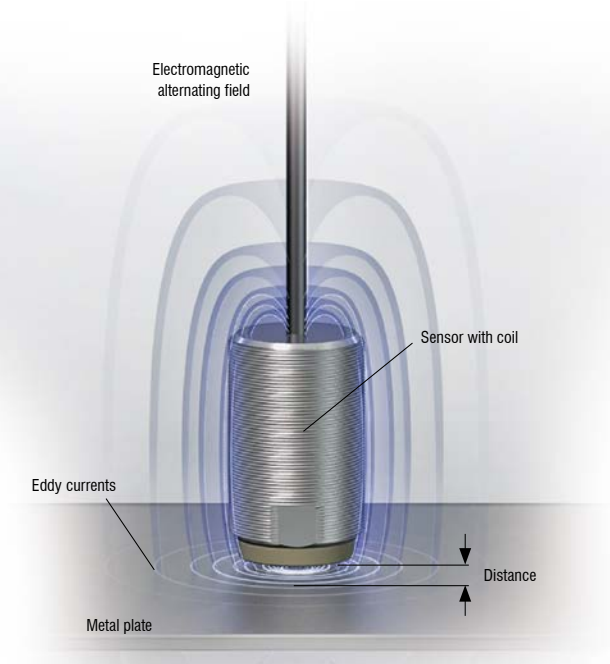
MICRO-EPSILON

More Precision

eddyNCDT // Inductive sensors based on eddy currents



Measuring principle

The eddy current principle occupies a unique position amongst inductive measuring methods. Measuring via eddy current is based on the extraction of energy from an oscillating circuit. This energy is needed for the induction of eddy currents in electrically-conductive materials. Here, a coil is supplied with an alternating current, causing a magnetic field to form around the coil. If an electrically conducting object is placed in this magnetic field, eddy currents are induced which form a field according to Faraday's induction law. This field acts against the field of the coil, which also causes a change in the impedance of the coil. The impedance can be calculated by the controller by looking at the change in the amplitude and phase position of the sensor coil.

High precision

For many years, Micro-Epsilon has been a pioneer in displacement measurement using eddy current technology. Eddy current sensors from Micro-Epsilon are designed for non-contact measurement of displacement, distance, position, oscillation and vibrations. In addition, they are extremely robust and precise.

Advantages

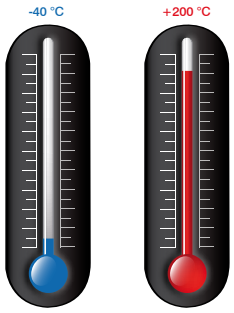
- Wear-free and non-contact measurement
- Highest precision and resolution
- High temperature stability
- Ferromagnetic and non-ferromagnetic materials
- For demanding, industrial environments: dirt, pressure, temperature
- Fast measurements up to 100 kHz

eddyNCDT combines robustness with maximum precision

Eddy current sensors from Micro-Epsilon are often used in applications where harsh ambient conditions are present and where maximum precision is required. Immunity to dirt, pressure and extreme temperature are distinctive features.

Specific sensors for OEM applications

Application examples are often found where the standard versions of the sensors and the controllers are performing at their limits. For these special tasks, we modify your measuring system according to your individual requirements. Changes requested include, for example, modified designs, target calibration, mounting options, individual cable lengths, modified measuring ranges or sensors with integrated controller.



Ideal for temperature fluctuations

- Active temperature compensation of sensor and controller
- Temperature range -40 °C to 200 °C and higher

Robust sensors

- Robust and reliable sensors IP67
- Pressure-resistant models up to 2000 bar
- Resistant to oil, dust & dirt

Comprehensive product range

- More than 400 sensor models
- Miniature sensors smaller than 2 mm
- Customer-specific modifications and OEM

- *Compact M12 design with integrated controller*
- *Frequency response 5 kHz (-3 dB)*
- *Sensor for ferromagnetic and non-ferromagnetic targets*
- *Temperature compensation up to 70 °C*
- *Easy to use (plug & play)*
- *Robust design to IP67*

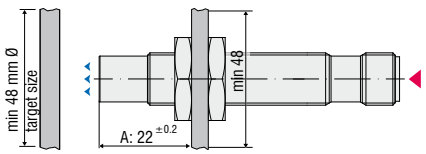
Robust M12 miniature eddy current sensor

The eddyNCDT 3001 is a powerful eddy current sensor whose compact dimensions have to date only been reserved for inductive sensors and proximity sensors. This compact sensor comes with an integrated controller including temperature compensation, offering an outstanding price/performance ratio, as well as easy operation. Therefore, the sensor is ideally suited to OEM integration and machine building applications. The temperature-compensated design provides high stability even in fluctuating ambient temperatures. The sensor is 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).

Installation instructions

The relative size of the measuring object to the sensor and the position of the mounting nut affect the linearity deviation for eddy current sensors.



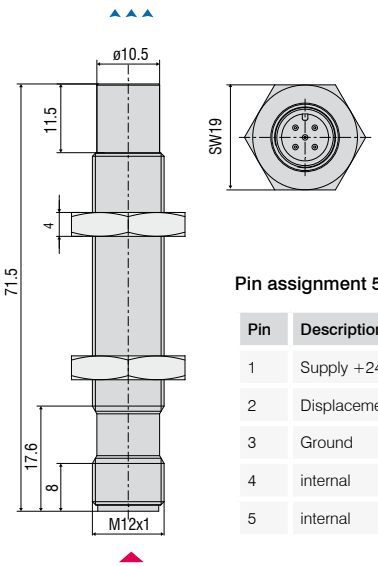
Please note:

- The target geometry shall be 4 times the sensor diameter.
- The mounting nut must not exceed the indicated dimension A.

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
Target [1]	aluminum	steel	aluminum	steel	aluminum	steel
Measuring range	2 mm		4 mm			
Offset distance	0.4 mm					
Linearity	28 µm					
Resolution [2]	4 µm					
Frequency response	5 kHz (-3dB)					
Temperature stability	0.03 % FSO/°C					
Temperature compensation range	0 ... +70 °C					
Temperature range – Operation	0 ... +70 °C					
Temperature range – Storage	-20 ... +80 °C					
Installation	unshielded					
Recommended target geometry (flat)	Ø 48 mm					
Connection	5-pole M12 connector				integrated cable, 5-pin, lengths: 3/6/9 m	
Output	0.5 ... 9.5 V				0.5 ... 4.5 V	
Power supply	12 ... 32 V					
Protection class	IP67 (plugged)				IP67	
Weight	25 g				60 g (3 m) 100 g (6 m) 140 g (9 m)	

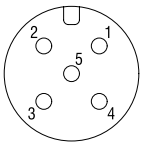
FSO = Full Scale Output
[1] Steel: ST37 DIN 1.0037 / aluminum: AlCuMgPb3.1645
[2] RMS noise relates to midrange at a frequency response of 5 kHz

DT3001-SA

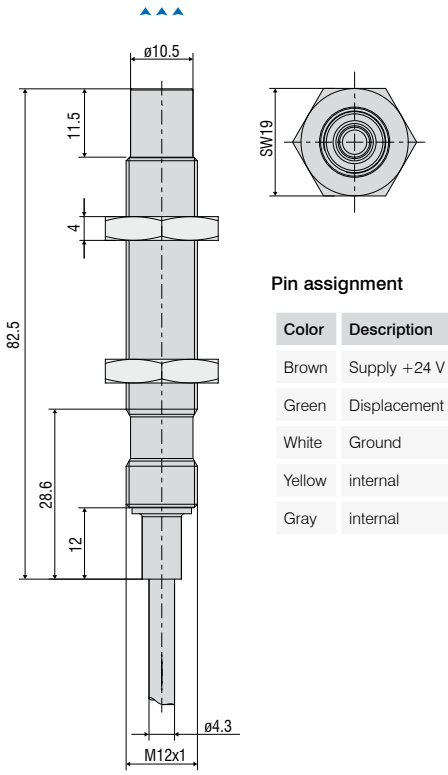


Pin assignment 5-pole M12-connector

Pin	Description
1	Supply +24 V
2	Displacement signal
3	Ground
4	internal
5	internal



DT3001-Cx



Pin assignment

Color	Description
Brown	Supply +24 V
Green	Displacement signal
White	Ground
Yellow	internal
Gray	internal

▲▲▲ Measurement direction ▲ Connector side

Dimensions in mm, not to scale.

- *Compact M18 sensor design with integrated controller*
- *Frequency response 5 kHz (-3 dB)*
- *Sensor for ferromagnetic and non-ferromagnetic targets*
- *Temperature compensation up to 70 °C*
- *Easy to use (plug & play)*
- *Robust design to IP67*

Robust M18 miniature eddy current sensor

The eddyNCDT 3001 is a powerful eddy current sensor in M18 design. This compact sensor comes with an integrated controller including temperature compensation, offering an outstanding price/performance ratio, as well as easy operation. Therefore, the sensor is ideally suited to OEM integration and machine building applications. The temperature-compensated design provides high stability even in fluctuating ambient temperatures. The sensor is factory-calibrated for ferromagnetic and non-ferromagnetic materials, which eliminates the need for on-site linearization of the sensor.

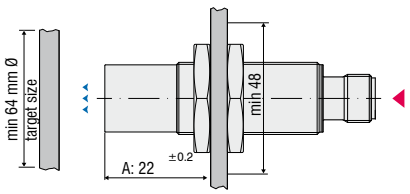
Its robust design combined with the eddy current measuring principle enables measurements in harsh industrial environments (oil, pressure, dirt). In addition, the eddyNCDT 3001 is suitable for offshore/marine applications (salt water).

Installation instructions

The relative size of the measuring object to the sensor and the position of the mounting nut affect the linearity deviation for eddy current sensors.

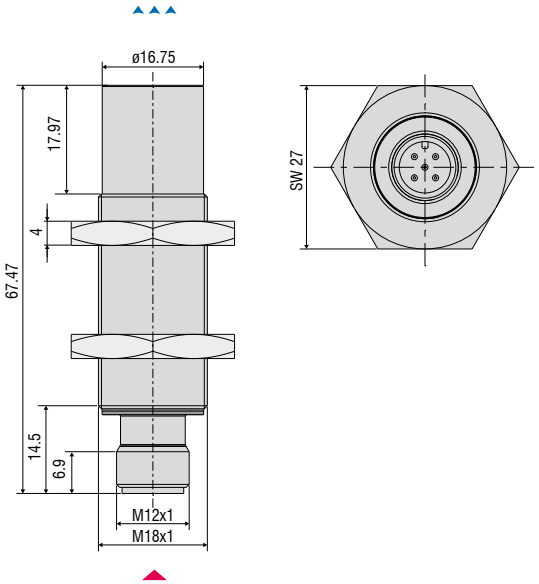
Please note:

- The target geometry shall be 4 times the sensor diameter.
- The mounting nut must not exceed the indicated dimension A.



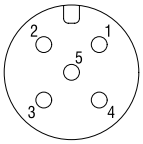
Model		DT3001-U6-A-SA	DT3001-U6-M-SA	DT3001-U8-A-SA	DT3001-U8-M-SA
Target [1]		aluminum	steel	aluminum	steel
Measuring range		6 mm		8 mm	
Offset distance		0.6 mm		0.8 mm	
Linearity		≤15 µm		≤ 20 µm	
		≤ 0.25 % FSO		≤ 0.25 % FSO	
Resolution [2]		≤ 3 µm		≤ 4 µm	
		≤ 0.05 % FSO		≤ 0.05 % FSO	
Frequency response (-3 dB)		5 kHz			
Temperature stability		≤ 0.025 % FSO/°C			
Temperature compensation range		0 ... +70 °C			
Temperature range	Operation	-20 ... +70 °C			
	Storage	-20 ... +80 °C			
Installation		unshielded			
Recommended target geometry (flat)		Ø 64 mm			
Connection		5-pole M12 connector			
Output	analog	0.5 ... 9.5 V			
	digital	RS485			
Power supply		12 ... 32 V			
Protection class		IP67 (plugged)			
Weight		34.4 g (without nuts)			

FSO = Full Scale Output
[1] steel: ST37 DIN 1.0037 / aluminum: AlCuMgPb3.1645
[2] RMS noise relates to midrange at a frequency response of 5 kHz



5-pole M12 connector of controller

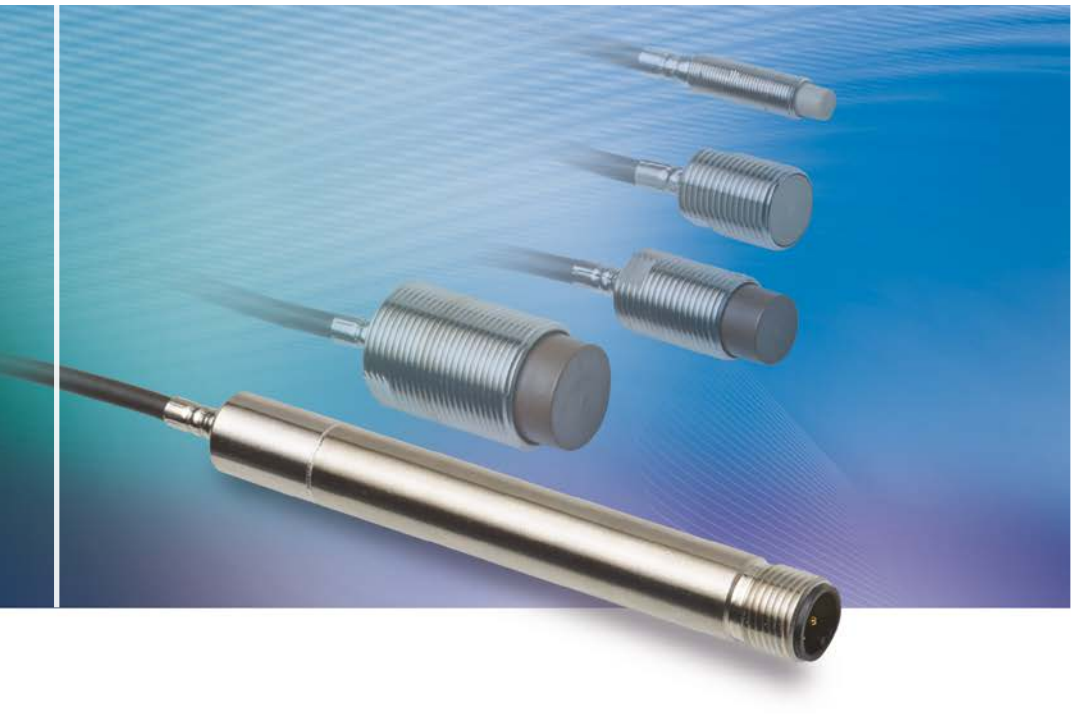
Pin	Description	PCx/5 cable
1	+24 V_{DC} supply	Brown
2	Analog output	White
3	Ground	Blue
4	RS485 (A+)	Black
5	RS485 (B-)	Gray



▲▲▲ Measurement direction

▲ Connector side

Dimensions in mm, not to scale.



