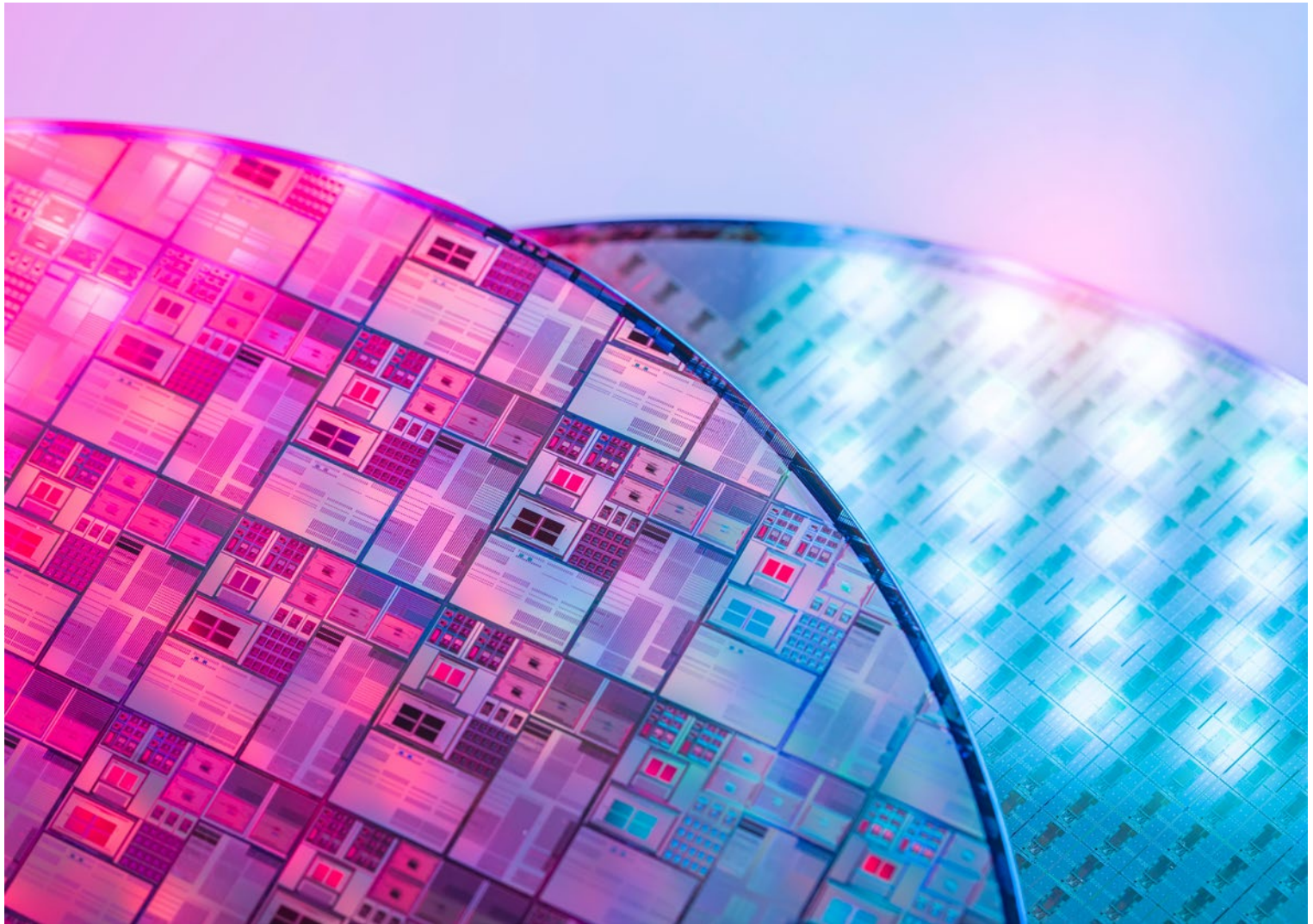# Sensors & Applications
Vacuum

MICRO-EPSILON

More Precision.

