MICRO-EPSILON

More Precision

eddyNCDT // Inductive sensors based on eddy currents

Compact eddy current measuring system
eddyNCDT 3005

- Compact and robust design
- Temperature compensation up to 180 °C
- High measurement accuracy
- Frequency response 5 kHz (-3dB)
- Measuring rate 75 kSa/s
- Versions for ferromagnetic and non-ferromagnetic targets
- Robust design IP67

Robust eddy current measuring system

The eddyNCDT 3005 is a powerful eddy current measuring system for fast, high precision displacement measurements. The system comprises a compact controller, a sensor and an integrated cable and is factory-calibrated for ferromagnetic and non-ferromagnetic materials.

As sensor and controller are temperature-compensated, high measurement accuracies can be achieved even in fluctuating temperatures. The sensors are designed for ambient temperatures up to max. +125 °C but can optionally be custom engineered for temperatures from -20 °C to 180 °C. The measuring system is pressure-resistant up to 10 bar and so is ideally suited to machine integration.

Integration into plant and machinery

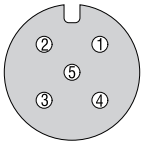
The eddyNCDT 3005 provides ease of use and high measurement accuracy, offering an outstanding price-performance ratio. Therefore, the sensor is ideal for OEM integration and serial applications in machine building, particularly where pressure, dirt, oil and high temperatures are present. When large quantities are required, customer-specific designs can be tailored to suit individual requirements.

Its compact M12 design allows for the controller to be easily installed in restricted and difficult-to-access places.

Pin assignment for power supply and signal

Pin	Assignment	Color (cable: PCx/5-M12)
1	Supply +24 V	Brown
2	Displacement signal	White
3	GND	Blue
4	RS485 A+	Black
5	RS485 B-	Gray

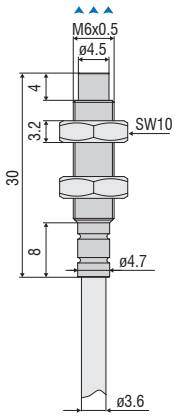
5-pole M12x1 housing connector
View on pin side



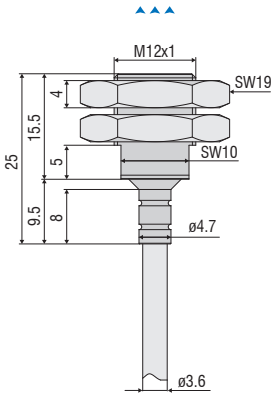
Model		DT3005-U1-A-C1	DT3005-U1-M-C1	DT3005-S2-A-C1	DT3005-S2-M-C1	DT3005-U3-A-C1	DT3005-U3-M-C1	DT3005-U6-A-C1	DT3005-U6-M-C1
Measuring range		1 mm		2 mm		3 mm		6 mm	
Start of measuring range		0.1 mm		0.2 mm		0.3 mm		0.6 mm	
Resolution [1]		0.5 µm		1 µm		1.5 µm		3 µm	
Frequency response (-3dB)		5 kHz							
Measuring rate	Analog output	75 kSa/s (16 bit)							
	Digital interface	1 kSa/s (16 bit)							
Linearity		< ±2.5 µm		< ±5 µm		< ±7.5 µm		< ±15 µm	
Repeatability		< 0.5 µm		< 1 µm		< 1.5 µm		<3 µm	
Temperature stability [2]	Sensor	< 0.25 µm / K		< 0.5 µm / K		< 0.75 µm / K		< 1.5 µm / K	
	Controller	< 0.25 µm / K		< 0.5 µm / K		< 0.75 µm / K		< 1.5 µm / K	
Temperature compensation	Sensor	+10 … +125 °C (optional -20 … +180 °C)							
	Controller	+10 … +60 °C (optionally -20 ... +70 °C)							
Sensor type		unshielded		shielded		unshielded		unshielded	
Min. target size (flat)		Ø 24 mm		Ø 24 mm		Ø 48 mm		Ø 72 mm	
Target material [3]		Aluminum	Steel	Aluminum	Steel	Aluminum	Steel	Aluminum	Steel
Supply voltage		12 … 32 VDC							
Power consumption		0.6 W							
Digital interface [4]		RS485 / USB / Ethernet / EtherCAT / PROFINET / EtherNet/IP							
Analog output		0.5…9.5 V							
Connection		Sensor: integrated cable, length 1 m, min. bending radius 27 mm (static) Supply/signal: 5-pin M12 connector (cable see accessories							
Temperature range	Storage	-20 … +80 °C							
	Operation	Sensor: -20 … +125 °C (optional -20 … +180 °C), controller: -20 … +70 °C							
Pressure resistance		10 bar (sensor, cable and controller on the front), controller on the rear IP67 (plugged in)							
Shock (DIN EN 60068-2-27)		15 g / 6 ms in 3 axes, 2 directions and 1000 shocks each							
Vibration (DIN EN 60068-2-6)		5 g / 10 … 500 Hz in 3 axes, 2 directions and 10 cycles each							
Protection class (DIN EN 60529)		IP67							
Weight [5]		approx. 70 g		approx. 75 g		approx. 77 g		approx. 95 g	