- *Compact and robust design*
- *Temperature compensation up to 180 °C*
- *High precision measurement accuracy*
- *High frequency response*
- *Sensors for ferromagnetic and non-ferromagnetic targets*
- *Easy to use (plug & play)*
- *Ideal for integration into plant and machinery*

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 or 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 -30 °C to 180 °C. The measuring system is pressure-resistant up to 10 bar and so is ideally suited to machine integration.

Ideal for integration into plant and machinery

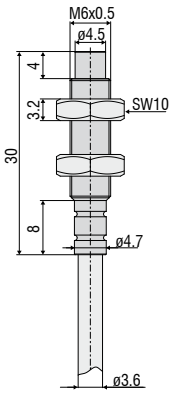
The eddyNCDT 3005 provides ease of use and high measurement accuracy, offering an outstanding price/performance ratio. Therefore, the sensor is ideally suited to OEM integration and mechanical engineering applications. Particularly where pressure, dirt, oil and high temperatures are present, the eddyNCDT 3005 is suitable. Where high volume orders are required, customer-specific designs can be tailored to suit individual requirements.

Compact design

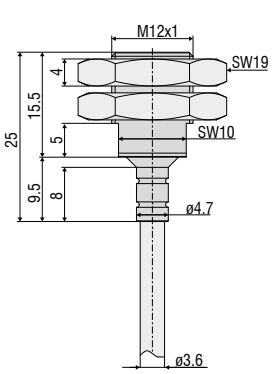
Model		DT3005-U1-A-C1	DT3005-U1-M-C1	DT3005-S2-A-C1	DT3005-S2-M-C1	DT3005-U3-A-C1	DT3005-U3-M-C1	DT3005-U6-A-C1	DT3005-U6-M-C1
Target [1]		aluminum	steel	aluminum	steel	aluminum	steel	aluminum	steel
Measuring range		1 mm		2 mm		3 mm		6 mm	
Offset distance		0.1 mm		0.2 mm		0.3 mm		0.6 mm	
Linearity	≤ ±0.25% FSO	2.5 µm		5 µm		7.5 µm		15 µm	
Resolution [2]	≤ ±0.05 % FSO	0.5 µm		1 µm		1.5 µm		3 µm	
Repeatability		≤ 0.05 % FSO							
Sensitivity deviation		≤ 1 %							
Frequency response		5 kHz (-3dB)							
Temperature stability (MMR)		0.025 % FSO/°C							
Temperature compensation range	Sensor	-10 ... +125 °C (optional -30 ... +180 °C)							
	Controller	+10 ... +60 °C							
Ambient temperature	Sensor	-30 ... +125 °C (optional -30 ... +180 °C)							
	Controller	-20 ... +70 °C							
Installation		unshielded		shielded		unshielded		unshielded	
Recommended target geometry (flat)		ø24 mm		ø24 mm		ø48 mm		ø72 mm	
Cable length		1 m							
Connection		5-pin M12 plug							
Output		0.5 ... 9.5 V							
Power supply		12 ... 32 V							
Protection class		IP67							
Pressure resistance		10 bar (sensor, cable and controller)							
Weight		70 g		75 g		77 g		95 g	

FSO = Full Scale Output
MMR = midrange
[1] Steel: ST37 DIN 1.0037 / aluminum: AlCuMgPb3.1645
[2] RMS noise relates to midrange at a frequency response of 5 kHz

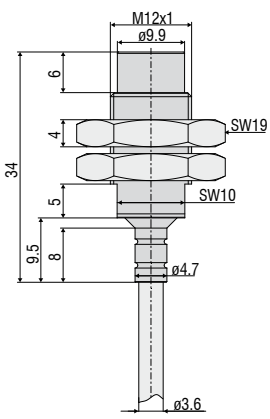
DT3005-U1



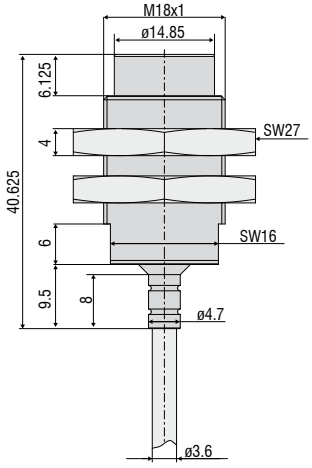
DT3005-S2



DT3005-U3

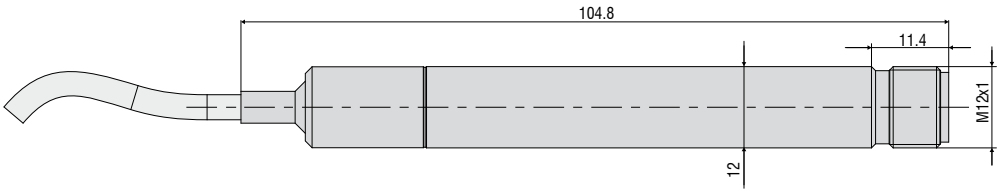


DT3005-U6



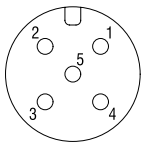
Measurement direction

Controller



Pin Assignment

Pin	Description	Color
1	Supply +24 V	Brown
2	Displacement signal	White
3	Ground	Blue
4	internal	Black
5	internal	Gray



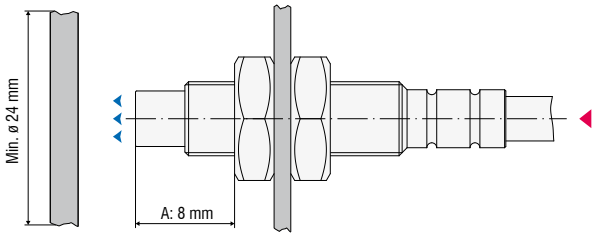
Installation instructions

The relative size of the measuring object to the sensor and the position of the mounting nut affect the linearity deviation for eddy current sensors.

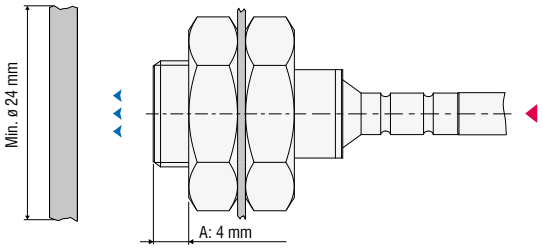
Please note:

- Depending on the sensor model, the target geometry shall be 2 or 4 times the sensor diameter.
- The mounting nut must not exceed the indicated dimension A.

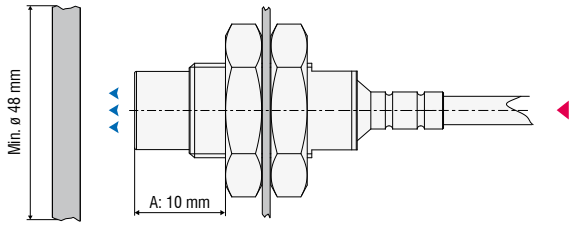
DT3005-U1-x-C1



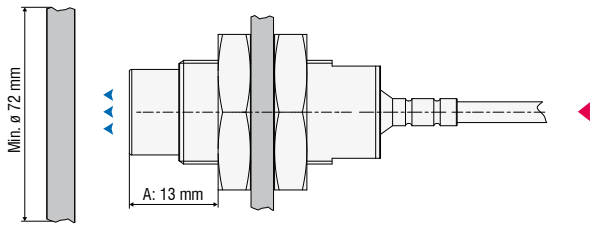
DT3005-S2-x-C1



DT3005-U3-x-C1



DT3005-U6-x-C1



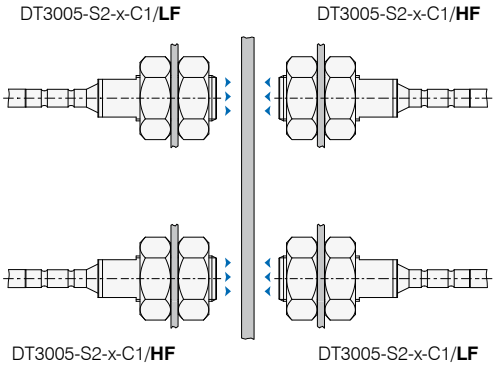
Multi-channel operation without mutual interference

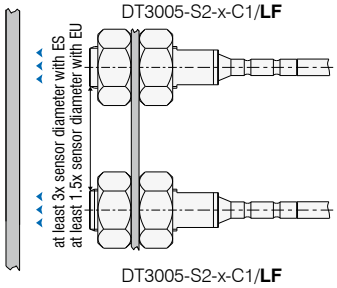
When two or more systems operate next to one another, there is no need for synchronization using a synchronization cable. For operating several systems, a new frequency separation (LF/HF) is provided, which enables to operate these systems in parallel without influencing one another.

Please note:

- 3x sensor diameter distance between two unshielded sensors with the same carrier frequency (e.g. low frequency)
- 1.5x sensor diameter distance between two shielded sensors with the same carrier frequency (e.g. low frequency)
- only two nearby mounted sensors as low frequency and high frequency models

Correct LF/HF arrangement





- *Combination of linearity, resolution and temperature stability sets new standards*
- *Easy integration with modern fieldbus connection and smart signal processing*
- *Maximum ease of use and intuitive configuration via web interface*
- *Industrial suitability due to robust system design*
- *Wide range of applications with more than 400 sensor models*

Performance and universality for industrial use

The eddyNCDT 3060 is a new, 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 either ferromagnetic or non-ferromagnetic materials. With more than 400 compatible sensor models, ease of use and smart signal processing, the eddyNCDT 3060 defines a new performance class in inductive displacement measurement.

Ideal for integration into plant and machinery

As sensor and controller are temperature-compensated, a high measurement accuracy can be achieved even in fluctuating temperatures. The sensors are designed for ambient temperatures up to a maximum of +200 °C and an ambient pressure up to 20 bar. The compact controller design as well as the fieldbus connection make the measuring system ideal for integration into plant and machinery.

New benchmark in controller technology

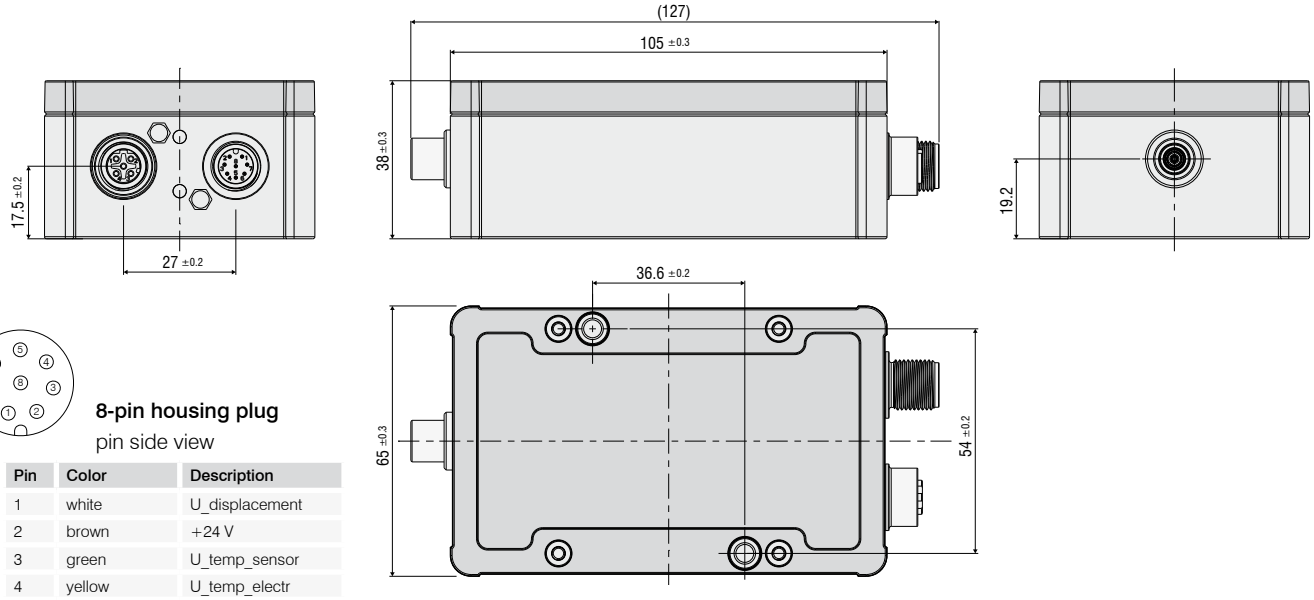
The industrial-grade M12 Ethernet interface offers a modern fieldbus connection. Configurable analog outputs enable to output the measured values as voltage or current. When connecting a PC via the Ethernet interface, a modern web interface can be accessed without any further installation and enables the software setting of sensor and controller.