Micro-Epsilon sensors in a vacuum

- Vacuum areas
- Typical industries
- Requirements
- Measurement variations
- Measuring in a vacuum
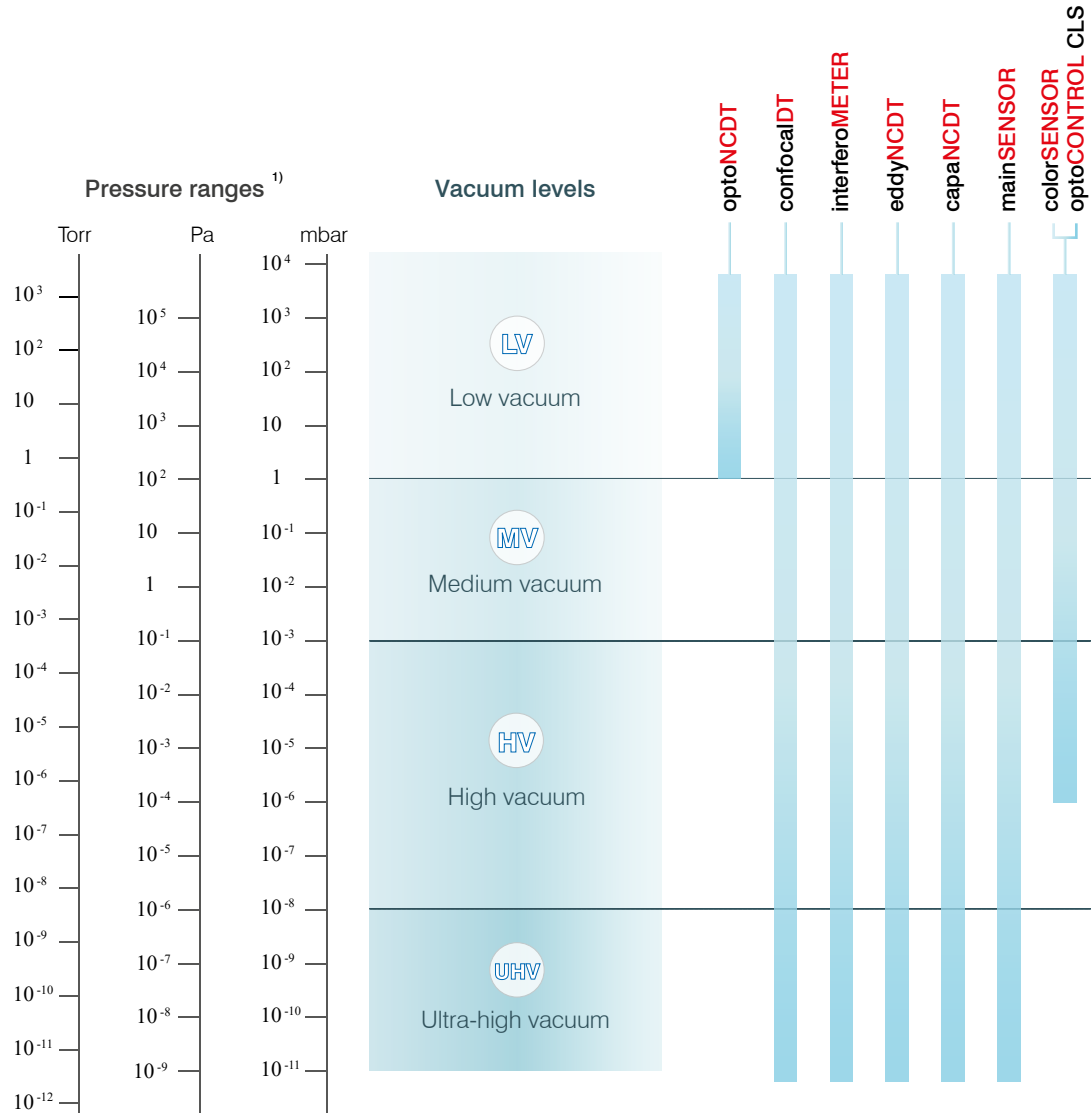- Measuring from outside onto the vacuum

		Catalog product	OEM solution
Measuring in a vacuum			
Optical sensors	**optoNCDT** // Laser displacement sensors	✓	✓
	confocalDT // Confocal chromatic sensor system	✓	✓
	interferoMETER // High-precision white light interferometer	✓	✓
Electromagnetic sensors	**eddyNCDT** // Eddy current-based inductive sensors	✓	✓
	capaNCDT // Capacitive sensors for displacement, distance & position	✓	✓
	mainSENSOR // Magneto-inductive displacement sensors	✓	✓
Color and fiber-optic sensors	**optoCONTROL CLS** // Fiber-optic sensors **colorSENSOR CFO** // True Color measuring systems	✓	✓

		Catalog product	OEM solution
Measuring from outside onto vacuumed environment			
Optical sensors	**optoNCDT** // Laser displacement sensors	✓	✓
	confocalDT // Confocal chromatic sensor system	✓	✓
Color sensors	**colorSENSOR** // True Color sensors	✓	✓
	colorCONTROL // Color measuring systems	✓	✓
2D/3D detection	**optoCONTROL** // Optical precision micrometers	✓	✓

Vacuum areas

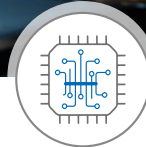The high-performance and robust sensors from Micro-Epsilon can be used up to ultra-high vacuum (UHV).

Pressure ranges [1]

Torr	Pa	mbar
10^3	10^5	10^4
10^2	10^4	10^3
10	10^3	10^2
1	10^2	10
10^{-1}	10	1
10^{-2}	1	10^{-1}
10^{-3}	10^{-1}	10^{-2}
10^{-4}	10^{-2}	10^{-3}
10^{-5}	10^{-3}	10^{-4}
10^{-6}	10^{-4}	10^{-5}
10^{-7}	10^{-5}	10^{-6}
10^{-8}	10^{-6}	10^{-7}
10^{-9}	10^{-7}	10^{-8}
10^{-10}	10^{-8}	10^{-9}
10^{-11}		10^{-10}
10^{-12}	10^{-9}	10^{-11}

Vacuum levels

LV — Low vacuum

MV — Medium vacuum

HV — High vacuum

UHV — Ultra-high vacuum

Sensors: optoNCDT, confocalDT, interferoMETER, eddyNCDT, capaNCDT, mainSENSOR, colorSENSOR, optoCONTROL CLS
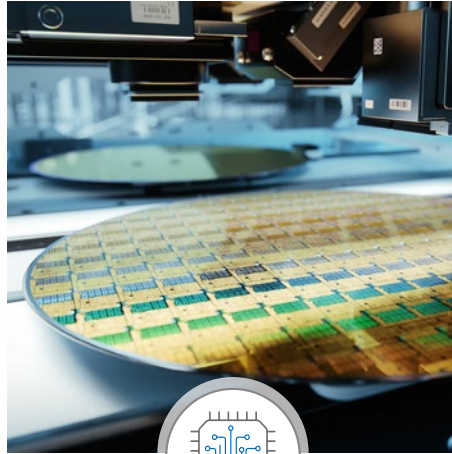
1) Source: iTeh STANDARD PREVIEW, 2019. Complies with ISO 3529-1:2019

Typical industries

Welding technology

Semiconductors

Aerospace

Coating technology

Optics

Research and development

Requirements

The vacuum-compatible and robust sensors from Micro-Epsilon withstand the high demands of a vacuum environment. The lower the desired pressure, the higher the demands on the materials in the vacuum. High and ultra-high vacuums place particularly high demands on the components used and therefore also on the measurement technology.