[1] RMS noise relates to mid of measuring range at a frequency response of 5 kHz
[2] Values are referenced to the mid of the measuring range within the compensated temperature range
[3] Steel: St37 steel DIN1.0037; aluminum: AlMg3 Steel: St37 steel DIN1.0037; aluminum: AlMg3
[4] USB, Ethernet, EtherCAT, PROFINET and EtherNet/IP require an interface module connection
[5] Total weight for controller, cable and sensor

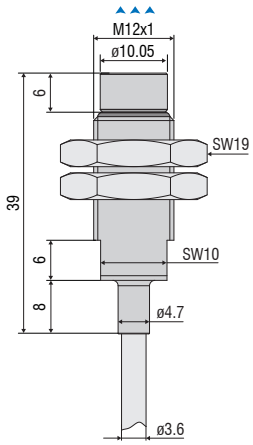
DT3005-U1



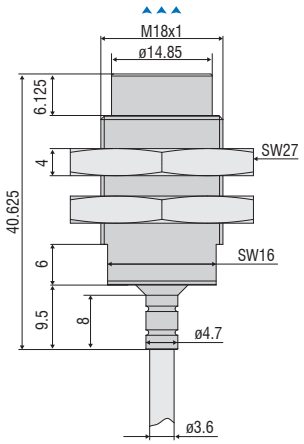
DT3005-S2



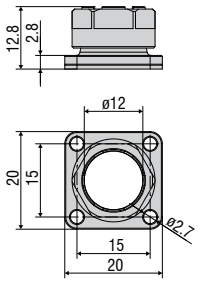
DT3005-U3



DT3005-U6

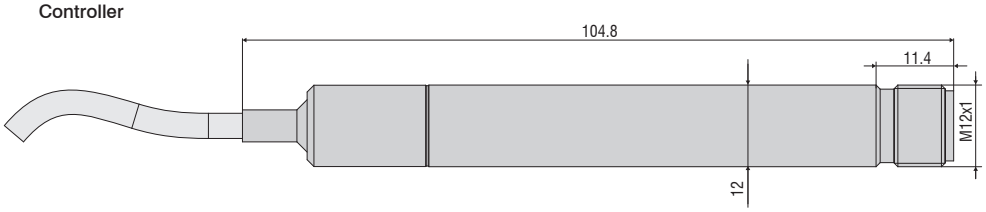


Clamping flange (optional)
Art. no.: 0801058



Measurement direction

Controller



All dimensions in mm, not to scale

Accessories
eddyNCDT

Item	Description	DT3001	DT3005	DT3020	DT3060	DT3070	DZ140	SGS
PCx/5-M12	**Power supply and signal cable** 5-pole with M12 connector Standard length: 5 m Optionally available: 10 m/20 m/40 m/80 m as drag-chain suitable variant	x	x					
PCx/8-M12	**Power supply and signal cable** 8-pole with M12 connector Standard length: 3 m Optionally available: 5 m/ 10 m /15 m / 10 m also as drag-chain suitable variant			x	x	x		
PC5/8-M12/105	**Power supply and signal cable** Increased temperature resistance up to 105 °C 8-pole with M12 connector Length: 5 m as drag-chain suitable variant			x	x	x		
PC4701-x	**Power supply and signal cable** 8-pole with M12 connector Standard length: 10 m Optionally available: 15 m 10 m also available as drag chain–suitable variant							x
SCD2/4/RJ45	**Ethernet cable** 4-pole with M12 connector on RJ45 connector Standard length: 2 m				x	x		
PC140-x	**Power supply and signal cable** 8-pole connector Standard length: 3 m Optionally available: 6 m						x	
PS2020	**Power supply unit** Input 100-240 VAC Output 24 VDC / 2.5 A; installation on symmetrical standard rail 35 mm x 7.5 mm, DIN 50022	x	x	x	x	x	x	x
IF2035	**Interface module for Industrial Ethernet connection** Connection of RS422 or RS485 interfaces to PROFINET / Ethernet/IP / EtherCAT 2 network connections for different network topologies Ideal for confined spaces due to a compact housing and DIN rail mounting		x	x				
IF1032	**Interface module for Ethernet/EtherCAT connection** 1x RS485 2x analog-in (14 bit, max. 4 ksps), voltage 1x analog-in, (14 bit, max. 4 ksps), current		x	x				
IF7001	**Single-channel converter cable from RS485 to USB** Conversion from RS485 to USB Easy sensor connection via USB Integration into plant and machinery		x	x				