The DT3061 controller provides enhanced features such as 5-point calibration, setting of switching and temperature outputs, as well as storage of multiple characteristic curves. When two or more systems operate next to one another, there is no need for synchronization. For operating several systems, a new frequency separation is provided, which enables to operate these systems in parallel without influencing one another.

Features	Controller type	
	DT3060	DT3061
Active temperature compensation for sensor and controller	✓	✓
Frequency separation (LF & HF)	✓	✓
Industrial Ethernet interface	✓	✓
Intuitive web interface	✓	✓
Multipoint calibration regardless of the distance (up to 3 points)	✓	✓
Scalable measuring range via analog output (teach function)	✓	✓
Scalable analog output	✓	✓
Switching and temperature outputs	-	✓
5-point calibration	-	✓
Storage of multiple characteristic curves	-	✓

Model		DT3060	DT3061
Resolution [1]	static (20 Hz)	0.002 % FSO	
	dynamic (20 kHz)	0.01 % FSO	
Frequency response (-3 dB)		selectable (20 kHz, 5 kHz, 20 Hz)	
Measuring rate		50 kSa/s	
Linearity	3-point linearization	≤ ± 0.2% FSO	
	5-point linearization	-	≤ ± 0.1% FSO
Temperature stability		≤ 0.015 % FSO / K	
Temperature compensation		+10 ... +50 °C	
Synchronization		no sync - LF & HF variants	
Target material		ferromagnetic, non-ferromagnetic	
Supply voltage		12 ... 32 VDC	
Power consumption		2.5 W	
Analog output		0 … 10 V (short circuit proof); 4 … 20 mA (load max. 500 Ohm)	
Digital interface		Industrial Ethernet (M12 socket)	
Connection		M12 connector	
Mounting		through bores	
Temperature range	Storage	-10 ... +70 °C	
	Operation	0 ... +50 °C	
Shock (DIN-EN 60068-2-29)		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 (when connected)	
Material		die-cast aluminum	
Weight		approx. 230 g	
No. of characteristic curves		1	max. 4

FSO = Full Scale Output
[1] RMS noise relates to midrange

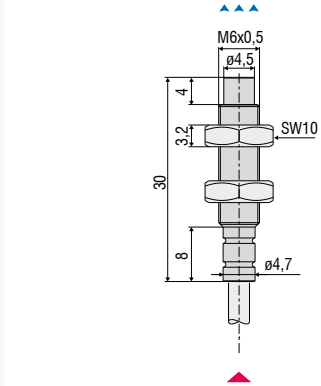


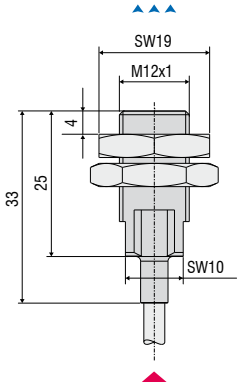
8-pin housing plug
pin side view

Pin	Color	Description
1	white	U_displacement
2	brown	+24 V
3	green	U_temp_sensor
4	yellow	U_temp_electr
5	gray	GND_temp_SW
6	pink	GND_displacement
7	blue	GND_power
8	red	I_displacement

Measurement direction

Cable side





Sensor type		ES-U1	ES-S2
Measuring range		1 mm	2 mm
Start of measuring range		0.1 mm	0.2 mm
Resolution [1) 2) 3)]		0.02 µm	0.04 µm
Linearity [1)]	3-point linearization	≤ ± 2 µm	≤ ± 4 µm
	5-point linearization [4)]	≤ ± 1 µm	≤ ± 2 µm
Temperature stability [1) 2)]		≤ 0.15 µm / K	≤ 0.3 µm / K
Temperature compensation		+10 ... +180 °C	+10 ... +180 °C
Min. target size (flat)	Operation	Ø 18 mm	Ø 18 mm
Sensor type		unshielded	shielded
Connection		integrated cable, axial standard length 3 m; 1 m, 6 m, 9 m optional [5)]	integrated cable, axial standard length 3 m; 1 m, 6 m, 9 m optional [5)]
Mounting		cable gland (M6)	cable gland (M12)
Temperature range	Storage	-50 ... +180 °C	-50 ... +200 °C
	Operation	-20 ... +180 °C	-20 ... +200 °C
Pressure resistance	Front	20 bars	20 bars
	Rear	5 bars	5 bars
Shock (DIN-EN 60068-2-29)		30 g	30 g
Vibration (DIN-EN 60068-2-6)		15 g	15 g
Protection class (DIN-EN 60529)		IP68 (plugged)	IP68 (plugged)
Material		stainless steel and plastic	stainless steel and plastic
Weight		2.4 g (without nuts)	11 g (without nuts)

FSO = Full Scale Output

[1)] valid for operation with DT306x controller, referred to nominal measuring range

[2)] relates to midrange

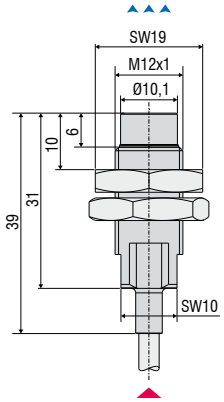
[3)] RMS value of the signal noise, static (20 Hz)

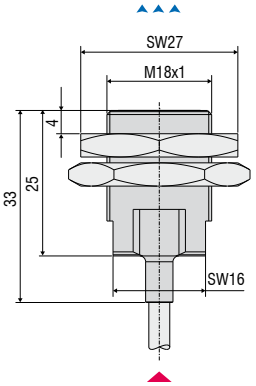
[4)] only available with controller DT3061

[5)] Length tolerance cable: +0.5 m / +1.25 m / +2.35 m / +3.5 m

Measurement direction

Cable side





Sensor type		ES-U3	ES-S4
Measuring range		3 mm	4 mm
Start of measuring range		0.3 mm	0.4 mm
Resolution [1) 2) 3)]		0.06 µm	0.08 µm
Linearity [1)]	3-point linearization	≤ ± 6 µm	≤ ± 8 µm
	5-point linearization [4)]	≤ ± 3 µm	≤ ± 4 µm
Temperature stability [1) 2)]		≤ 0.45 µm / K	≤ 0.6 µm / K
Temperature compensation		+10 ... +180 °C	+10 ... +180 °C
Min. target size (flat)	Operation	Ø 36 mm	Ø 27 mm
Sensor type		unshielded	shielded
Connection		integrated cable, axial standard length 3 m; 1 m, 6 m, 9 m optional [5)]	integrated cable, axial standard length 3 m; 1 m, 6 m, 9 m optional [5)]
Mounting		cable gland (M12)	cable gland (M18)
Temperature range	Storage	-50 ... +200 °C	-50 ... +200 °C
	Operation	-20 ... +200 °C	-20 ... +200 °C
Pressure resistance	Front	20 bars	20 bars
	Rear	5 bars	5 bars
Shock (DIN-EN 60068-2-29)		30 g	30 g
Vibration (DIN-EN 60068-2-6)		15 g	15 g
Protection class (DIN-EN 60529)		IP68 (plugged)	IP68 (plugged)
Material		stainless steel and plastic	stainless steel and plastic
Weight		12 g (without nuts)	30 g (without nuts)

FSO = Full Scale Output

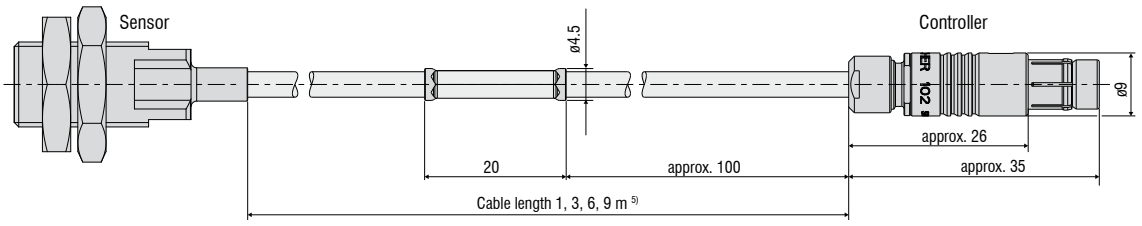
[1)] valid for operation with DT306x controller, referred to nominal measuring range

[2)] relates to midrange

[3)] RMS value of the signal noise, static (20 Hz)

[4)] only available with controller DT3061

[5)] Length tolerance cable: +0.5 m / +1.25 m / +2.35 m / +3.5 m

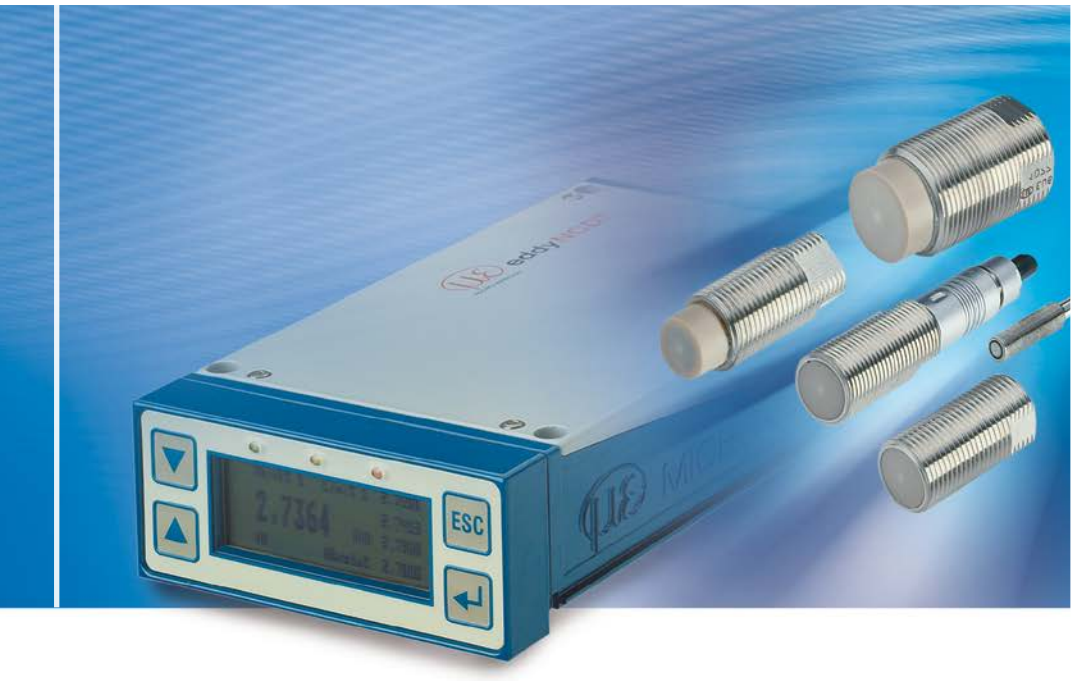


Cables

Cable design	coaxial
Sheath material	FKM
Temperature stability	-20…+200 °C
Outer diameter	3.6 mm ± 0.2 mm
Bending radius	static: ≥ 18 mm dynamic: ≥ 36 mm
Suitable for use with robots	no

Connector (controller)

Model	triaxial connector, type B
Locking method	push-pull
Protection class	IP 68 (connected)
Temperature stability	-20…+200 °C
Material (housing)	nickel- and chrome-plated brass
Mechanical service life	10,000 cycles



- *Micrometer accuracy*
- *Ideal for high speed measurements: frequency response up to 100 kHz (-3dB)*
- *Numerous sensor models even for customer-specific applications*
- *Robust and industrial-grade sensor designs*
- *Synchronized multi-channel measurement*

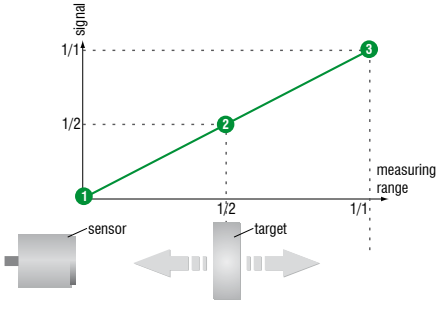
The eddyNCDT 3300 eddy current measuring system is considered one of the most powerful displacement measuring systems in the world. Due to a mature technical design, the system offers numerous benefits to customers in multiple application areas such as manufacturing automation, machine monitoring and quality control.