Micro-Epsilon offers customized sensors according to individual customer specifications. The high-performance and robust vacuum sensors from Micro-Epsilon are manufactured in an ISO 6 class clean room.

Regular checks using TENAX and particle probes, for example, enable us to provide our customers with a high level of safety and an optimum working environment with low particle concentrations.

Our advantages at a glance:
- TENAX sampling
- Avoidance of critical materials (silicones, halogens, etc.)
- Wet chemical cleaning processes
- Dry cleaning processes
- Residual gas analysis (RGA)
- Clean mechanical production
- High cleanliness control using UV light / white light
- Helium leak test for hermetically sealed sensors
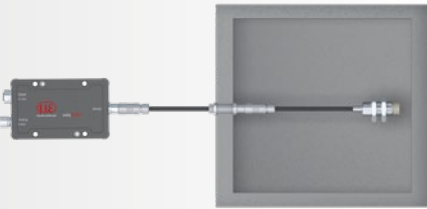- Strong network: highly qualified suppliers and cleaning service providers

© www.Lindner-Group.de
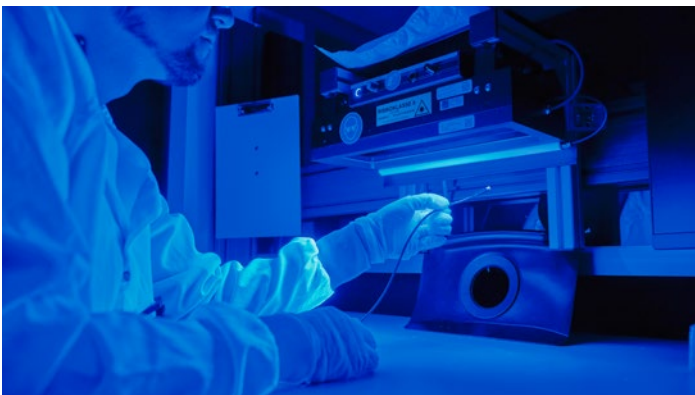
Measurement variations

Measuring in a vacuum
In this application, part of the system is in a vacuum.
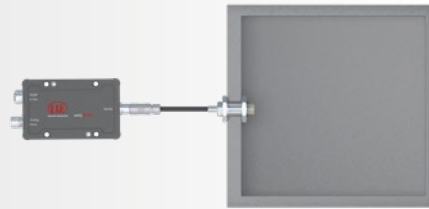
|		
Variant 1: Both the sensor and the vacuum-compatible cable are fed into the vacuum chamber via a vacuum feedthrough.	**Variant 2 (customized sensor):** Only the sensor is in a vacuum. The sensor acts as a vacuum feedthrough and can also be developed according to customer requirements.	**Variant 3 (customized electronics):** Miniature sensors and electronics in hermetic enclosures
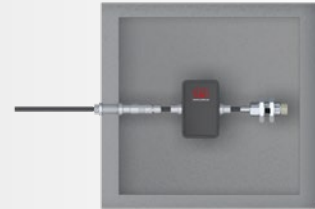
Stringent requirements must be met when measuring in a vacuum.
In the first two variants, the controller is always located outside the system.

Measuring from outside onto vacuumed environment
Here, the sensor, the cable, and the controller are all located outside the vacuum. A transparent enclosure or viewing window can be used to measure the target in a vacuum from the outside.

Measuring in a vacuum

Subsystem in a vacuum // Optical sensors

(LV) (book icon) (made for OEM)

optoNCDT

- Compact laser triangulation displacement sensor for fast and precise measurements
- Non-contact displacement and distance measurement with large measuring ranges
- High accuracy on numerous surfaces
- Compact design and easy mounting
- Suitable up to low vacuum

Download catalog:

The optoNCDT laser sensors are extremely compact and have a fully integrated controller. This makes mounting and wiring quick and easy. These laser sensors can therefore be easily integrated even in confined installation spaces.

Model	ILD1400	ILD1900
Measuring range	10 mm ... 500 mm	2 mm ... 500 mm
Start of measuring range	20 mm ... 100 mm	15 mm ... 100 mm
Mid of measuring range	25 mm ... 350 mm	16 mm ... 350 mm
End of measuring range	30 mm ... 600 mm	17 mm ... 600 mm
Linearity [1]	from < ±0.08 % FSO	from < ±0.02 % FSO
Repeatability	from 0.5 μm [2]	from < 0.1 μm [3]
Temperature stability [4]	from ±0.01 % FSO / K	±0.005 % FSO / K
Light spot diameter	from 45 x 40 μm with 24 mm	from 55 x 65 μm with 16 mm
Light source	Semiconductor laser ≤ 1 mW, 670 nm (red) with laser class 2	
Laser class	Class 2 in accordance with IEC 60825-1: 2014	Class 2 in accordance with IEC 60825-1: 2014 (Class 3 available on request)
Permissible ambient light	up to 50,000 lx	up to 50,000 lx

[1] FSO = Full Scale Output; the specified data apply to white, diffuse reflecting surfaces (Micro-Epsilon reference ceramic for ILD sensors)
[2] Messrate 2 kHz, Median 9
[3] Typical value with measurements at 4 kHz and median 9
[4] The specified value is only achieved by mounting on a metallic sensor holder. Good heat dissipation from the sensor to the holder must be ensured.

Other model variants for vacuum applications are available on request.

