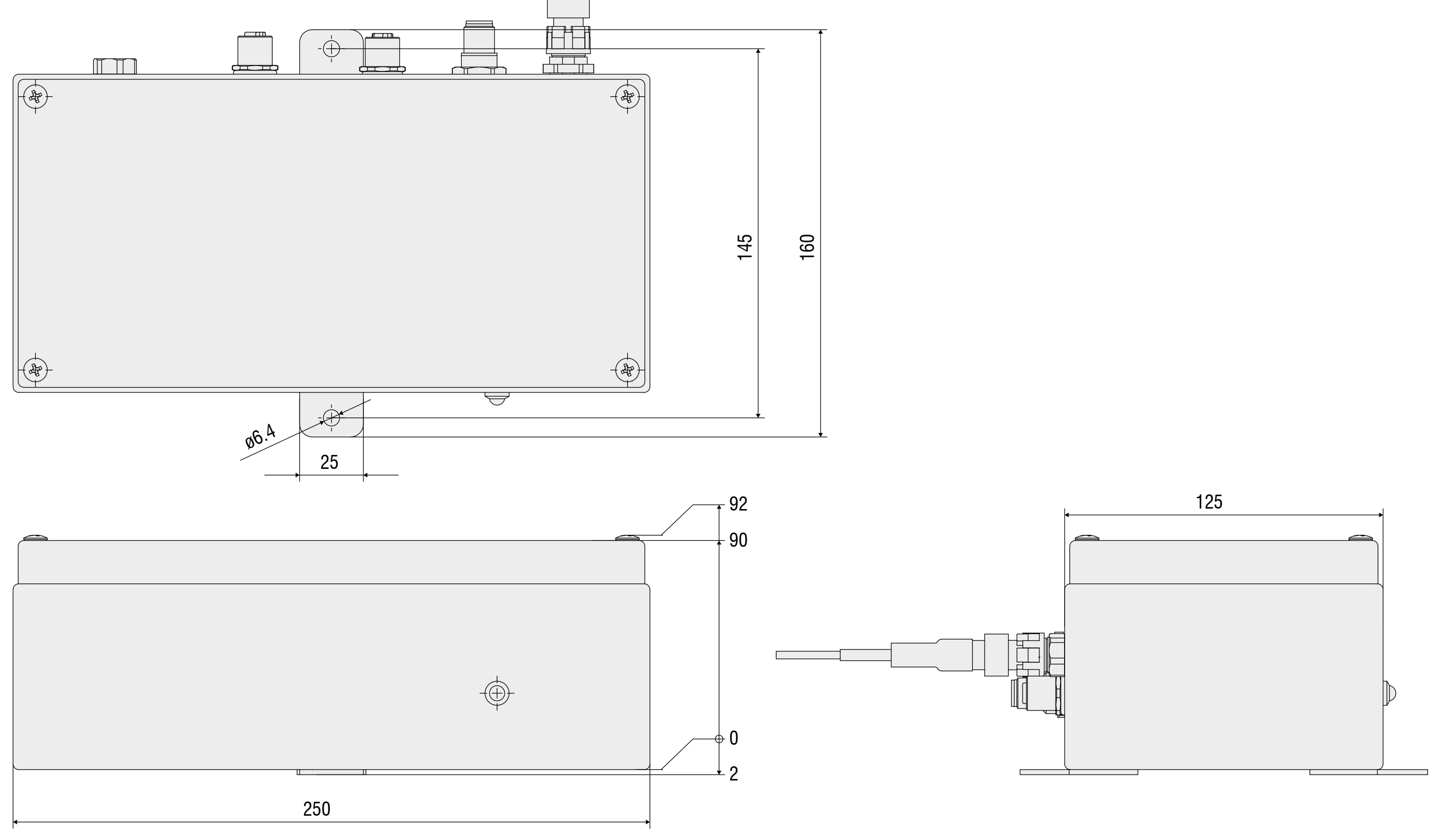
### IMS5420-TH24 Sensor




### IMS5420-TH24 Controller




### IMS5420/IP67-TH24 Measuring system with controller housing made of stainless steel and protection class IP67



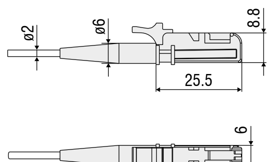
**Cables**

**Standard E2000/APC (controller) and FC/APC connector (sensor)**

| | |
|---|---|
| C5421-1 | Optical fiber, length 1 m |
| C5421-2 | Optical fiber, length 2 m |
| C5421-3 | Optical fiber, length 3 m |
| C5421-5 | Optical fiber, length 5 m |

Other lengths up to 20 m on request

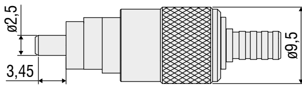
**E2000/APC standard connector**



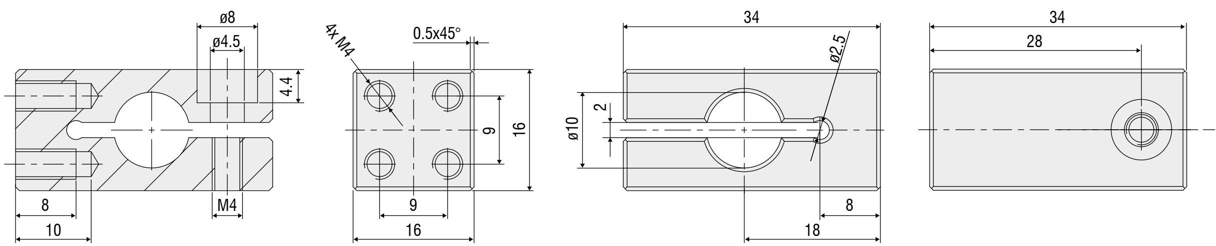

**With protection class IP67, IP9 SC socket (controller) and FC/APC connector (sensor)**

| | |
|---|---|
| C5421/IP67-0,5 | Optical fiber, length 0.5 |
| C5421/IP67-1 | Optical fiber, length 1 |
| C5421/IP67-2 | Optical fiber, length 2 |

**FC/APC standard connector**




**Sensor mounting adapter for sensor TH24**




**Other accessories**

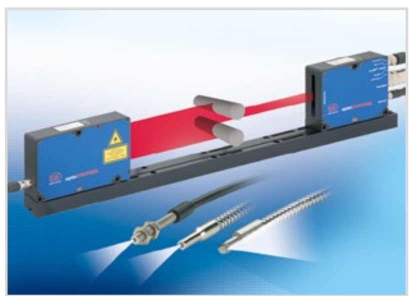
| | |
|---|---|
| SC2471-x/IF2008 | IMC5400/5600 connector cable+ IF2008/PCIE, length 3 m / 10 m |
| SC2471-x/RS422/OE | IMC5400/5600 interface cable + IF2001/USB, length 3 m / 10 m |
| IF2001/USB | RS422/USB converter |
| IF2008/PCIE | Interface card |
| IF2035/PNET | Interface module for PROFINET integration |
| PS2020 | Power supply 24V / 2.5A |
| EC2471-3/OE | Encoder cable, 3 m |

## Sensors and Systems from Micro-Epsilon

Sensors and systems for displacement, position and dimension

Sensors and measurement devices for non-contact temperature measurement

Measuring and inspection systems for quality assurance



Optical micrometers, fiber optics, measuring and test amplifiers

Color recognition sensors, LED Analyzers and inline color spectrometers

3D measurement technology for dimensional testing and surface inspection

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