Multifunctional controller

The eddyNCDT 3300 controllers are equipped with high performance processors for reliable signal processing and further processing. The three-point linearization feature enables almost fully automatic linearization, which provides high accuracies for any metallic target and installation environment. The operation is supported by a dialog-aided graphical display.

Linearization and calibration

eddyNCDT 3300 systems can be individually linearized and calibrated by the user. Therefore, optimum measurement accuracies will always be achieved, even in the case of difficult target materials or harsh ambient conditions. The adjustment is made using three distance points (①,②,③) which are defined by a reference standard.



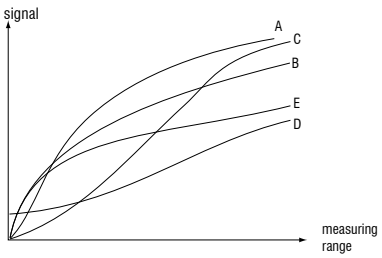
3-point linearisation

Field calibration ensures highest precision

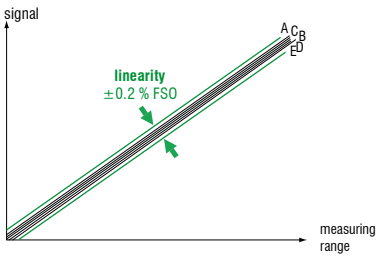
In order to achieve maximum precision, eddyNCDT 3300 provides the field calibration function for achieving extremely precise measurement results. The following influences are taken into account:

A: Different target materials
B: Different target sizes (measuring spot)
C: Target shape
D: Side preattenuation
E: Target tilt angle

The measuring range can also be extended using the field calibration.



Conventional sensor without field calibration
Massive linearity deviation results from the different influences

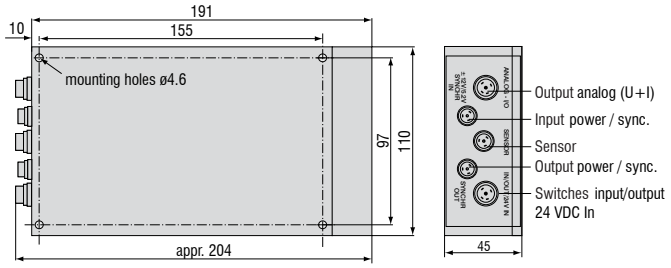


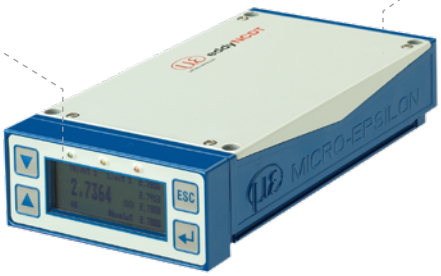
Best practice:
eddyNCDT 3300 with Micro-Epsilon field calibration
High accuracy though compensation of the influences

Controller		DT3300	DT3301
Linearity		≤ ± 0.2% FSO	
Resolution [2]	up to 25Hz	≤0.005 % FSO (≤0.01 % FSO with ES04, ES05 and EU05)	
	up to 2.5 kHz	≤ 0.01 % FSO	
	up to 25/100 kHz	≤ 0.2% FSO	
Frequency response		selectable 25 kHz / 2.5 kHz / 25 Hz (-3 dB); 100 kHz for measuring ranges ≤1mm	
Temperature compensation range		10 ... 100 °C (option TCS: -40 ... 180 °C) [3]	
Temperature range	Controller	+5 ... +50 °C	
Outputs		selectable 0 ... 5 V / 0 ... 10 V / ± 2.5 V / ± 5 V / ± 10 V (or inverted) / 4 ... 20 mA (load 350 Ohm)	
Power supply		±12 VDC / 100 mA, 5.2 VDC / 220 mA [1]	11 ... 32 VDC / 700 mA
Synchronization		via cable PSC 30 (accessories)	via cable E SC 30 (accessories)
Electromagnetic compatibility		according to EN 50081-2 / EN 61000-6-2	
Controller functions		limit value monitoring, auto-zero, peak-to-peak, minimum, maximum, average, storage of 3 characteristics (calibrations)	

FSO = Full Scale Output
Reference material: aluminum (non-ferromagnetic) or steel DIN 1.0037 (ferromagnetic)
Reference temperature for reported data is 20 °C (70 °F); resolution and temperature stability refer to midrange
Data may differ with magnetic inhomogeneous materials.
[1] Additionally 24 VDC for external reset and limit switch
[2] Resolution data are based on noise peak-to-peak values
[3] Temperature stability may differ with TCS option

Controller dimensions





Quadruple limit switch

- Two freely definable minimum and maximum limit values
- Individual switching threshold
- LED display for upper and lower limit warnings

Automatic calibration

- Three-point linearization for optimum on-site calibration

Four configurations can be stored

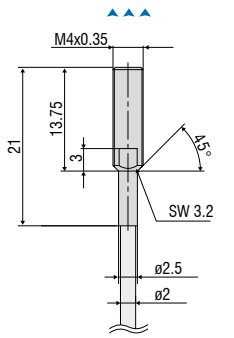
- Factory calibration and three individual characteristic curves can be stored
- Simple microprocessor-controlled single-cycle calibration

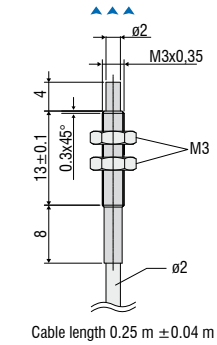
Outputs

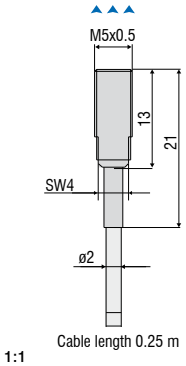
- Voltage/current
- Metric/Inch and graphic display
- Display of auto-zero, peak-to-peak value, minimum, maximum
- Scalable display for conversion to indirect measured values

Measurement direction

Connector side



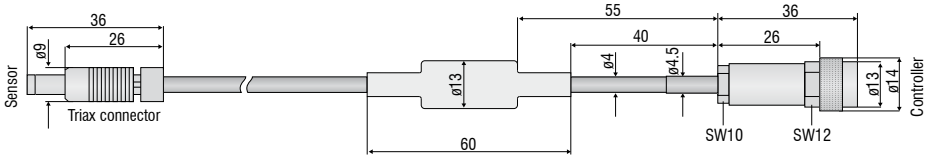




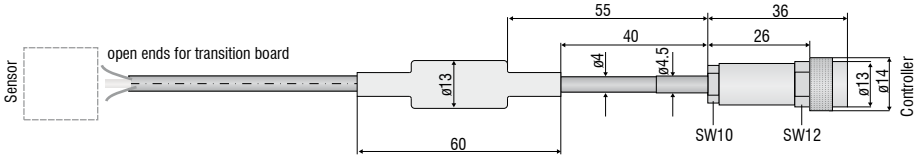
Sensor type	ES04	EU05	ES08
Design	shielded	unshielded	shielded
Measuring range	0.4 mm	0.4 mm	0.8 mm
Offset distance	0.04 mm	0.05 mm	0.08 mm
Linearity	≤ ± 0.8 µm	≤ ± 1 µm	≤ ± 1.6 µm
Resolution	0.02 µm	0.025 µm	0.04 µm
Temperature stability (MMR)	≤ ± 0.06 µm/°C	≤ ± 0.075 µm/°C	≤ ± 0.12 µm/°C
Temperature (max.)	150 °C	150 °C	150 °C
Pressure resistance (sensor front)	100 bars	-	20 bars
Integrated cable/length	approx. 0.25 m	approx. 0.25 m	approx. 0.25 m
Temperature (sensor cable)	180 °C	180 °C	180 °C
Material (sensor housing)	stainless steel	stainless steel and ceramics	stainless steel and plastic

MMR = midrange

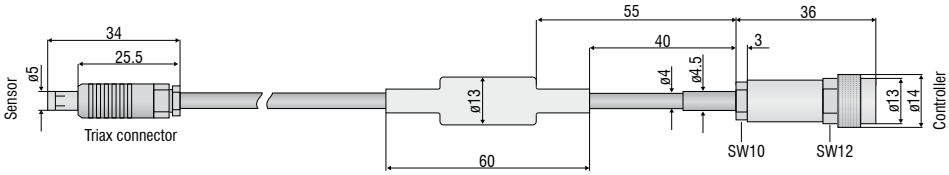
ECx sensor cable, length is selectable up to x≤15m



ECx/1 extension cable for solder connection, length is selectable up to x≤15 m

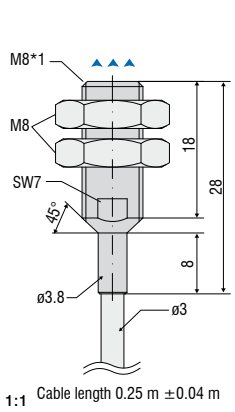


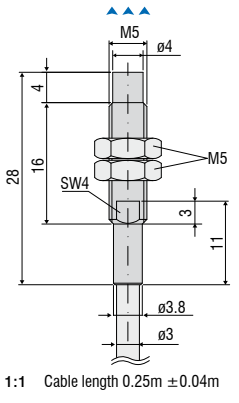
ECx/2 extension cable for plug connection, length is selectable up to x≤15 m

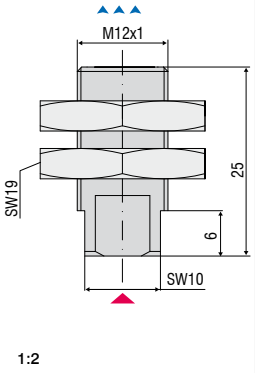


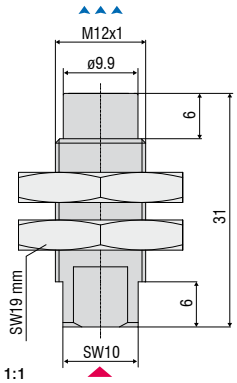
Measurement direction

Connector side









Sensor type	ES1	EU1	ES2	EU3
Design	shielded	unshielded	shielded	unshielded
Measuring range	1 mm	1 mm	2 mm	3 mm
Offset distance	0.1 mm	0.1 mm	0.2 mm	0.3 mm
Linearity	≤ ± 2 µm	≤ ± 2 µm	≤ ± 4 µm	≤ ± 6 µm
Resolution	0.05 µm	0.05 µm	0.1 µm	0.15 µm
Temperature stability (MMR)	≤ ± 0.15 µm/°C	≤ ± 0.15 µm/°C	≤ ± 0.3 µm/°C	≤ ± 0.45 µm/°C
Temperature (max.)	150 °C	150 °C	150 °C	150 °C
Pressure resistance (sensor front)	-	-	20 bars	20 bars
Integrated cable/length	approx. 0.25 m	approx. 0.25 m	-	-
Temperature (sensor cable)	180 °C	180 °C	-	-
Material (sensor housing)	stainless steel and plastic	stainless steel and plastic	stainless steel and plastic	stainless steel and plastic

MMR = midrange

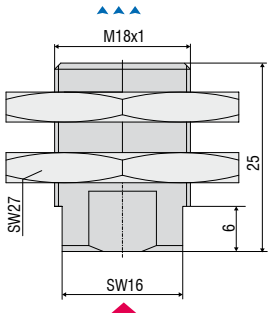
Cable

Cable design	coaxial with sheath wire
Sheath material	FEP/Fluoropolymer thermoplastics
Temperature resistance	-30 °C to +200 °C
Outer diameter	3.9 mm ± 0.1 mm
Bending radius	One-time bending during installation: 2 x cable diameter Minimum bending radius for movement: 5 x cable diameter Optimum bending radius at continuous movement: 10 x cable diameter
Suitable for use with robots	no

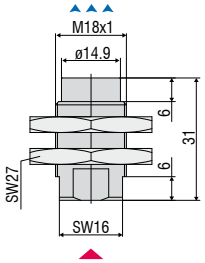
Plug	**Controller side**	**Sensor side**		
Model		**ECx**	**ECx/1**	**ECx/2**
Type	5-pin socket, cable socket	plug (male), triaxial	5-pin plug (male)	plug (male), triaxial
Locking method:	screw	push-pull	screw	push-pull
Protection class	IP67	IP67 (when connected)	IP67 (when connected)	IP68
Temperature stability	-30 °C to +85 °C	-30 °C to +150 °C	-40 °C to +85 °C	-65 °C to +135 °C
Material housing	brass nickel-plated	brass nickel-plated, mat	brass nickel-plated	brass nickel-plated, mat
Mechanical service life	> 500 mating cycles	> 5,000 mating cycles	> 500 mating cycles	> 5,000 mating cycles