Accessories:

- Vacuum feedthrough

Measuring in a vacuum

Subsystem in a vacuum // Optical sensors

(UHV) (book icon) made for OEM

confocalDT

- Distance and thickness measurement
- Ultra-small light spot
- Large tilt angle
- Nanometer resolution
- Suitable up to ultra-high vacuum

Download catalog:

The confocalDT sensors are designed with passive components and therefore do not emit any heat into the environment. Micro-Epsilon offers sensors, cables, and accessories especially for use in a vacuum and suitable for the respective specification (clean room, vacuum, ultra-high vacuum UHV). Vacuum-compatible sensors are available with various measuring ranges, both with axial and radial beam paths.

Model		IFS2406-3/VAC(001)	IFS2406/90-2,5/VAC(001)	IFS2406-2,5/VAC(003)	IFS2406-10/VAC(001)	IFS2405-28/VAC(001)
Measuring range		3 mm	2.5 mm	2.5 mm	10 mm	28 mm
Start of measuring range		75 mm	12.6 mm	17.2 mm	27 mm	220 mm
Resolution	Static [1]	50 nm	18 nm	18 nm	38 nm	130 nm
	Dynamic [2]	168 nm	97 nm	97 nm	207 nm	747 nm
Linearity [3]	Distance	$< \pm 1.5\,\mu m$	$< \pm 0.75\,\mu m$	$< \pm 0.75\,\mu m$	$< \pm 2\,\mu m$	$< \pm 7\,\mu m$
	Thickness	$< \pm 3\,\mu m$	$< \pm 1.5\,\mu m$	$< \pm 1.5\,\mu m$	$< \pm 4\,\mu m$	$< \pm 14\,\mu m$
Light spot diameter		$35\,\mu m$	$10\,\mu m$	$10\,\mu m$	$15\,\mu m$	$60\,\mu m$
Numerical aperture (NA)		0.14	0.30	0.30	0.25	0.10

[1] Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
[2] RMS noise relates to mid of measuring range (1 kHz)
[3] All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.

Other model variants for vacuum applications are available on request.

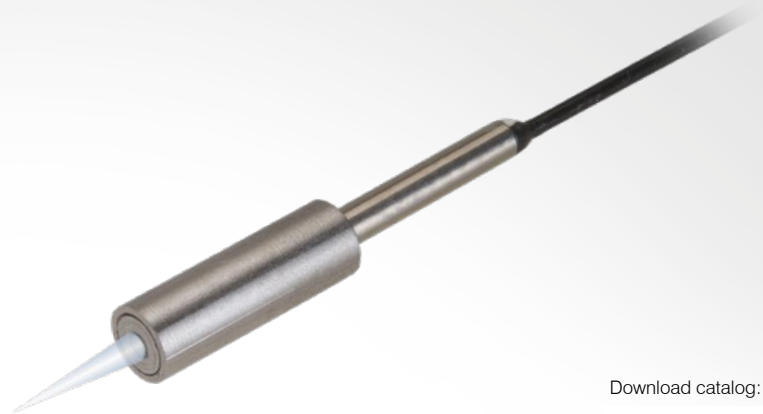## Accessories:

- Vacuum-compatible cables
- Vacuum feedthrough

Measuring in a vacuum

Subsystem in a vacuum // Optical sensors

UHV | (book icon) | made for OEM

interferoMETER

- Absolute distance measurement with nanometer accuracy
- Multi-peak distance measurement and multi-layer thickness measurement
- Precise thickness measurements, regardless of the distance of the sensor
- High signal stability
- Suitable up to ultra-high vacuum

Download catalog:

The industrial-grade white light interferometer consists of a robust sensor, a highly flexible sensor cable, and a controller in an aluminum housing that can be attached to a DIN rail. Due to its robust design, the interferometer can also be integrated in industrial environments. Micro-Epsilon offers sensors, cables, and accessories especially for use in a vacuum and suitable for the respective specification (clean room, vacuum, ultra-high vacuum UHV). Vacuum-compatible sensors are available with various measuring ranges, both with axial and radial beam paths.

Model		IMP DS1/VAC	IMP DS0.5/90/VAC	IMP DS10/90/VAC	IMP DS19
Measuring range	Distance	1 mm	1.5 mm	1.5 mm	2.1 mm
	Thickness [1]	0.01 ... 0.7 mm	0.01 ... 1.0 mm	0.01 ... 1.0 mm	0.01 ... 1.3 mm
Start of measuring range		1 mm	0.5 mm	10 mm	19 mm
Resolution [2]		< 30 pm	< 30 pm	< 30 pm	< 30 pm
Linearity [3]		< ±10 nm	< ±10 nm	< ±10 nm	< ±10 nm
Light spot diameter		10 μm	10 μm	10 μm	10 μm
Sensor Dimensions	Diameter	Ø4	Ø10	Ø10	Ø10
	Length	23 mm	approx. 78.1 mm	approx. 68.6 mm	55 mm
Target material		Glass, reflecting or diffuse surfaces			

[1] Application for MP measurement
[2] All data at constant ambient temperature (24 ±2 °C). Measuring rate 0.5 kHz, moving average over 64 values, measured differentially between the front and back of a thin glass plate in the mid of the measuring range (2 sigma)
[3] Maximum deviation from reference system over the entire measuring range, measured on front surface of ND filter

Other model variants for vacuum applications are available on request.