Interfaces

RS485:
1 channel

Analog:
3 channels

Interface IF1032/ETH
Interface module for
Ethernet/EtherCAT connection

RS485:
Multi-channel

Interface IF7001
Single-channel converter cable
from RS485 to USB

RS485:
Multi-channel

Interface IF2035
Interface module for
Industrial Ethernet connection

Ethernet

EtherCAT

Ethernet

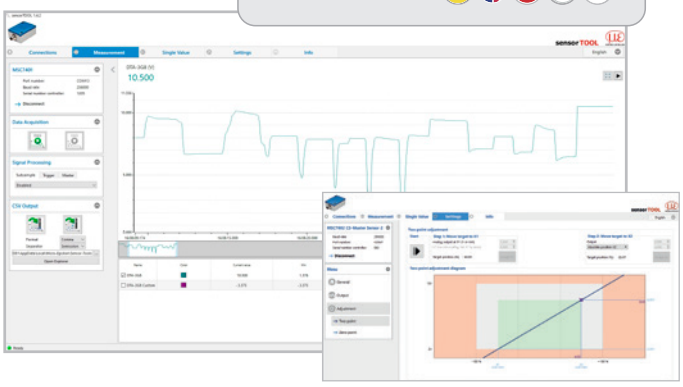
Web interface IF1032

Web interface for display and visualization of measured data
- Data display and scaling via Ethernet and web interface
- CSV export
- Easy integration without admin rights on PC
- Additional EtherCAT interface

Ethernet

USB

sensorTOOL



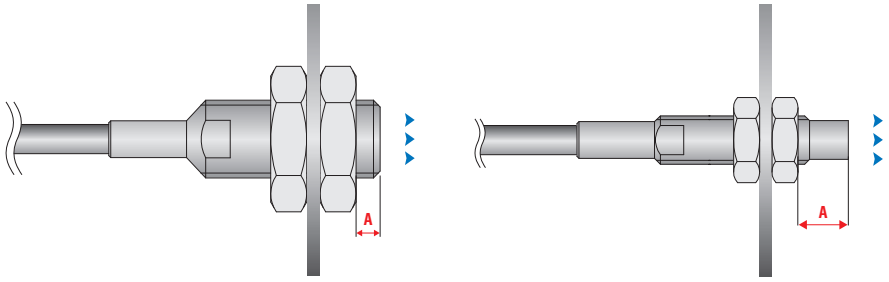
SensorTool for parameterization, data display, etc.
- Basic settings: sensor type, output signal, frequency response
- 2-point and zero point adjustments
- Scaling
- Visualization of data
- Sub-sampling
- Export

EtherCAT EtherNet/IP PROFINET

Standard installation situation

Distance between the nut and the measuring area

eddyNCDT sensors are mounted using the two mounting nuts included in the delivery. During the factory-calibration of the sensors, these were mounted in a defined distance A and included in the calibration. In order to achieve maximum linearity, the nut must be mounted in the defined distance indicated in the table.



