



More Precision

eddyNCDT // Inductive sensors based on eddy currents



Compact eddy current sensor with integrated controller

eddyNCDT 3001

-  Compact M12 design with integrated controller
-  Frequency response 5 kHz (-3dB)
-  Measuring rate 75 kSa/s
-  Versions for ferro- and non-ferromagnetic targets
-  Temperature compensation up to 70 °C
-  Easy operation (plug and play)
-  Robust design IP67



Robust M12 miniature eddy current sensor

The two eddyNCDT 3001 U2 and U4 models are powerful eddy current sensors whose compact dimensions have to date only been reserved for inductive sensors and proximity sensors. These compact sensors are equipped with an integrated controller including temperature compensation while offering an excellent price-performance ratio, as well as easy operation. Therefore, the sensors are ideally suited to OEM integration and machine building applications.

The temperature-compensated design provides high stability even when surrounded by fluctuating ambient temperatures. The sensors are factory-calibrated for ferromagnetic and non-ferromagnetic materials, which eliminates the need for on-site linearization of the sensor. Its robust design combined with the eddy current measuring principle enables measurements in harsh industrial environments (oil, pressure, dirt). In addition, the eddyNCDT 3001 is suitable for offshore/marine applications (salt water).

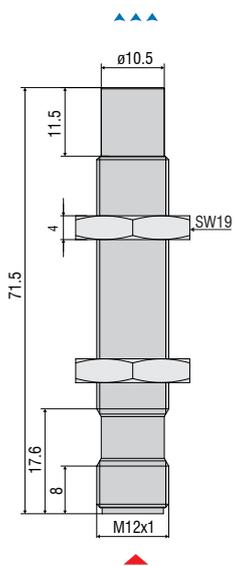
Model	DT3001-U2-A-SA	DT3001-U2-M-SA	DT3001-U4-A-SA	DT3001-U4-M-SA	DT3001-U4-A-Cx	DT3001-U4-M-Cx
Measuring range	2 mm		4 mm			
Start of measuring range	0.4 mm					
Resolution ^[1]	4 μm					
Frequency response (-3dB)	5 kHz					
Measuring rate	Analog output		75 kSa/s (16 bit)			
Linearity	< ±28 μm					
Temperature stability ^[2]	< 0.6 μm / K		< 1.2 μm / K			
Temperature compensation	0 ... +70 °C					
Sensor type	unshielded					
Min. target size (flat)	Ø 48 mm					
Target material ^[3]	Aluminum	Steel	Aluminum	Steel	Aluminum	Steel
Supply voltage	12 ... 32 VDC					
Power consumption	0.5 W					
Analog output	0.5 ... 9.5 V				0.5 ... 4.5 V	
Connection	Supply/signal: 5-pole M12 connector (cable see accessories)				integrated cable, 5-pin, lengths: 3/6/9 m	
Temperature range	Storage	-20 ... +80 °C				
	Operation	0 ... +70 °C				
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 (plugged)				IP67	
Weight	25 g				60 g (3 m) 100 g (6 m) 140 g (9 m)	

^[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

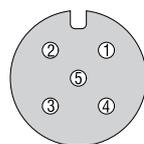
^[3] Steel: S37 steel DIN1.0037; aluminum: AlMg3

DT3001-U2-SA DT3001-U4-SA

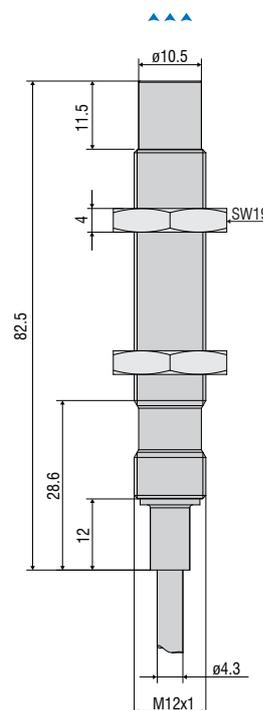


Pin assignment for power supply and signal

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



DT3001-U4-Cx



Pin assignment of integrated supply and signal cable

Assignment	Cable color
Supply +24 V	Brown
Displacement signal	Green
GND	White
assigned internally	Yellow
assigned internally	Gray

Measurement direction Connector side

All dimensions in mm, not to scale

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Robust miniature sensors in M18 housing

The U6 and U8 models of the eddyNCDT 3001 series are powerful eddy current sensors with integrated controller in an M18 design. Calibrated for ferromagnetic and non-ferromagnetic materials, these compact sensors offer measuring ranges of 6 mm or 8 mm.