Accessories:
- Vacuum-compatible cables
- Vacuum feedthrough

Measuring in a vacuum

Subsystem in a vacuum // Electromagnetic sensors

UHV

made for OEM

eddyNCDT

- Inductive sensors (eddy current) for displacement, distance, position
- Non-contact displacement and distance measurement
- High frequency response for dynamic measurements
- Temperature-stable, ideal for harsh environmental conditions
- Pressure-resistant versions up to 2000 bar
- Catalog sensors up to medium vacuum, OEM products up to ultra-high vacuum

Download catalog:

The eddyNCDT displacement sensors are designed for non-contact detection of displacement, distance, position, oscillation, and vibration. Eddy current sensors from Micro-Epsilon are considered to be particularly robust and extremely precise and are therefore often used in industrial environments. The high-performance eddyNCDT sensors can be used on both ferromagnetic and non-ferromagnetic materials. They also provide excellent measurement results when EMC requirements are greater, offering a high bandwidth.

Model	Sensors of DT3060	Sensors of DT3070
Measuring range	1 ... 8 mm	0.4 ... 0.8 mm
Start of measuring range	0.1 ... 0.8 mm	0.04 ... 0.08 mm
Resolution [1]	max. 0.02 μm [2]	0.02 μm[3]
Linearity	max. $< \pm 1\,\mu m$ [4]	$< \pm 1\,\mu m$ [5]
Temperature stability [6]	up to 0.15 μm/K	$< 0.1\,\mu m$/K
Min. target size (flat)	from Ø 12 mm	Ø 5 mm
Temperature range	-20... +200 °C	-20... +180 °C

[1] Relates to the mid of the measuring range, in the compensated temperature range
[2] RMS noise relates to mid of measuring range
[3] RMS value of the signal noise, static (20 Hz)
[4] Only with DT3061 controller and 5-point linearization
[5] Only with DT307x controller and 3-point or 5-point linearization
[6] Relates to the mid of the measuring range, in the compensated temperature range

Other model variants for vacuum applications are available on request.

Accessories:
- Vacuum-compatible cables
- Vacuum feedthrough

Measuring in a vacuum

Subsystem in a vacuum // Electromagnetic sensors

UHV

made for OEM

capaNCDT

- Capacitive displacement sensors for industrial measuring tasks
- Sub-nanometer accuracy
- Highly precise even with temperature fluctuations
- Ideal for long-term stable measurements
- Suitable up to ultra-high vacuum

Download catalog:

Capacitive displacement sensors are often used in vacuum environments or in clean rooms. In a particle-free environment, the capacitive sensors from Micro-Epsilon achieve a resolution in the sub-nanometer range. The capaNCDT sensors are used for distance and thickness measurement on conductive objects. They are therefore ideally suited for use in industrial environments. The capaNCDT sensors are also highly resistant to interference in electrical or magnetic fields.

Model	Cylindrical sensors	Flat sensors
Measuring range [1]	0.2 … 2 mm	0.2 … 5 mm
Linearity [1] [2]	up to $\leq \pm 0.054\,\mu m$	up to $\leq \pm 0.05\,\mu m$
Resolution Static	up to 0.15 nm	up to 0.15 nm
Temperature stability Sensitivity	-24 to -2.4 nm/K	-24 to -2.4 nm/K
Min. target diameter	from Ø7 mm	from Ø7 mm

[1] Valid for operation with reference controller, relates to nominal measuring range
[2] RMS value of the signal noise

Other model variants for vacuum applications are available on request.

Accessories:
- Vacuum-compatible cables
- Vacuum feedthrough

Measuring in a vacuum

Subsystem in a vacuum // Magneto-inductive sensors

HV | 📖 | made for OEM

mainSENSOR

- Robust sensor design
- Flexible sensor concept
- Wear-free
- Non-contact
- Suitable up to high vacuum
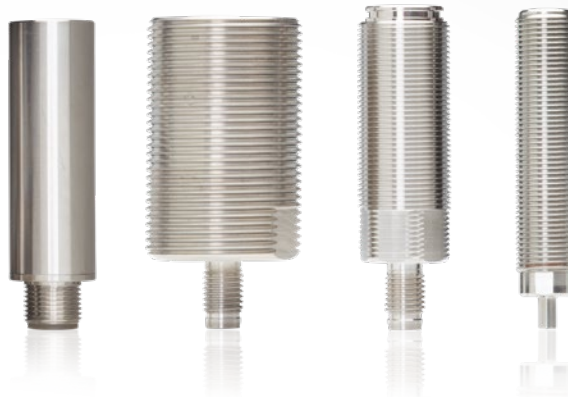
Download catalog:

Magneto-inductive sensors measure the distance on permanent magnets and are therefore able to measure through non-ferromagnetic materials, especially metals such as aluminum and stainless steel. This is a decisive advantage for applications in closed systems or housings, as the sensor and magnet can be housed separately. For example, the magnet can be mounted in a harsh environment and the sensor in a safe area.

Model	MDS-45	MDS-35	MDS-40
Measuring range [1]	45 mm	35 mm	40 mm
Start of measuring range	1 ... 5 mm	1 mm	1.5 mm
Resolution	0.05 % FSO	0.05 % FSO	0.05 % FSO
Linearity	≤ ±3% FSO	≤ ±5% FSO	≤ ±3 % ... < ± 5 % FSO
Repeatability	≤ 0.05 % FSO	≤ 0.05 % FSO	≤ 0.05 % FSO
Temperature stability	≤ 250 ppm FSO/K	≤ 500 ppm FSO/K	≤ 500 ppm FSO/K

[1] Measuring range changes by using other magnets; external magnetic fields and/or ferromagnetic material in the measuring range of the sensor system affect the sensor characteristic line and the technical data.

Measuring in a vacuum

Subsystem in a vacuum // Color and fiber-optic sensors

HV | made for OEM

Fiber-optic sensor CFS

Download catalog:

- Extremely robust and compact
- Highly flexible
- Food-safe
- Resistant to chemicals

A wide variety of reflection, transmission, and standard sensors are available for the optoCONTROL and colorSENSOR systems. These fiber-optic sensors are extremely robust and therefore ideal for use in high vacuums, high-temperature areas, and harsh environments.