Measurement direction

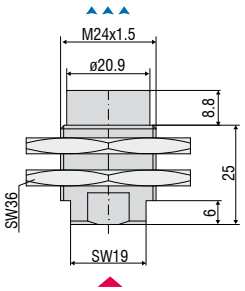
Connector side



1:1



1:2

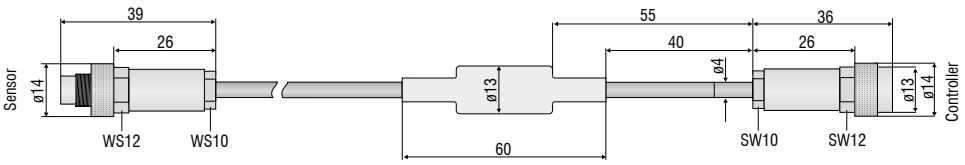


1:2

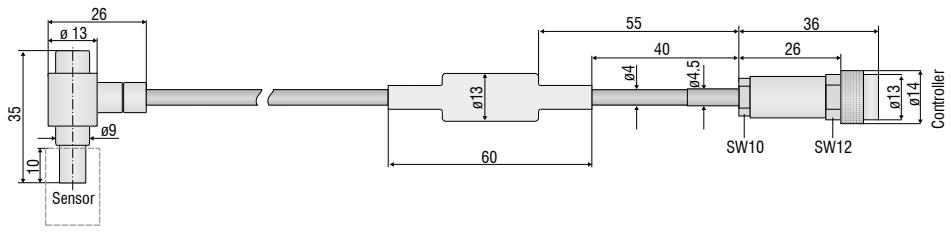
Sensor type	ES4	EU6	EU8
Design	shielded	unshielded	unshielded
Measuring range	4 mm	6 mm	8 mm
Offset distance	0.4 mm	0.6 mm	0.8 mm
Linearity	≤ ± 8 µm	≤ ± 12 µm	≤ ± 16 µm
Resolution	0.2 µm	0.3 µm	0.4 µm
Temperature stability (MMR)	≤ ± 0.6 µm/°C	≤ ± 0.9 µm/°C	≤ ± 1.2 µm/°C
Temperature (max.)	150 °C	150 °C	150 °C
Pressure resistance (sensor front)	20 bars	20 bars	20 bars
Integrated cable/length	-	-	-
Temperature (sensor cable)	-	-	-
Material (sensor housing)	stainless steel and plastic	stainless steel and plastic	stainless steel and plastic

MMR = midrange

ECEx sensor cable extension, length is selectable up to x≤15 m

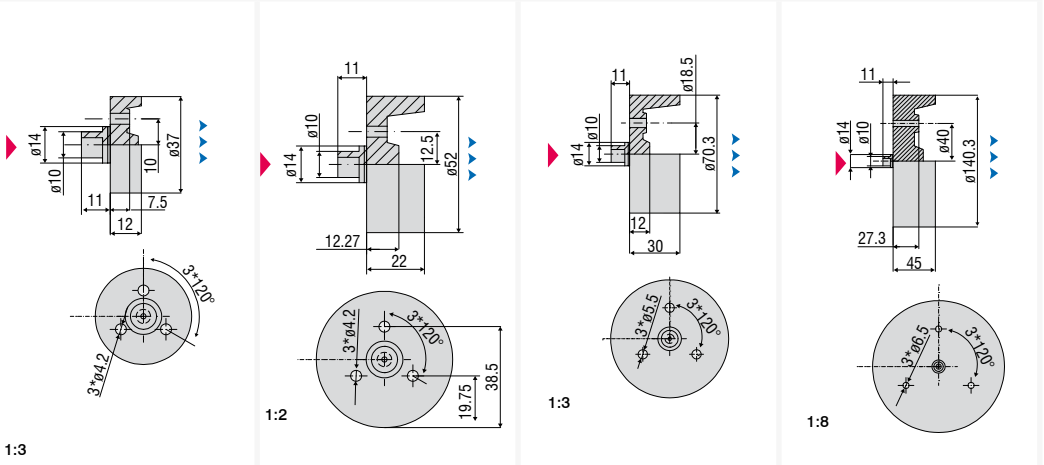


ECx/90 sensor cable with 90°connector (sensor-sided), length is selectable up to x≤15 m



Measurement direction

Connector side



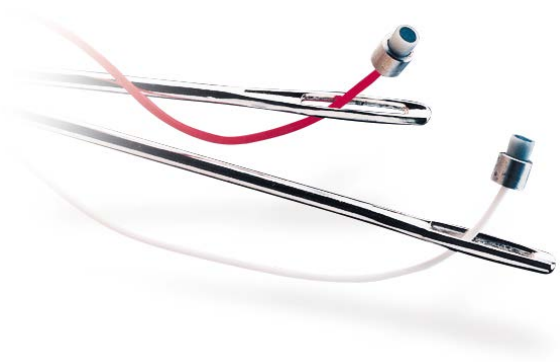
Sensor type	EU15	EU22	EU40	EU80
Design	unshielded	unshielded	unshielded	unshielded
Measuring range	15 mm	22 mm	40 mm	80 mm
Offset distance	1.5 mm	2.2 mm	4 mm	8 mm
Linearity	≤ ± 30 µm	≤ ± 44 µm	≤ ± 80 µm	≤ ± 160 µm
Resolution	0.75 µm	1.1 µm	2 µm	4 µm
Temperature stability (MMR)	≤ ± 2.25 µm/°C	≤ ± 3.3 µm/°C	≤ ± 6 µm/°C	≤ ± 12 µm/°C
Temperature (max.)	150 °C	150 °C	150 °C	150 °C
Pressure resistance (sensor front)	-	-	-	-
Integrated cable/length	-	-	-	-
Temperature (sensor cable)	-	-	-	-
Material (sensor housing)	epoxy	epoxy	epoxy	epoxy

MMR = midrange

Cable

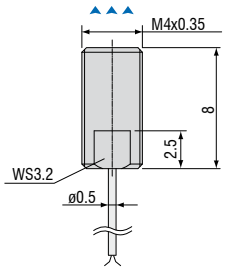
Cable design	coaxial with sheath wire
Sheath material	FEP/Fluoropolymer thermoplastics
Temperature resistance	-30°C to +200°C
Outer diameter	3.9 mm ± 0.1 mm
Bending radius	One-time bending during installation: 2 x cable diameter Minimum bending radius for movement: 5 x cable diameter Optimum bending radius at continuous movement: 10 x cable diameter
Suitable for use with robots	no

Plug	**Controller side**	**Sensor side**	
Model		**ECEx**	**ECx/90**
Type	5-pin socket, cable socket	5-pin plug (male)	plug (male), triaxial, angle
Locking method:	screw	screw	push-pull
Protection class	IP67	IP67 (when connected)	IP67 (when connected)
Temperature stability	-30 °C to +85 °C	-30 °C to +85 °C	-65 °C to +135 °C
Material housing	brass nickel-plated	brass nickel-plated	brass nickel-plated, mat
Mechanical service life	> 500 mating cycles	> 500 mating cycles	> 5000 mating cycles



Subminiature sensors for restricted spaces

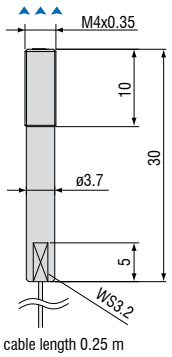
As well as standard sensors in conventional designs, miniature sensors with the smallest possible dimensions that achieve high precision measurement results are also available. Pressure-resistant versions, screened housings, ceramic types and other special features characterize these sensors, which achieve highly accurate measurement results despite their small dimensions. The miniature sensors are primarily used in high pressure applications, for example, in combustion engines.



2:1

ES04/180(25) Shielded Sensor

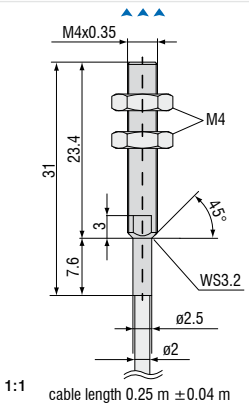
Measuring range 0.4 mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 1 m (ø 0.5 mm), short silicon tube at cable exit
Pressure resistance (static): front 100 bar
Max. operating temperature: 180 °C
Housing material: stainless steel
Sensor cable: ECx/1 or ECx/2, length ≤6 m



1:1

ES04/180(27) Shielded Sensor

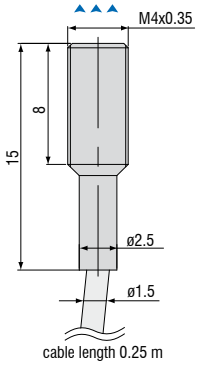
Measuring range 0.4 mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 100 bar
Max. operating temperature: 180 °C
Housing material: stainless steel
Sensor cable: ECx/1, length ≤ 6 m



1:1

ES04(34) Shielded Sensor

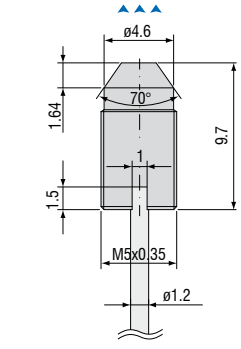
Measuring range 0.4 mm
Temperature stability ≤ ± 0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 2 mm) with sealed triaxial connector
Pressure resistance (static): front 100 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: stainless steel and ceramic
Sensor cable: ECx, length ≤6 m



2:1

ES04(35) Shielded Sensor

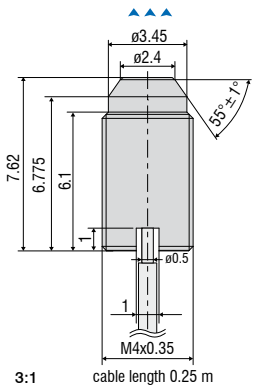
Measuring range 0.4 mm
Temperature stability ≤ ± 0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 1.5 mm) with sealed triaxial connector
Pressure resistance (static): front 100 bar / rear side 5 bar
Max. operating temperature: 150 °C
Housing material: stainless steel and ceramic
Sensor cable: ECx/1, length ≤ 6 m



2:1

ES04(44) Shielded Sensor

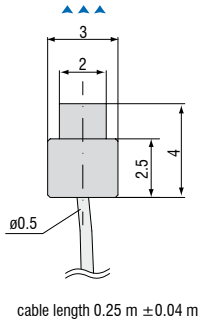
Measuring range 0.4 mm
Temperature stability ≤ ± 0.025 % FSO/°C
Connection: integrated coaxial cable 0.2 m (ø 1.2 mm) with sealed triaxial connector
Pressure resistance (static): front 100 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: stainless steel and ceramic
Sensor cable: ECx, length ≤ 6 m



3:1

ES04(70) Shielded Sensor

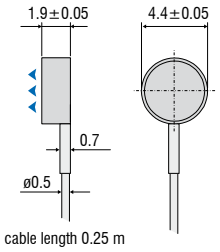
Measuring range 0.4mm
Temperature stability ≤ ± 0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 100 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: stainless steel and ceramic
Sensor cable: ECx/1, length ≤ 6 m



EU05(10) Unshielded Sensor

Measuring range 0.5 mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Max. operating temperature: 150 °C
Housing material: stainless steel and ceramic
Sensor cable: ECx/1, length ≤ 6 m

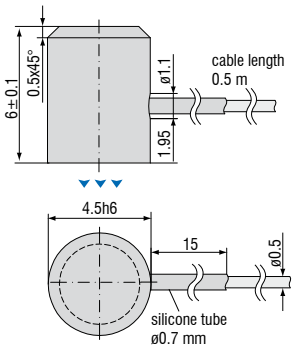
3:1



ES05/180(16) Shielded Sensor

Measuring range 0.5 mm
Temperature stability ≤ ± 0.025 %FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Max. operating temperature: 180 °C
Housing material: stainless steel and epoxy
Sensor cable: ECx/1, length ≤ 6 m

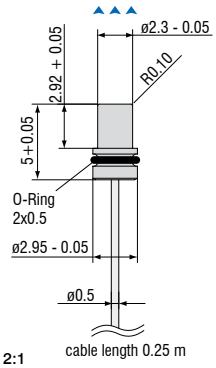
3:1



ES05(36) Shielded Sensor

Measuring range 0.5 mm
Connection: integrated coaxial cable 0.5 m (ø 0.5 mm) with solder connection board
Max. operating temperature: 150 °C
Housing material: stainless steel and epoxy
Sensor cable: ECx/1, length ≤ 6 m

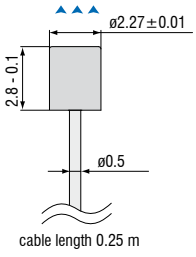
3:1



EU05(65) Unshielded Sensor

Measuring range 0.5 mm
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 700 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: ceramic
Sensor cable: ECx/1, length ≤ 6 m

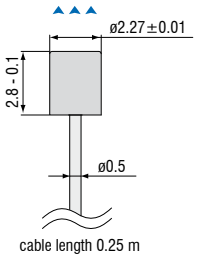
2:1



EU05(66) Unshielded Sensor

Measuring range 0.5 mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 400 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: ceramic
Sensor cable: ECx/1, length ≤ 6 m

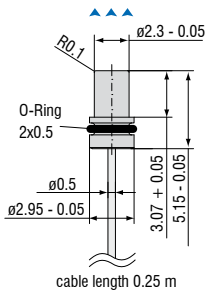
3:1



EU05(72) Unshielded Sensor

Measuring range 0.4mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 2000 bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: ceramic
Sensor cable: ECx/1, length ≤ 6 m

3:1



EU05(93) Unshielded Sensor

Measuring range 0.4 mm
Temperature stability ≤ ±0.025 % FSO/°C
Connection: integrated coaxial cable 0.25 m (ø 0.5 mm) with solder connection board
Pressure resistance (static): front 2000bar / rear side splash water
Max. operating temperature: 150 °C
Housing material: ceramic
Sensor cable: ECx/1, length ≤ 6 m

2:1

turboSPEED DZ140

- *Speed range from 200 to 400,000 rpm*
- *Miniature sensor ø3 mm*
- *Measuring aluminum and titanium*
- *Large distances up to 2.2 mm*
- *No modification of the compressor wheel*
- *Ideal for test bench and road test*
- *Highest immunity to interference and accuracy even in harsh test conditions*
- *Sensor operating temperature up to 285 °C*

Measuring principle

A coil is integrated in a sensor housing and energized by a high-frequency alternating current. The electromagnetic field from the coil generates eddy currents in the turbocharger blade, while every blade generates a pulse. The controller identifies the speed (analog 0–5V) by considering the number of blades.