As these sensors are temperature-compensated, they provide high signal stability even in fluctuating ambient temperatures. Due to their robust design, these sensors are used for measurement tasks in harsh, industrial environments.

Model	DT3001-U6-A-SA	DT3001-U6-M-SA	DT3001-U8-A-SA	DT3001-U8-M-SA
Measuring range	6 mm		8 mm	
Start of measuring range	0.6 mm		0.8 mm	
Resolution ^[1]	3 μm		4 μm	
Frequency response (-3dB)	5 kHz			
Measuring rate	Analog output	75 kSa/s (16 bit)		
Linearity	< $\pm 15 \mu\text{m}$		< $\pm 20 \mu\text{m}$	
Temperature stability ^[2]	< 1.5 $\mu\text{m} / \text{K}$		< 2 $\mu\text{m} / \text{K}$	
Temperature compensation	0 ... +70 °C			
Sensor type	unshielded			
Min. target size (flat)	\varnothing 72 mm			
Target material ^[3]	Aluminum	Steel	Aluminum	Steel
Supply voltage	12 ... 32 VDC			
Power consumption	0.6 W			
Analog output	0.5...9.5 V			
Connection	Supply/signal: 5-pole M12 connector (cable see accessories)			
Temperature range	Storage	-20 ... +70 °C		
	Operation	-20 ... +70 °C		
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 (plugged)			
Weight	approx. 35 g (without nuts)			

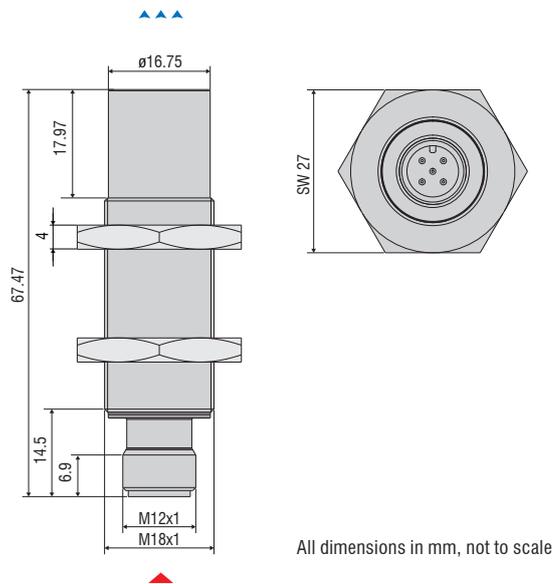
^[1] RMS noise relates to mid of measuring range at a frequency response of 5 kHz

^[2] Values are referenced to the mid of the measuring range within the compensated temperature range

^[3] Steel: St37 steel DIN1.0037; aluminum: AlMg3

DT3001-U6-SA

DT3001-U8-SA



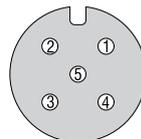
All dimensions in mm, not to scale

Pin assignment for power supply and signal

Pin	Assignment	Color (cable: PCx/5-M12)
1	Supply +24 V	Brown
2	Analog output	White
3	GND	Blue
4	assigned internally	Black
5	assigned internally	Gray