Model	CFS1	CFS2	CFS3	CS4
Working distance	max. 125 mm	max. 100 mm	max. 20 mm	max. 320 mm
Measurement spot diameter	from Ø 7 mm	from Ø 11 mm	from Ø 1,5 mm	from Ø 0,8 mm
Min. Measuring object	Ø 7 mm	from Ø 11 mm	from Ø 1,5 mm	from Ø 1 mm
Max. tilt angle	±45°	±45°	±30°	±45°

Other model variants for vacuum applications are available on request.

optoCONTROL CLS

Download catalog:

- Extremely robust and compact
- Detection range reflex sensor max.1200 mm
- Range of transmission sensor
  max. 2000 mm
- Detection of the finest structures
- Switchable NPN; PNP; PP
- Extremely high ambient light resistance up to 50,000 lx
- Suitable up to high vacuum

The optoCONTROL CLS controllers consist of a compact transceiver unit with integrated signal evaluation.
The compact and robust design enables quick and easy integration for monitoring numerous measuring tasks.

Accessories:
- Vacuum-compatible fiber-optic sensors
- Vacuum feedthrough

colorSENSOR CFO

Download catalog:

- High repeatability ΔE < 0.3
- Measuring speeds up to 30 kHz
- Intuitive operation via web interface
- Color and grayscale detection
- Multi-teach function
- Suitable up to high vacuum

The colorSENSOR CFO is a high-performance controller for precise color detection in industrial measuring tasks. The controller is distinguished by high color accuracy, state-of-the-art interfaces and intuitive operation.
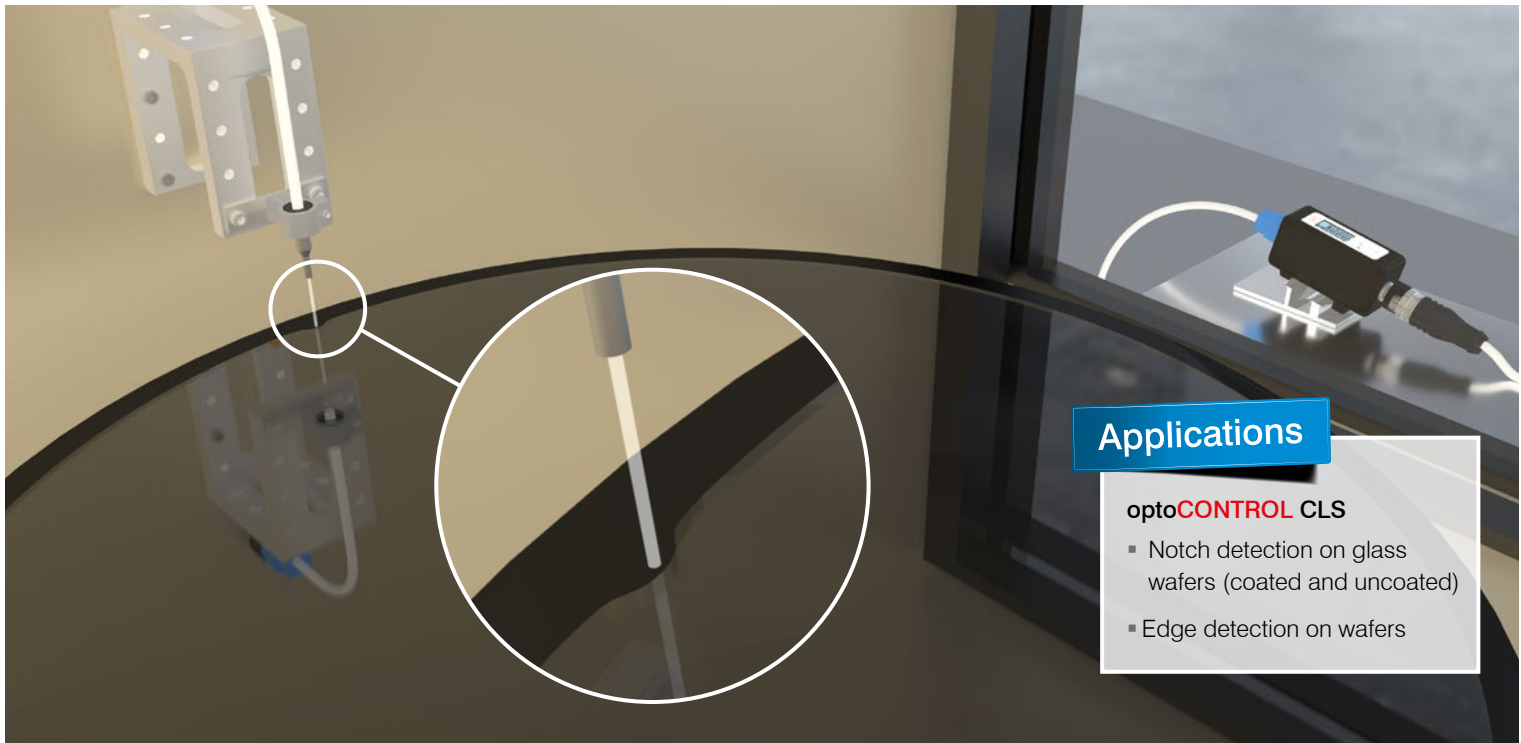
Applications