Robust miniature controller

As the entire electronics is in a sealed miniature housing and designed for ambient temperatures up to 115 °C, the controller is easy to integrate into the engine compartment. turboSPEED DZ140 offers excellent EMC immunity in test cells and road tests.

Engine compartment application

The DZ140 eddy current measuring system is resistant to oil and dirt. This is a key advantage especially compared to optical speed measuring systems, as this immunity helps to achieve high precision measurements on a continuous basis.

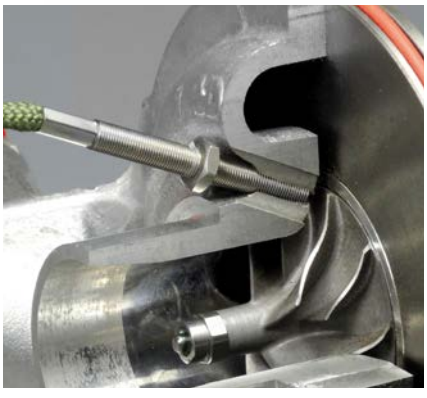
Ease of use

A tri-color ‘status’ LED on the controller indicates when the sensor has reached the ideal distance from the turbocharger blades. This simple feature enables greatly reduced installation time. As the sensor is connected with the electronics via a special BNC connector, it is therefore downward compatible with all previous sensor models. An industrial push-pull connector guarantees a reliable connection between the electronics and the power supply as well as the analog outputs.

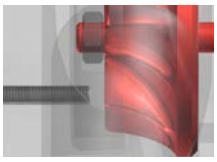
Measuring aluminum and titanium blades

The DZ140 measures both aluminum and titanium blades. The sensors can be mounted at a relatively large distance from the blade. The maximum distance of 2.2 mm enables reliable operation.

Extremely compact design



Large measuring distances both at aluminum and titanium



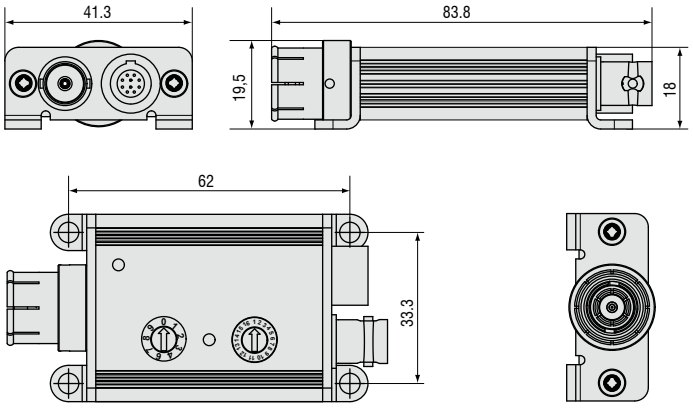
Axial installation

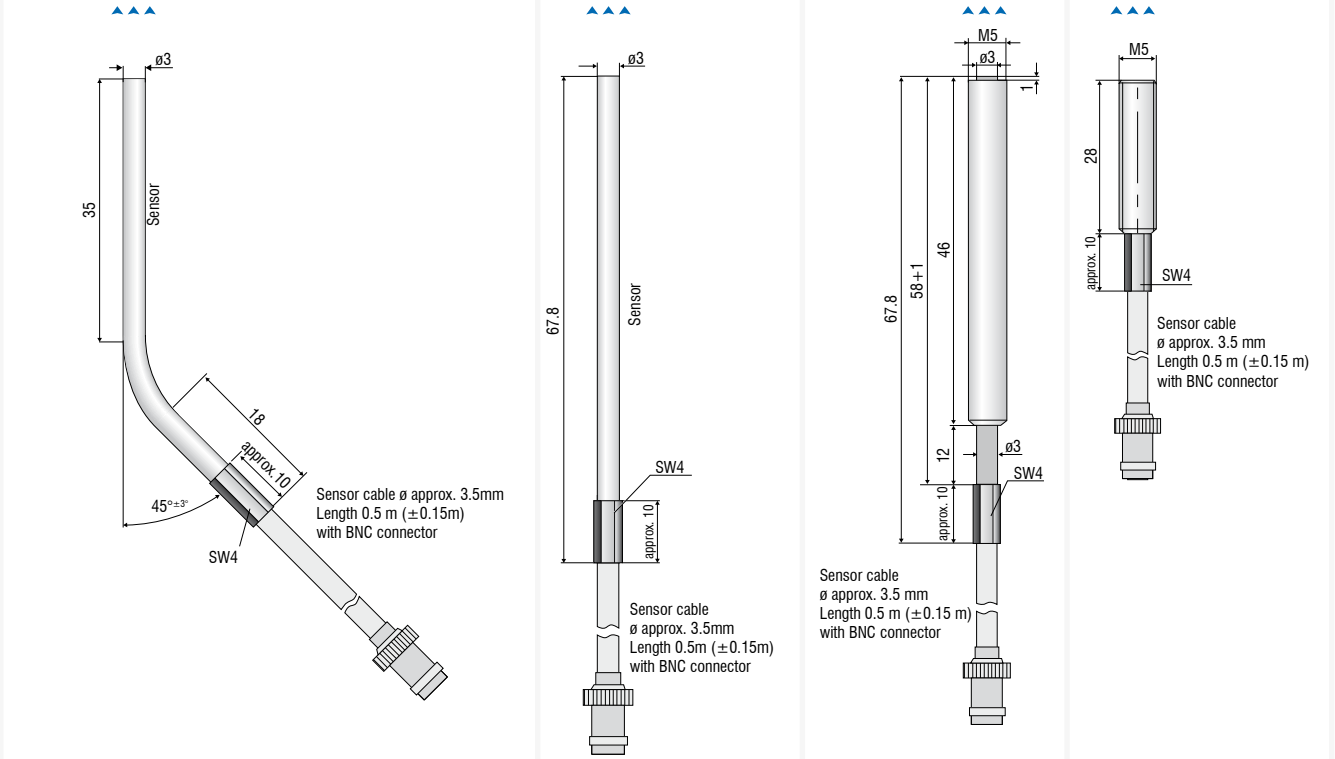
Radial installation

Model		DZ140 (Controller)							
Sensors		DS 05(03)	DS 05(04)	DS 05(07)	DS 05(14)	DS 05(15)	DS 1	DS 1(04)	DS 1/T
Target (blade material)		aluminum or titanium							
Speed range (measuring range)		200 ... 400,000 rpm							
Operating temperature	Controller	-20 ... +115 °C							
	Sensor	-40 ... +235°C (short-term +285 °C)							
Distance sensor to blade (wall thickness 0.35 mm)	Aluminum	radial 0.6 mm / axial 1.1 mm					radial 1.3 mm / axial 1.6 mm		
	Titanium	radial 0.6 mm / axial 1.0 mm					radial 1.2 mm / axial 1.6 mm		
		adjustment with three-state LED							
Integral sensor cable		0.5 m ± 0.15 m					0.75 m ± 0.15 m	0.8 m ± 0.15 m	
No. of blades		adjustable, accessible from outside via rotary switch for 1 to 16 blades							
Output (digital)		1 pulse / blade (TTL-level, variable pulse duration) or 1 pulse / revolution (TTL-level, pulse duration 100 µs)							
Output (analog)		0 ... 5 V (200 ... 200,000 rpm) 0 ... 5 V (200 ... 400,000 rpm) adjustable, mode rotary switch accessible from outside							
	Linearity	± 0.2 % FSO							
	Resolution	0.1 % FSO							
		test pulse generation to control the measurement chain; load resistance > 5 kOhm, load capacitance max. 1nF							
RAW output (via BNC socket)		for easy sensor installation via oscilloscope							
Power supply		9 V ... 30 VDC / max. 50 mA (short-term up to 36 VDC)							
Cables		PC140-3 supply and signal cable, 3 m							
		PC140-6 supply and signal cable, 6 m							
Weight		controller DZ140: approx. 85 g							
Protection class		controller DZ140: IP 65							

FSO = Full Scale Output

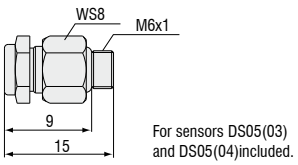
Controller DZ140





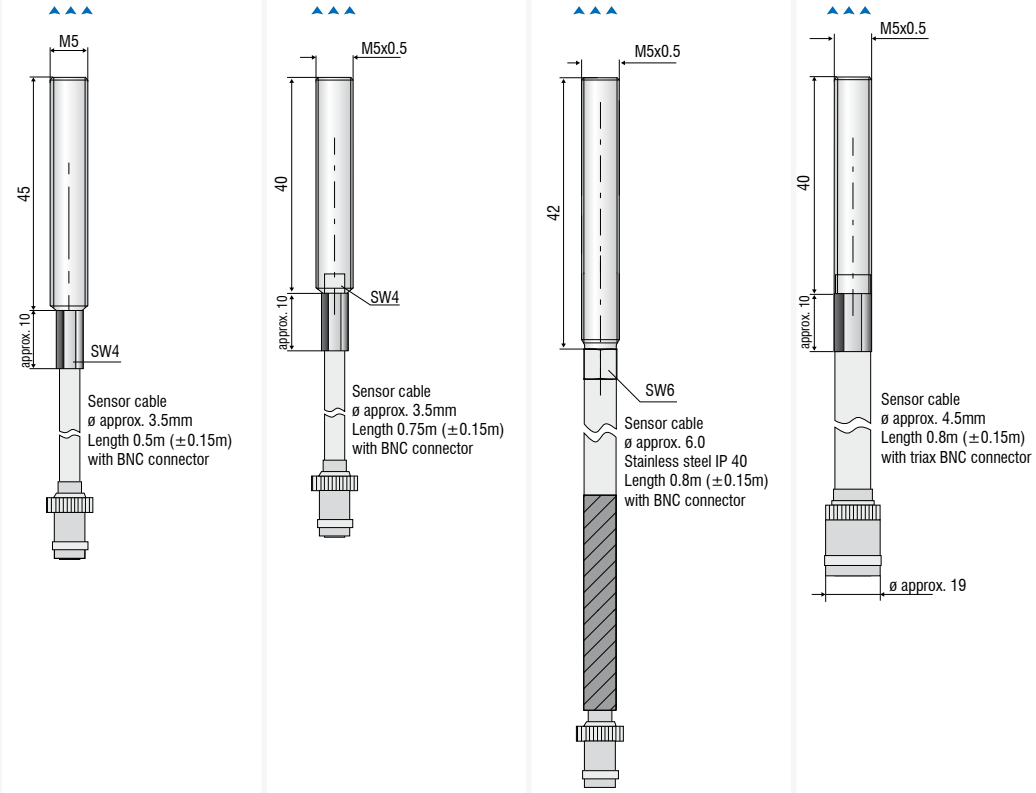
Sensor type	DS 05(03)	DS 05(04)	DS 05(07)	DS 05(14)
Measuring range	0.5 mm	0.5 mm	0.5 mm	0.5 mm
Thread length	-	-	45 mm	28 mm
Thread	-	-	M5 x 0.8	M5 x 0.8
Integrated cable/length	0.5 m	0.5 m	0.5 m	0.5 m
Special feature	curved housing	-	-	length of housing 42.5 mm

Mounting adapter MA135



For sensors DS05(03)
and DS05(04)included.

Measurement direction



Sensor type	DS 05(15)	DS 1	DS 1(04)	DS 1/T
Measuring range	0.5 mm	1 mm	1 mm	1 mm
Thread length	45 mm	40 mm	40 mm	40 mm
Thread	M5 x 0.8	M5 x 0.5	M5 x 0.5	M5 x 0.5
Integrated cable/length	0.5 m	0.75 m	0.8 m	0.8 m
Special feature	-	-	stainless steel protection hose	-

- *Miniature sensor design*
- *Sensor can be completely integrated into the spindle*
- *Miniature controller can be integrated in the spindle or installed via a flange*
- *For ferromagnetic and non-ferro-magnetic materials*
- *Temperature measurement integrated in sensor*
- *Cost-optimized design*

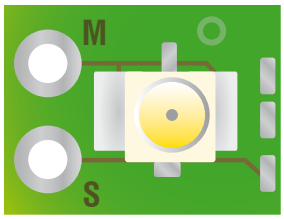
Measuring the thermal extension of spindles

The SGS4701 displacement measuring system (Spindle Growth System) is developed specifically for high speed milling machine applications. Due to high machining speeds and the heat generated, the linear thermal expansion of the spindle in precision machine tools needs to be compensated for in order to keep the tool in a defined position at all times. The SGS sensor measures the thermal and centrifugal force expansion of the spindle. These measurement values are fed into the CNC machine tool as correctional values, compensating for any positioning errors.