Please note the respective distances recommended in the table below when mounting the sensors:

Series	Model	Distance A
DT3001-	U2-A-SA	22 mm (±0.2 mm)
	U2-M-SA	22 mm (±0.2 mm)
	U4-A-SA	22 mm (±0.2 mm)
	U4-M-SA	22 mm (±0.2 mm)
	U4-A-Cx	22 mm (±0.2 mm)
	U4-M-Cx	22 mm (±0.2 mm)
	U6-A-SA	22 mm (±0.2 mm)
	U6-M-SA	22 mm (±0.2 mm)
	U8-A-SA	22 mm (±0.2 mm)
	U8-M-SA	22 mm (±0.2 mm)
DT3005-	U1-A-C1	8 mm (±0.2 mm)
	U1-M-C1	8 mm (±0.2 mm)
	S2-A-C1	4 mm (±0.2 mm)
	S2-M-C1	4 mm (±0.2 mm)
	U3-A-C1	10 mm (±0.2 mm)
	U3-M-C1	10 mm (±0.2 mm)
	U6-A-C1	13 mm (±0.2 mm)
	U6-M-C1	13 mm (±0.2 mm)
DT3020 / DT3060	ES-U1	8 mm (±0.2 mm)
	ES-S1	4 mm (±0.2 mm)
	ES-U2	8 mm (±0.2 mm)
	ES-S2	4 mm (±0.2 mm)
	ES-U3	10 mm (±0.2 mm)
	ES-S4	4 mm (±0.2 mm)
	ES-U6	20.4 mm (±0.2 mm)
	ES-U8	24.6 mm (±0.2 mm)
	ES04	2.1 mm (±0.2 mm)
	EU05	5.5 mm (±0.2 mm)
	ES08	2.7 mm (±0.2 mm)
	ES1	4 mm (±0.2 mm)
	EU1	6.7 mm (±0.2 mm)
	ES2	4 mm (±0.2 mm)
	EU3	10 mm (±0.2 mm)
	ES4	4 mm (±0.2 mm)
	EU6	10.125 mm (±0.2 mm)
	EU8	12.8 mm (±0.2 mm)
DT3070-	ES-S04	2.4 mm (±0.2 mm)

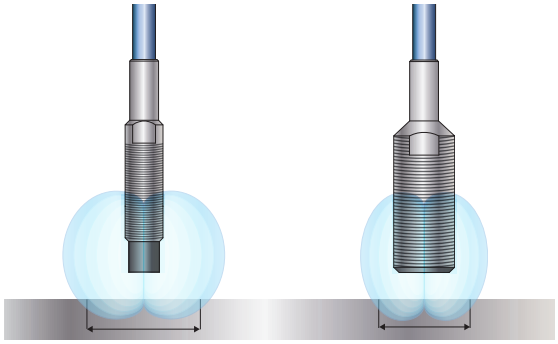
Influences on the measurement signal

Sensor installation

The notes mentioned under "Standard installation situation" for correct sensor installation affect the measurement signal.

Minimum diameter of the target (flat)

The relative size of the target has effects on the linearity deviation. Ideally, the target size with shielded sensors is at least 2 times the sensor diameter, with unshielded sensors it is 4 times the sensor diameter. From this size on, almost all field lines run from the sensor to the target. Here, nearly any field line penetrates the target via the front surface and therefore contributing to the formation of eddy currents. With smaller target diameters, field linearization is recommended.



Unshielded sensor
Measurement spot =
4x sensor diameter

Shielded sensor
Measurement spot =
2x sensor diameter

ø Target = 4x or 2x sensor diameter
recommended (no linearization is required)

ø Target = 3x or 1.5x sensor diameter
requires field linearization (DT306x / DT3300)

Minimum diameter of round targets

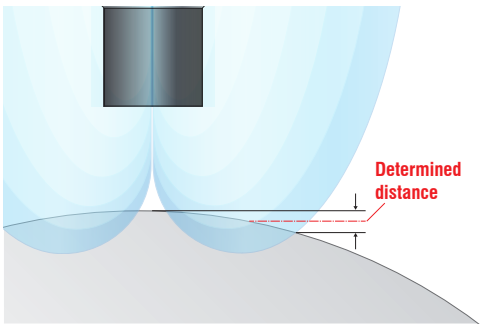
As well as the minimum size for flat geometries, a minimum diameter for round measuring objects is required.

Diameter > 10x sensor diameter
requires field linearization (DT306x / DT3300)

Diameter < 10x sensor diameter
requires factory calibration

Compensating the distance with curved measuring objects

When measuring on curved surfaces such as shafts, the sensors use the medium distance which results from the closest and the most distant field line range. However, this is not the distance between the vertex of the curved target and the sensor. For this reason, eddy current measuring systems from Micro-Epsilon enable the storage of the actual distance in the controller. This is how measurements can be performed on cylindrical objects such as rolls or shafts.