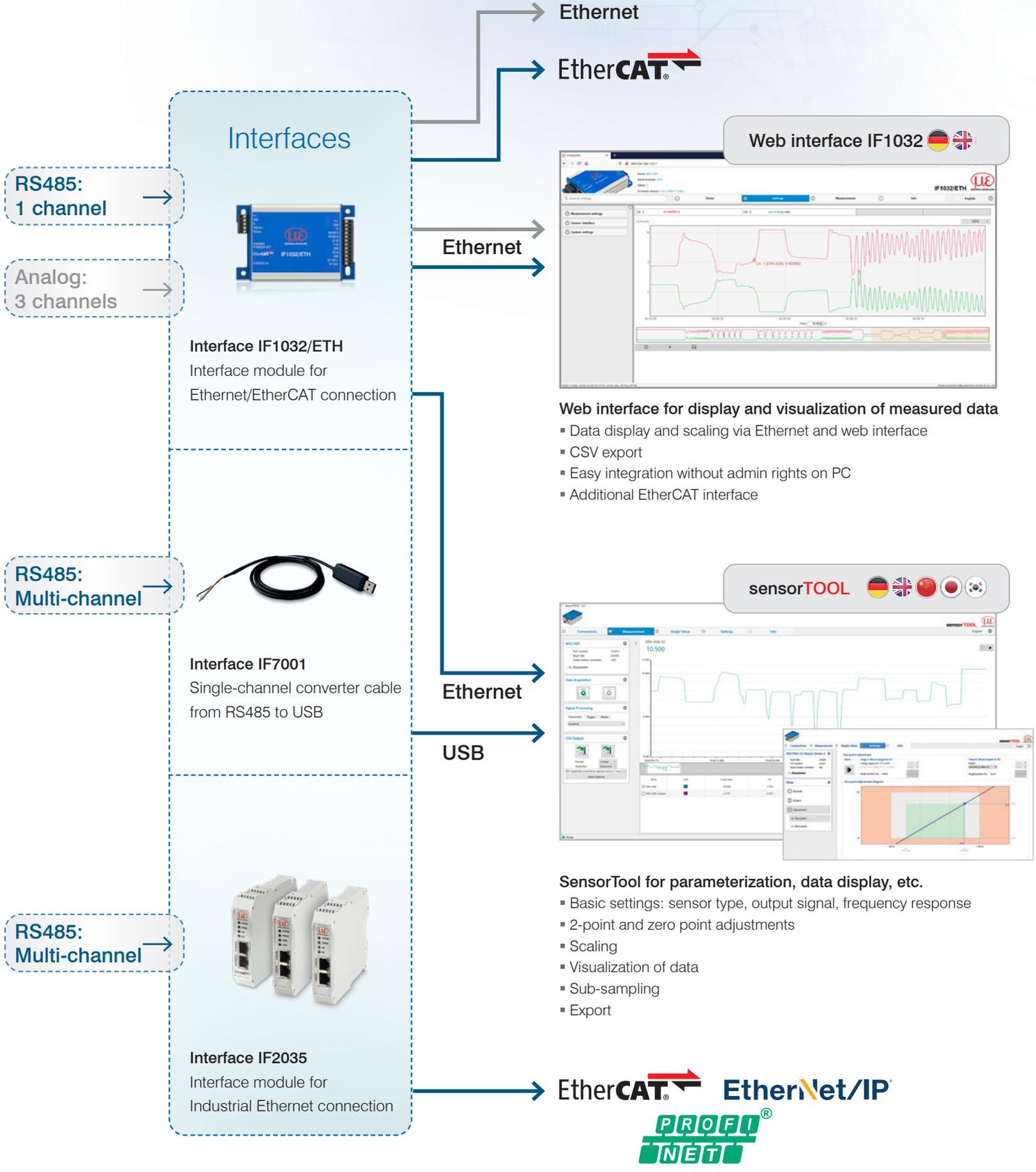


5-pole M12x1 housing connector
View on pin side



Measurement direction Connector side

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				



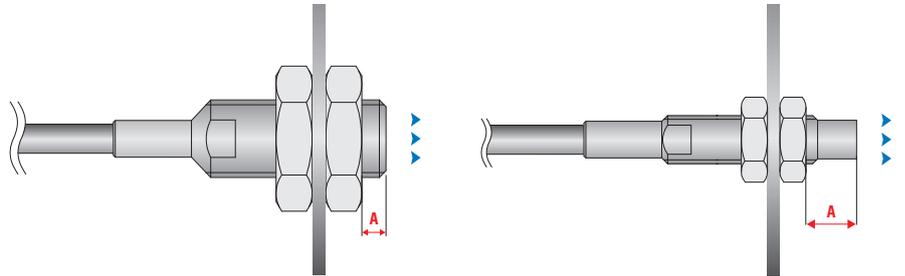
- Web interface for display and visualization of measured data**
- Data display and scaling via Ethernet and web interface
 - CSV export
 - Easy integration without admin rights on PC
 - Additional EtherCAT interface