The SGS4701 operates on the eddy current measuring principle. This non-contact measurement method is wear-free. Furthermore, the measurement procedure is resistant to disturbances such as heat, dust and oil.

System design

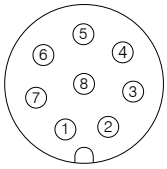
The SGS4701 consists of a sensor, a sensor cable and a controller, factory calibrated either for ferromagnetic or non-ferromagnetic measurement objects. Two miniature sensors enable it to be installed directly in the spindle, where the measurements take place, typically on the labyrinth-ring of the spindle. As well as measuring linear thermal expansion, the temperature of the sensor is also detected and output. The compact controller can be installed on the spindle housing via a flange or directly in the spindle.



The sensor cable must not be shortened as functionality loss may arise. Removing the connector is only permitted behind the plug-sided crimp when using the solder connections.

S = signal = inner conductor
M = ground = shield = outer conductor

8-pin M12 plug Pin view onto controller

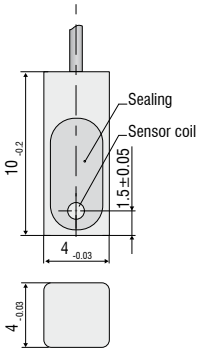


Pin	Description
1	Ground
2	+24 V
3	Displacement signal
4	Temperature signal
5	not connected
6	do not connect
7	do not connect
8	not connected

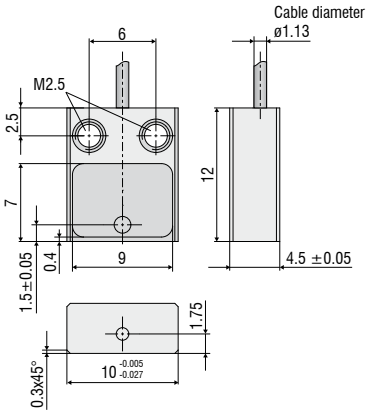
Sensor system		SGS4701
Measuring range		500 µm (option 250 µm [2])
Offset distance		100 µm (option 50 µm [2])
Linearity		± 2 µm
Resolution [1]		0.5 µm
Frequency response		2000 Hz
Target material		ferromagnetic or non-ferromagnetic
Continuous operating temperature	Sensor	0 ... +90 °C
	Controller	+10 ... +70 °C
Temperature stability	Sensor	± 150 ppm FSO/°C (MMR)
	Controller	± 500 ppm FSO/°C (MMR)
Temperature compensation range	Sensor	+10 ... +80 °C
	Controller	+10 ... +70 °C
Power supply		12 ... 32 VDC
Analog out (displacement)		0.5 ... 9.5 V ≙ 100 ... 600 µm (optional 50 ... 300 µm [2])
Analog out (temperature)		0.5 ... 9.5 V (≙ 0 ... +90 °C)
Protection class	Sensor+Controller	IP67 [3]
Dimensions	EMU04(102)	12x10x4.5 mm [4]
	EMU04(121)	10x4x4 mm [4]
Sensor cable [3]	Diameter	Ø 1.13 mm
	Length	1000 mm (400 ... 1500 mm on request)
	min. bend radius	12 mm
	Jacket	FEP

FSO = full scale output; MMR = midrange
[1] Static, MMR
[2] For OEM modifications: sensors with a measuring range of 250 µm and an offset of 50 µm are possible
[3] In mated condition
[4] Detailed cable specifications can be found in the operating instructions

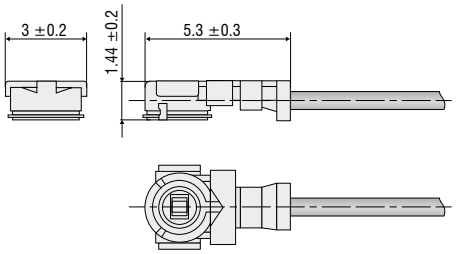
EMU04(121)



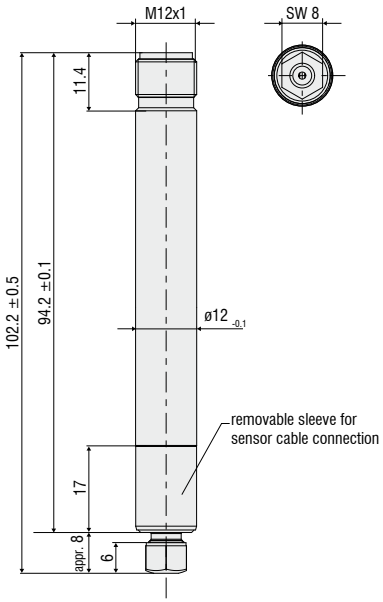
EMU04(102)



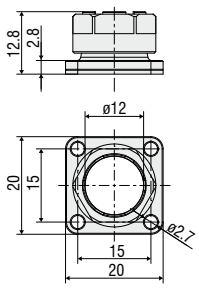
Connector (max. 20 mating cycles possible)



Controller

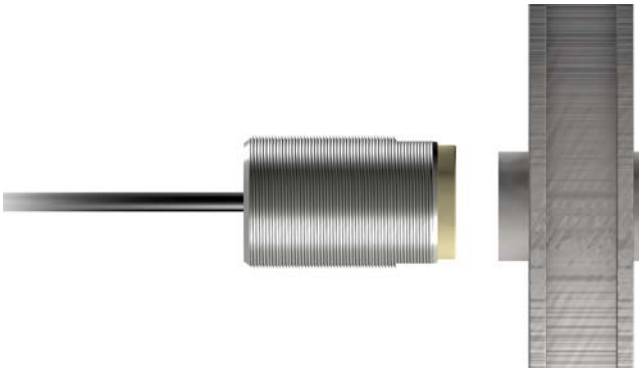


Clamping flange
(optional)

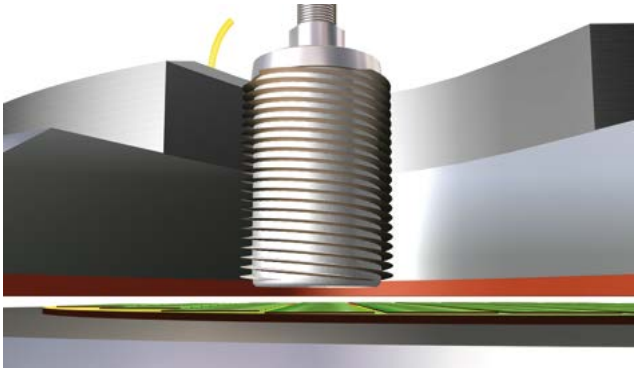


Eddy current sensors from Micro-Epsilon have many possible areas of application. High measurement accuracy and frequency response with an extremely robust design enable measurements where conventional sensors are not applicable.

Eddy current sensors from Micro-Epsilon represent high-performance measurement, particularly under extreme operating conditions. Environmental influences such as oil, temperature, pressure and moisture are largely compensated for and have a minimal effect on the signal. For this reason, the sensors are ideal in challenging application areas, such as industrial mechanical engineering and automotive inspection systems.



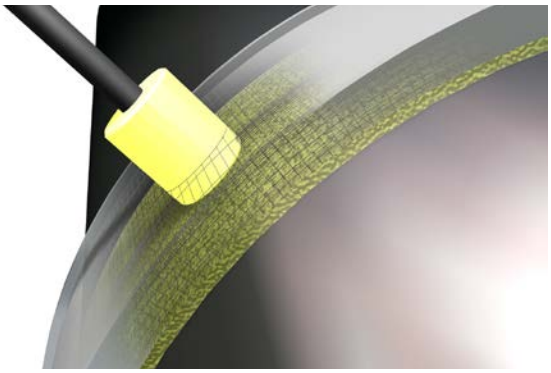
Measuring the axial shaft oscillation



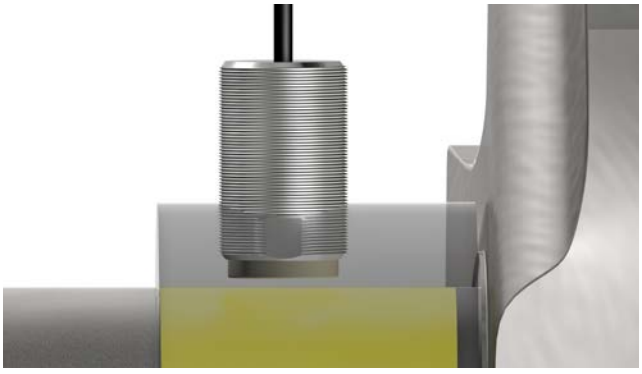
Position measurement for machine monitoring

Measuring the thermal expansion of milling spindles

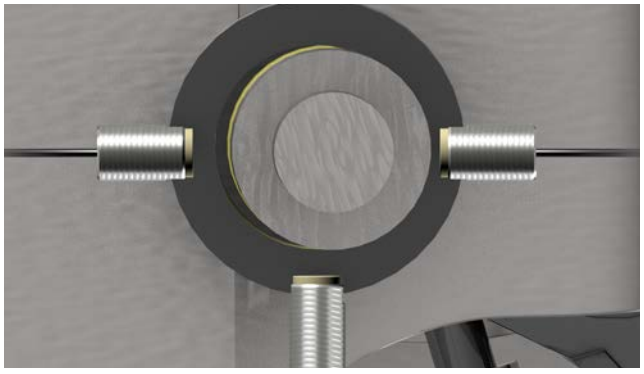
Monitoring the lubricating gap in the combustion engine



Oil film thickness measurement



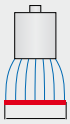
Run-out monitoring of rolls



Measuring the radial shaft expansion

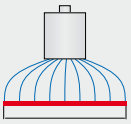
Article	Description	eddyNCDT 3001	eddyNCDT 3005	eddyNCDT 3060	eddyNCDT 3300
PCx/8-M12	Supply and signal cable, 8-pin, lengths: 3 / 5 / 10 / 15 m			•	
PCx/5-M12	Supply and signal cable, 5-pin, 5 m / 20 m	•	•		
SCD2/4/RJ45	Industrial Ethernet cable with M12 connector, 4-pin, 2 m			•	
PS2020	Power supply 24 V / 2.5 A, input 100 - 240 VAC, output 24 VDC / 2.5 A, mounting onto symmetrical standard rail 35 mm x 7.5 mm, DIN 50022;	•	•	•	•
SCAx/5	Signal cable, analog, 3 / 6 / 9 m				•
SCDx/8	Signal cable for switching inputs and outputs, 3 / 6 m (also for 11 - 32 VDC supply); for DT3301				•
PSCx	Supply and synchronization cable 0.3 / 1 m, for DT3300				•
ESCx	Synchronization cable 0.3 / 1 m, for DT3301				•

Target size of eddy current sensors



Type ES:
Measuring spot =
1.5x sensor diameter

ES (shielded sensor)
Measuring spot = 1.5x sensor diameter



Type EU:
Measuring spot =
3x sensor diameter

EU (unshielded sensor)
Measuring spot = 3x sensor diameter

The relative size of the measuring object to the sensor affects the linearity deviation for eddy current sensors. Ideally, the measuring object size for shielded sensors should be at least 1.5 times the diameter of the sensor and at least three times the diameter of the sensor for unshielded ones. From this size, almost all lines of the magnetic field run from the sensor to the target. Therefore, almost all magnetic field lines penetrate the target via the face and so contribute to eddy current generation, where only a small linearity deviation occurs.

Factory calibration

As standard, eddy current sensors are tuned to

- St37 with ferromagnetic target
- aluminum with non-ferromagnetic target

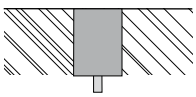
With other materials, linearity calibration can be performed at the factory.

Choosing the right sensor

Eddy current sensors are grouped into shielded (e.g. ES05) and unshielded (e.g. EU05) sensors. With shielded sensors, a separate sheathing achieves a narrower distribution of the field lines, so they are insensitive towards radially neighboring metals. With unshielded sensors, the field lines emerge at the side of the sensor normally causing an extended measuring range.
Correct installation is important for signal quality. The following information applies for mounting in ferromagnetic and non-ferromagnetic materials.

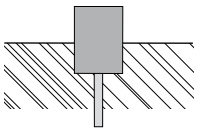
Installation instructions for shielded sensors (ES) in metal

Correct



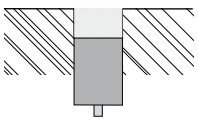
Flush mounting

Correct



Protruding mounting

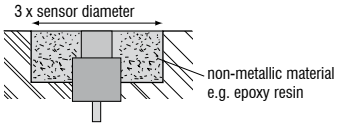
False



Surrounding material attenuates the sensor; measurement not possible.