Material and thickness of the target

Stable measurement results require a certain target minimum thickness that depends on the target material used. For one-sided distance measurements, the following standard values are recommended:

Target material	Recommended target thickness
Aluminum	0.504 mm
Lead	1.377 mm
Gold	0.447 mm
Graphite	8.100 mm
Copper	0.402 mm
Magnesium	0.627 mm
Brass	0.747 mm
Nickel	0.081 mm
Permalloy	0.012 mm
Phosphor Bronze	0.906 mm
Silver	0.390 mm
Steel DIN 1.1141	0.069 mm
Steel DIN 1.4005	0.165 mm
Steel DIN 1.4301	2.544 mm

Tilt angle

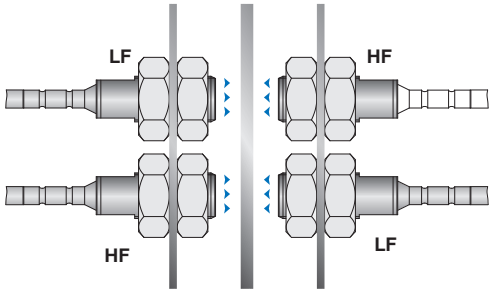
The high accuracy of the eddyNCDT sensors is only achieved with vertical sensor installation. When the sensor or the target are tilted, the measured results slightly deviate from those measured in the vertical position.

The extent of deviation differs from sensor to sensor. The tilt angle of ±3° can be neglected for most of the measurement tasks. With a tilt angle of larger than 6°, factory calibration is recommended. With a 3-point calibration, the tilt angle can be stored in the controller. This compensates for all influences affecting the signal.

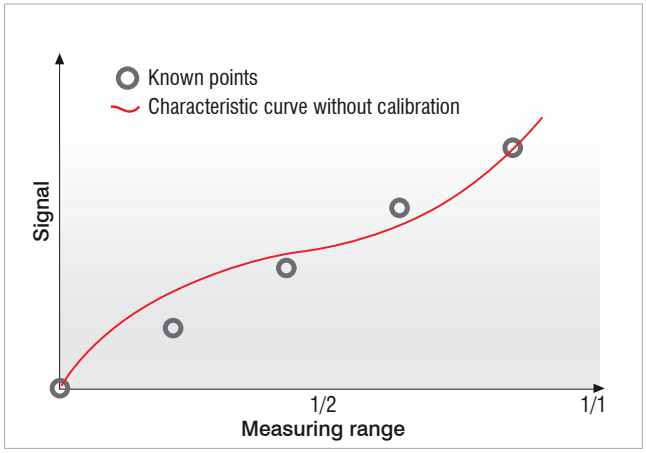
Terms
eddyNCDT

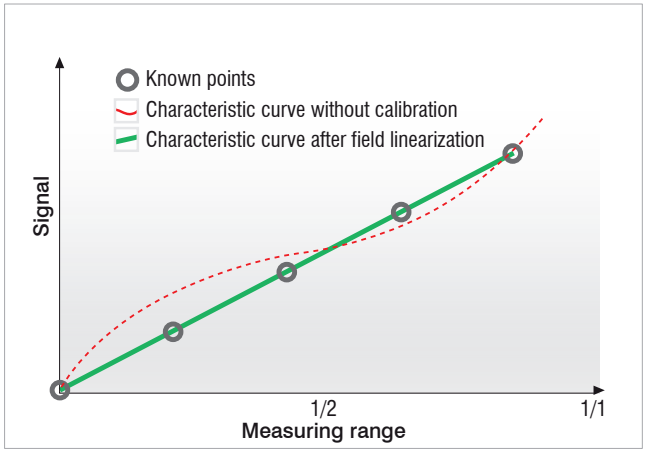
Frequency separation

For the simultaneous operation of several eddyNCDT measuring systems, these are available with a new type of frequency separation (LF/HF). The frequency separation enables multi-channel operation without mutual influence. This function makes a synchronization cable superfluous.