- 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

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)

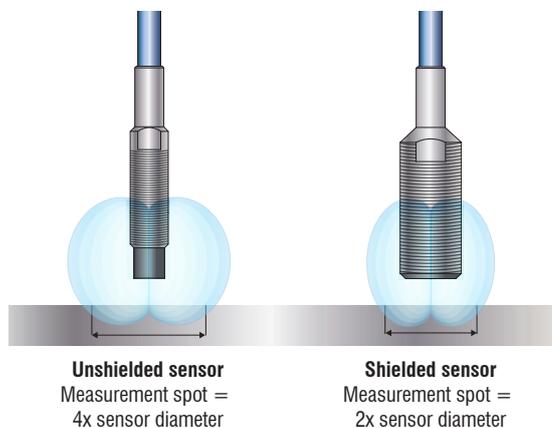
Influences on the measurement signal

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.



-  **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)



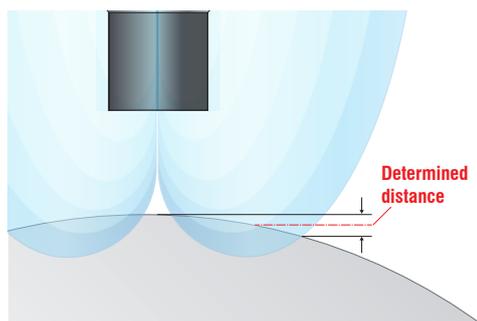
Minimum diameter of round targets

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



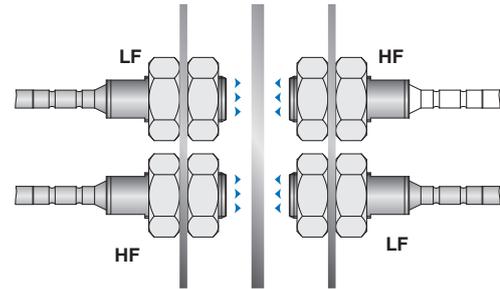
Tilt angle

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.

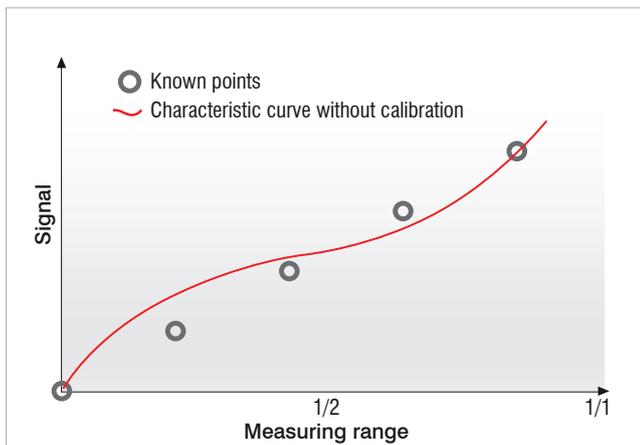
The extent of deviation differs from sensor to sensor. The tilt angle of $\pm 3^\circ$ can be neglected for most of the measurement tasks. With a tilt angle of larger than 6° , factory calibration is recommended. With a 3-point calibration, the tilt angle can be stored in the controller. This compensates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

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.