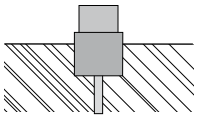
Assembly references for unshielded sensors (EU) in metal

Correct



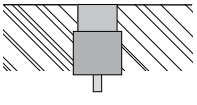
Sensor must be set up free-standing.
Minimum distance to the sensor:
approx. three times the diameter of the sensor

Correct



Protruding sensor mounting
Projecting length: 2-3 times the measuring range

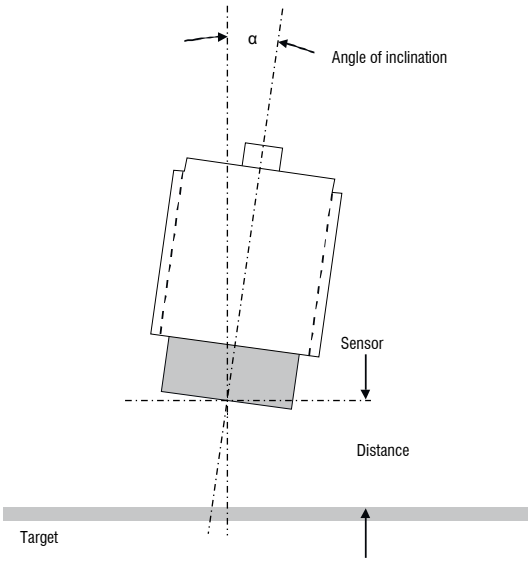
False

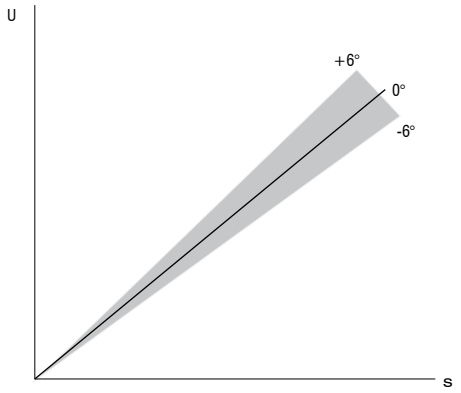


Surrounding material attenuates sensor in the standard version; measurement not possible.

Tilt angle and measurement signal

The eddyNCDT non-contacting displacement measuring system is frequently used since it provides excellent linearity and high resolution. This high resolution is achieved with right angle position, only. Sometimes, it is not possible to exactly install the sensor at right angles due to the installation environment. In this case, the measured values slightly deviate from the values measured in right angle position. Hence it is important to know the influence to the measuring signal if the sensor is tilted. The following graphs show the influence to the measuring signal of a tilted sensor.

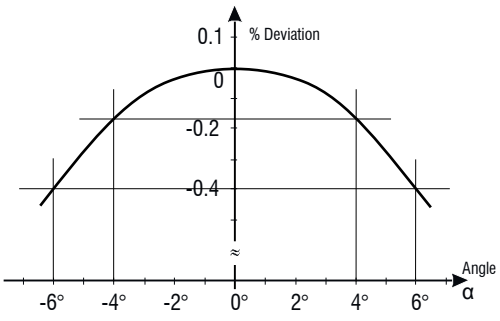




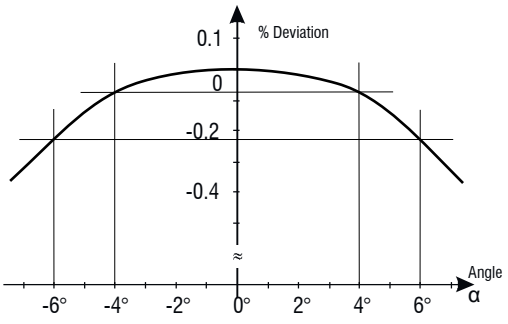
Example: Tilt a sensor 6° with 3 mm measuring range, means a deviation of 5μm at 2/3measuring distance.

A permanent tilt angle can already be lodged at the controller with the 3-point linearization. This avoids an influence of this tilt angle to the signal.

Tilt angles, the controller not linearized for, cause deviations of the measured values in comparison to right angled measurements.



Tilt angle at 1/3 distance



Tilt angle at 2/3 distance

The extent of deviation differs from sensor to sensor. These diagrams were taken with a U6 sensor and aluminum target. The diagrams show, that an inclination of ±4 degrees can be accepted and neglected in most applications.

A tilt angle of more than 6 degree is rather possible with unshielded sensors than with shielded, but should be avoided. In principle, only a special linearized sensor provides a precise signal.

Required target thickness

The principle of eddy current displacement measurement requires a minimum thickness for stable results. This minimum thickness depends on the target material used and the sensor frequency. The sensor generates an alternating electromagnetic field which penetrates the target. Eddy currents being formed in the target cause a secondary magnetic field which attenuates the primary field.

Skin or penetration depth

Electromagnetic fields are attenuated on entering an electrically or magnetically conducting material. The reduction in the field strength and therefore the current density is accompanied by losses which occur in the vicinity of the material surface. The characteristic length at which the current density reduces to the value 1/e or to 37 % is known as the skin depth (see Fig. 2).

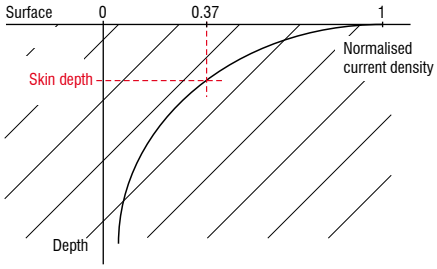


Fig. 2: Current density distribution in the target

Calculating the skin depth

The skin depth can be calculated with the following formula (it applies to the ideal case of a plane boundary layer and an infinitely extended object).

You can determine the permeability for some materials from Fig. 3. Or you can read off the skin depth directly from Table 1.

$$\delta = \frac{1}{\sqrt{\sigma \cdot f \cdot \mu \cdot \pi}}$$

δ = Skin depth
σ = electrical conductivity
f = Sensor frequency
$\mu = \mu_0 * \mu_r$ = Permeability
$\mu_0 = 12{,}566 * 10^{-7} \frac{Vs}{Am}$

Target material	Skin depth in µm at	
	250 kHz	1 MHz
Aluminum	168	84
Lead	459	230
Gold	149	74
Graphite	2700	1350
Copper	134	67
Magnesium	209	104
Brass	249	124
Nickel	27	14
Permalloy	4	2
Phosphor Bronze	302	151
Silver	130	65
Steel DIN 1.1141	23	12
Steel DIN 1.4005	55	27
Steel DIN 1.4301	848	424

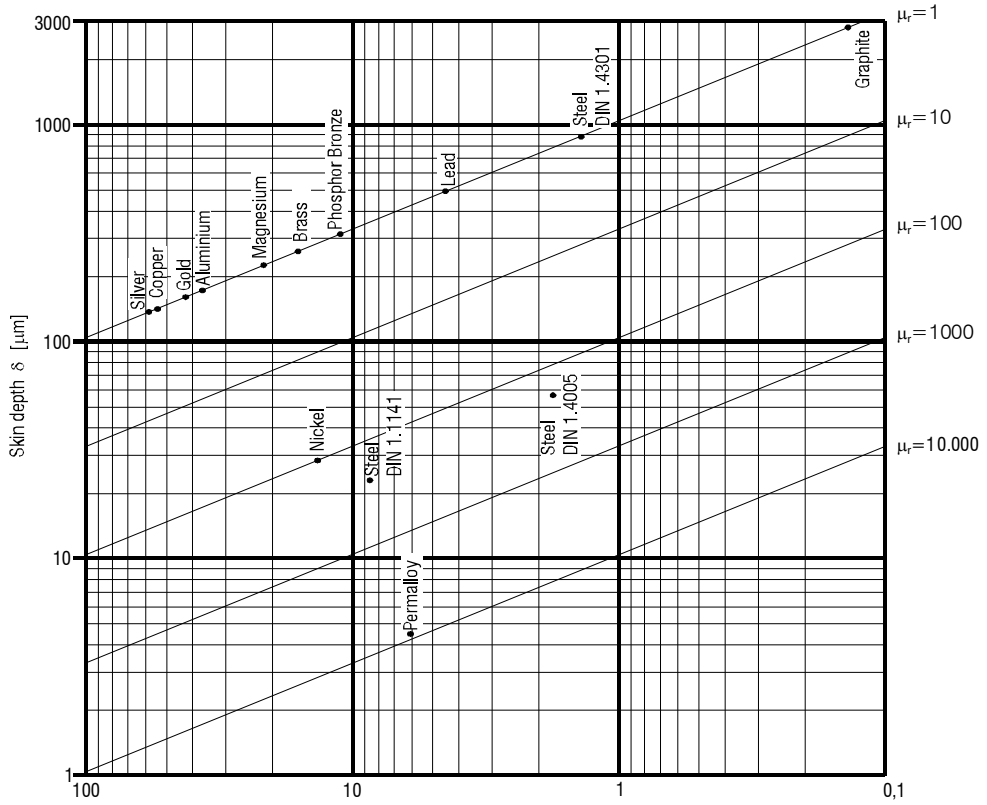
Tab.1: Various skin depths

Calculating the minimum thickness

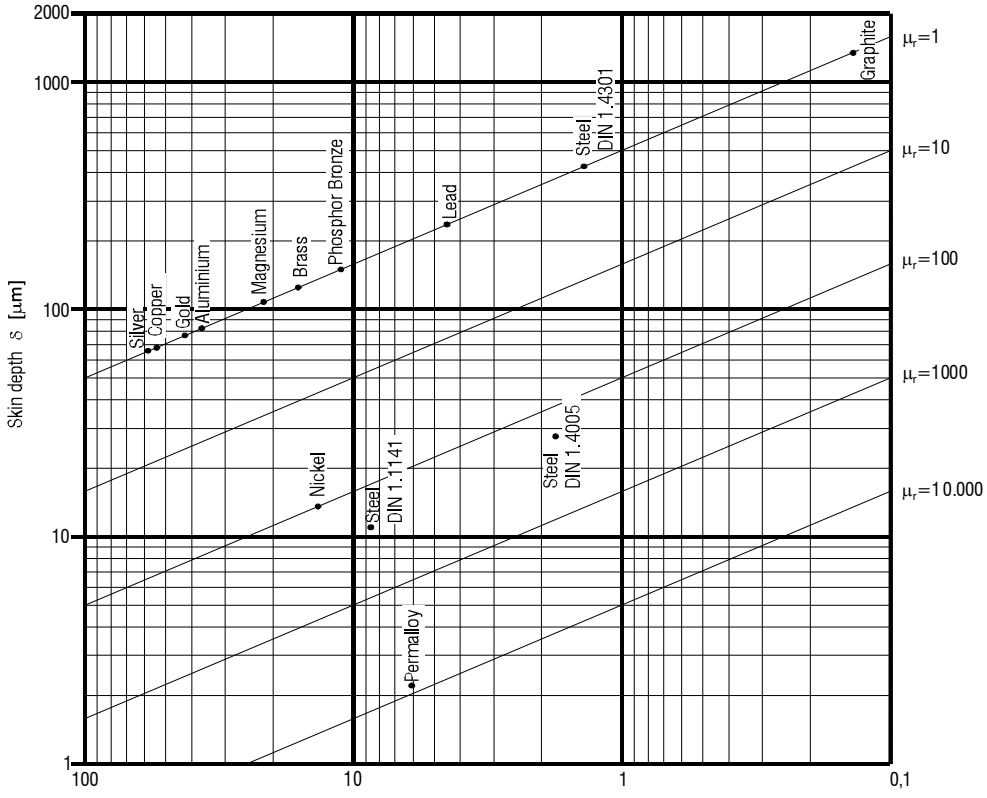
To calculate the minimum thickness of a material, take the appropriate skin depth from Table 1 or read off the skin depth from Fig. 3. Then you find the minimum thickness with the approximation value from Table 2. This calculation only applies when using a sensor with a frequency of 250 kHz or 1 MHz.

Measurement application	Minimum target thickness
Object detection (without displacement measurement)	"Skin depth" x 0.25
Displacement measurement at approx. constant (room)temperature	"Skin depth" x 1.00
Displacement measurement with changing temperature	"Skin depth" x 3.00
Thickness measurement with two opposing sensors	"Skin depth" x 6.00

Tab.2: Approximation values for simple determination of the minimum thickness



Tab. 3a: Skin depth at 250 kHz



Tab. 3b: Skin depth at 1 MHz

High performance sensors made by Micro-Epsilon

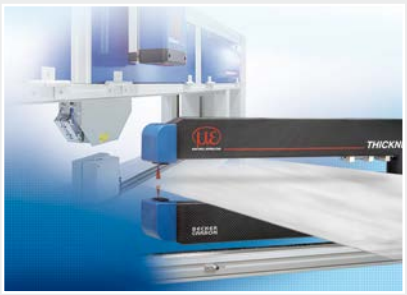
Sensors and systems for displacement and position

Sensors and measurement devices for non-contact temperature measurement

2D/3D profile sensors (laser scanner)

Optical micrometers, fiber optic sensors and fiber optics

Color recognition sensors, LED analyzers and color online spectrometer



Measurement and inspection systems

MICRO-EPSILON

MICRO-EPSILON Headquarters
Koenigbacher Str. 15 · 94496 Ortenburg / Germany
Tel. +49 (0) 8542 / 168-0 · Fax +49 (0) 8542 / 168-90
info@micro-epsilon.com · **www.micro-epsilon.com**