Field calibration



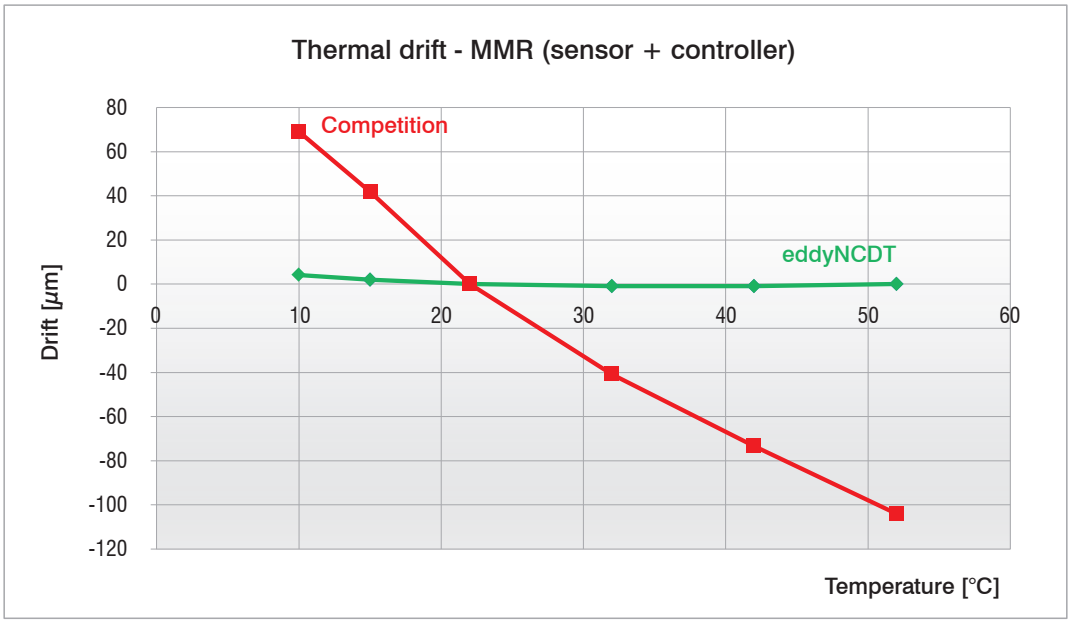


If the installation situation does not correspond to the standard installation conditions, field linearization is recommended (available with eddyNCDT 3060 and eddyNCDT 3300) This on-site calibration compensates for influences which result from the installation scenario or the target materials and shapes. Therefore, optimum measurement accuracies will always be achieved even in the case of difficult installation conditions.

For machine integration, linearization with 2 fixed points (start and end point) is sufficient in most cases. Using 3 or 5 points for linearization enables to increase the accuracy again.

For a linearization with 2 or more points, this applies only within the selected edge points. Outside this range, there may be larger linearity deviations.

Thermal drift of a Micro-Epsilon eddy current system compared with the competitors



All eddyNCDT sensors and controllers are actively temperature-compensated (sensors up to max. 180 °C, controllers up to max. 50 °C). This means that the temperatures of the sensor and the controller are recorded during operation and considered in the measurement result. This results in an extremely stable measurement signal.

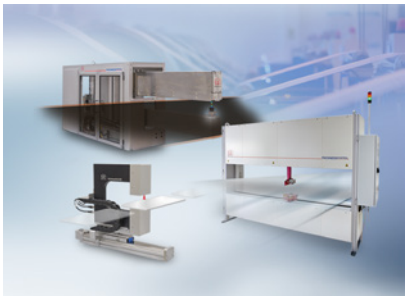
The figure shows a Micro-Epsilon sensor (green) compared with competing products (red). The maximum deviation over the entire temperature range is significantly below the 150 ppm/°C specified in the data sheet. Occasionally the deviation for the temperature increase of one degree amounts to a maximum of 150 ppm.

Conclusion: In order to keep precise measurement values in the µm range constant and reliable, the resolution to be achieved and the temperature influence are crucial factors. The temperature stability of the Micro-Epsilon system achieves such a high level that temperature fluctuations are actively compensated for. Due to the higher temperature influence of the competitor system, even daily temperature fluctuations of ±2.5 °C can cause a deviation of >20 µm. Measurements with micrometer accuracy are therefore not possible with the competitor system without active temperature compensation, even in normal environments.

Sensors and Systems from Micro-Epsilon

Sensors and systems for displacement, distance and position

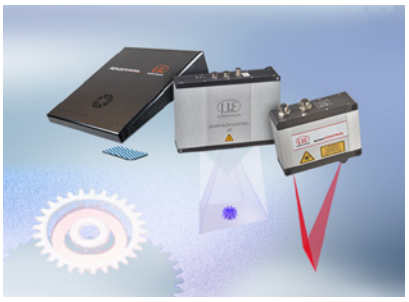
Sensors and measurement devices for non-contact temperature measurement



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

MICRO-EPSILON

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