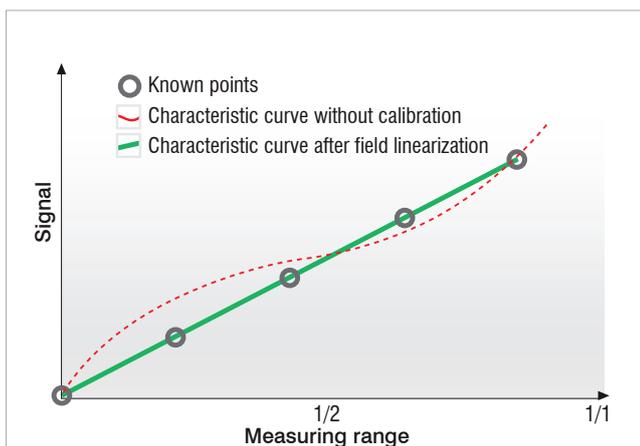


Field calibration



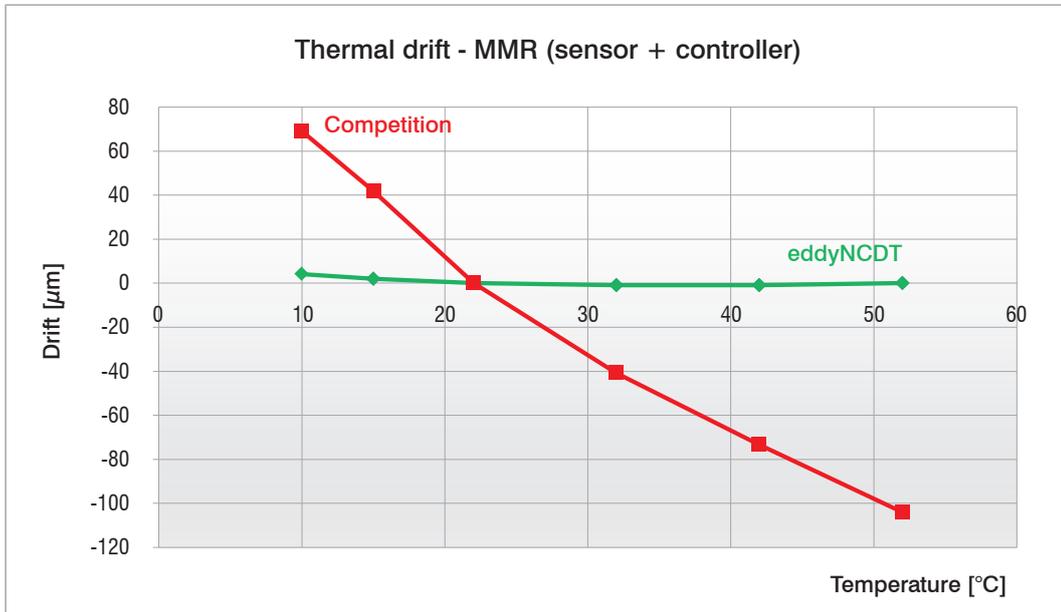
If the installation situation does not correspond to the standard installation conditions, field linearization is recommended (available with eddyNCDT 3060 and eddyNCDT 3300). This on-site calibration compensates for influences which result from the installation scenario or the target materials and shapes. 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.

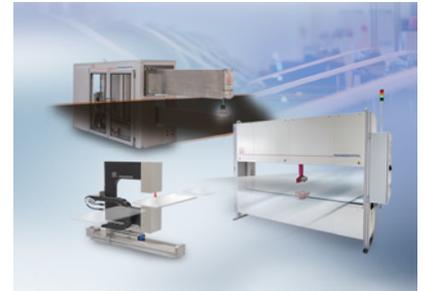
Sensors and Systems from Micro-Epsilon



Sensors and systems for displacement, distance and position



Sensors and measurement devices for non-contact temperature measurement



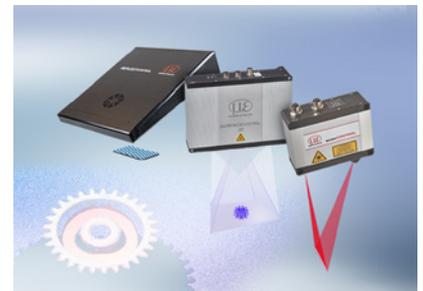
Measuring and inspection systems for metal strips, plastics and rubber



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