optoCONTROL CLS
- Notch detection on glass wafers (coated and uncoated)
- Edge detection on wafers
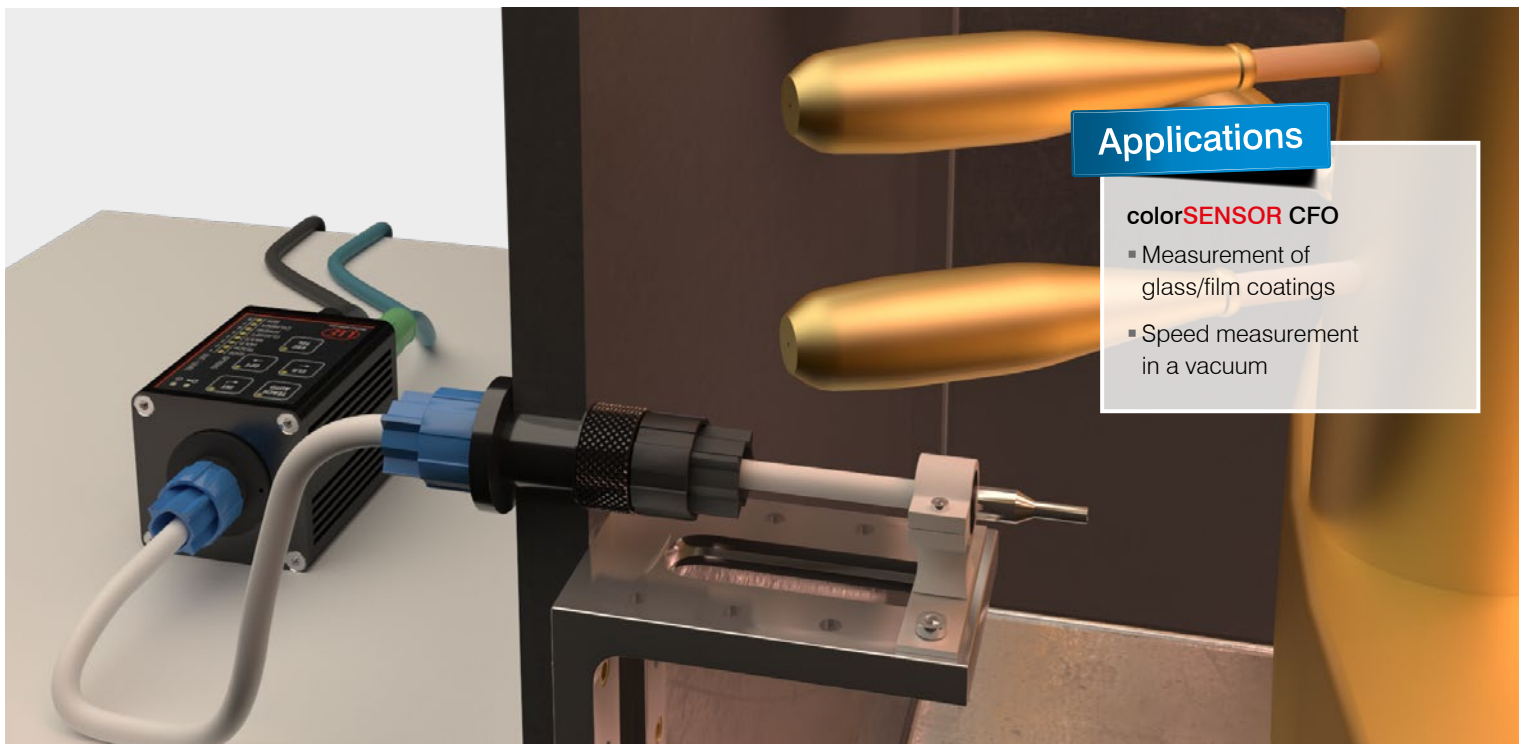
Applications

colorSENSOR CFO
- Measurement of glass/film coatings
- Speed measurement in a vacuum

Measuring from outside onto the vacuum

For some applications, measurement from outside the vacuum chamber is required. Sensors with a large measuring range and offset distance are used for this purpose. The following sensors are available for this purpose.

Optical sensors

optoNCDT

With over 70 standard models and measuring ranges from 2 – 1000 mm, optoNCDT laser triangulation sensors from the optoNCDT series cover a wide range of applications in numerous industries.

Application example: Semiconductor technology
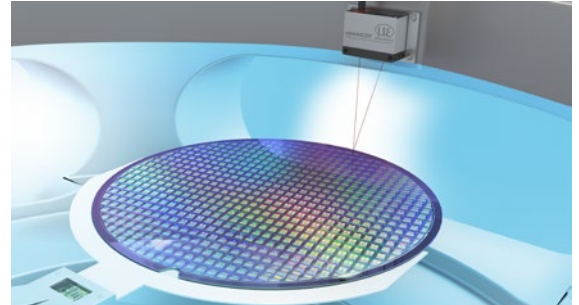
confocalDT

The confocalDT sensor series epitomizes maximum precision and dynamics in confocal chromatic measurement technology. Numerous sensors with a large offset distance allow for measurement through protective glass from the outside into the vacuum.

**Application example:** Semiconductor technology
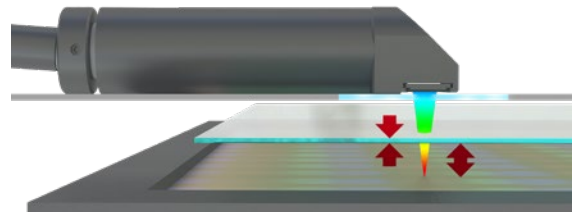
2D/3D measurement technology

optoCONTROL

Optical micrometers from Micro-Epsilon work according to the transmitted light method (ThruBeam micrometers). A parallel light curtain is generated by a transmitter and strikes a receiver unit. If a target is guided into the light beam, the beam is interrupted. The resulting shadow is detected by the receiving optics and output as a measured value.

Application example: Undulator wire position measurement in a vacuum
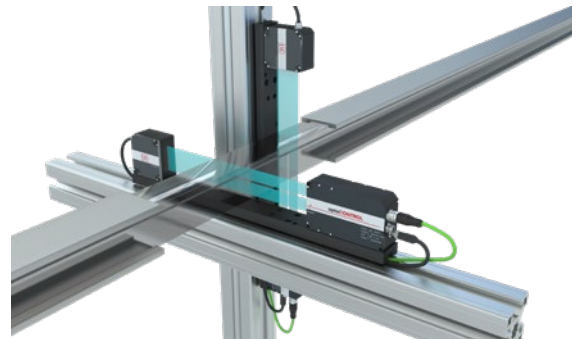
Color sensors

colorSENSOR

The high-quality sensors with glass fiber optics are characterized by their compact size and robust materials. This makes them particularly suitable for use under mechanical stress and adverse environmental conditions such as high temperatures. As the sensor head requires little space, the sensor can also be used in confined spaces.

Application example: Coating technology

colorCONTROL

The colorCONTROL inline color measuring system not only detects the reference colors in comparison, but also measures the absolute color in accordance with DIN 11664. Thanks to the very high measuring speed, the colorCONTROL ACS is suitable wherever colors and shadows have to be checked with very high accuracy during ongoing production. Due to its high measuring accuracy, the system is also used in laboratories.

Application example: Pressure control of vacuumed containers
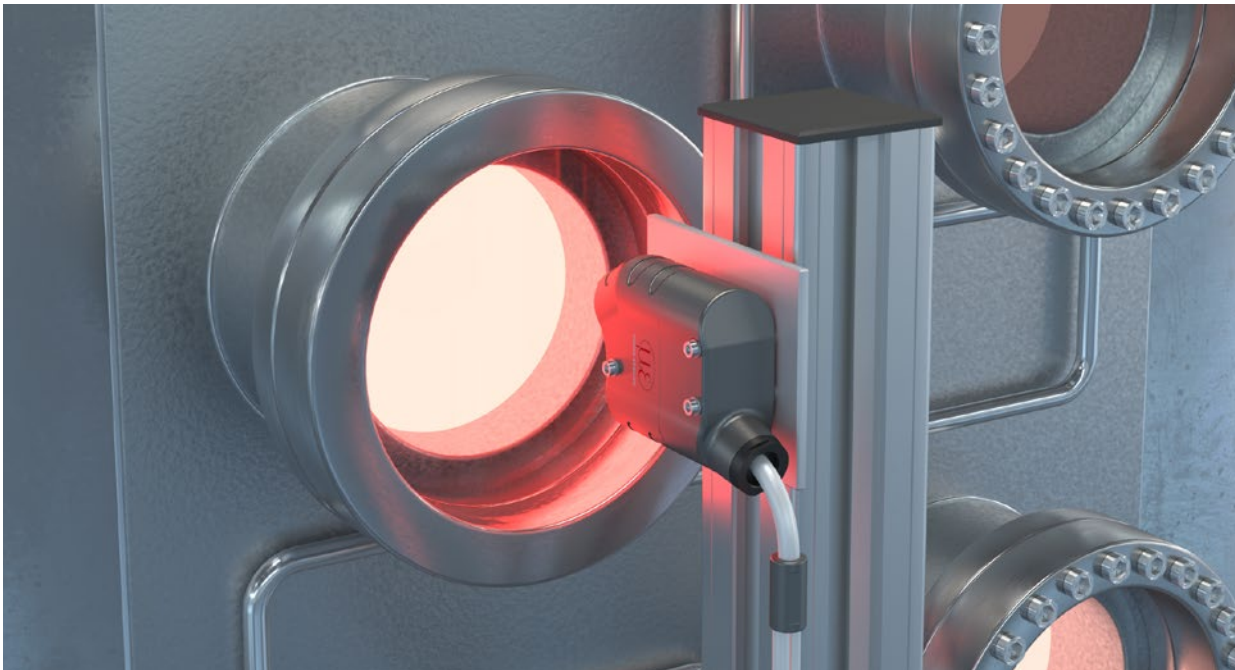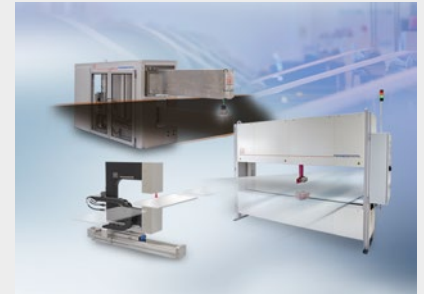
Sensors and Systems from Micro-Epsilon

Sensors and systems for displacement, distance and position

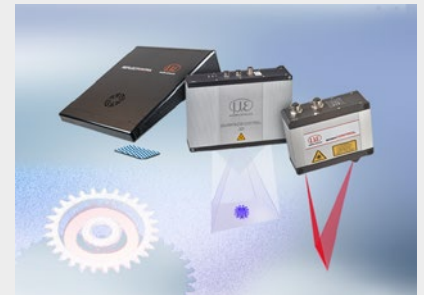Sensors and measurement devices for non-contact temperature measurement

Measuring and inspection systems for metal strips, plastics and rubber

Optical micrometers and fiber optics, measuring and test amplifiers

Color recognition sensors, LED analyzers and inline color spectrometers

3D measurement technology for dimensional testing and surface inspection

More Precision

Whether it is for quality assurance, predictive maintenance, process and machine monitoring, automation or R&D – sensors from Micro-Epsilon make a vital contribution to the improvement of products and processes. High precision sensors and measuring systems solve measurement tasks in all core industries – from machine building to automated production lines and integrated OEM solutions.

MICRO-EPSILON

www.micro-epsilon.com