



Operating Instructions
eddyNCDT SGS 4701

Digital Eddy-Current Measuring System for Spindle Growth System

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1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

The following symbols are used in these operating instructions.



Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.



Indicates a situation that may result in property damage if not avoided.



Indicates a user action.



Indicates a tip for users.

Measure

Indicates hardware or a software button/menu.

1.2 Warnings



Connect the power supply and the display/output device according to the safety regulations for electrical equipment.

> Risk of injury

> Damage to or destruction of the controller and/or sensor

The supply voltage must not exceed the specified limits.

> Damage to or destruction of the controller and/or sensor



Avoid shocks and impacts to the sensor and controller.

> Damage to or destruction of the controller and/or sensor

Protect the cable against damage

> Failure of the measuring device

1.3 Notes on CE Marking

The following apply to the measuring system eddyNCDT series SGS 4701:

- EU Directive 2014/30/EU
- EU Directive 2011/65/EU, "RoHS" category 9

Products which carry the CE mark satisfy the requirements of the EU directives cited and the European harmonized standards (EN) listed therein. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, article 10, at:

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The measuring system is designed for use in industrial environments and meets the requirements.

1.4 Intended Use

- The measuring system eddyNCDT series SGS 4701 is designed for use in industrial areas. It is used
 - for displacement, distance and movement measurement
 - for temperature detection
 - position measuring of parts or machine components
- The measuring system must only be operated within the limits specified in the technical data, [see 2.5](#).
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the controller.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

Protection class:	IP 67 (in plugged state)	Humidity:	5 - 95 % (non-condensing)
Temperature range operation:		Ambient pressure:	Atmospheric pressure
Controller	+10 ... +70 °C (+50 ... +158 °F)	Temperature range storage:	0 ... +70 °C (+32 ... +158 °F)
Sensor/sensor cable	0 ... +90 °C (+32 ... +194 °F)		

2. System Description

2.1 Measuring Principle

The eddyNCDT series SGS 4701 (Non-Contacting Displacement Transducers) measuring system operates on the basis of eddy currents without making physical contact. It is used for measurements on objects consisting of electrically conducting materials which have ferromagnetic or non-ferromagnetic properties.

High frequency alternating currents flow through a coil cast in a sensor housing. The electromagnetic field from the coil induces eddy currents in the electrically conducting target, causing the alternating current resistance of the coil to change. This change of impedance delivers an electrical signal proportional to the distance of the target from the sensor.

The eddyNCDT SGS 4701 conditions the sensor signals user-fairly at a bandwidth of 2,000 Hz. Thus a so-called spindle monitoring is also still possible at numbers of revolutions up to 120,000 rpm. The spindle growth itself can be detected at even higher numbers of revolutions.

Monitoring an axial expansion requires subsequent individual filtering by the user. Micro-Epsilon recommends averaging or filtering across several revolutions in order to record only the relative expansion during a defined period. During an unfiltered/non-averaged measurement, effects such as those within a single revolution also become visible; this can cause incorrect interpretations.

In order to achieve highly accurate measurements, it is imperatively necessary that one (or more) sample(s) item under test is / are provided by the customer.

2.2 Electrical Runout

Ferromagnetic metals can have areas with different magnetizations called Weiss domains; these in turn dampen the sensor's eddy current field differently. Even with constant distance between sensor and target, different distance values can occur. The domains can be reproduced, but show unrealistic axial runout deviations within one revolution.

If the eddyNCDT SGS4701 is to be used for recording an axial runout measurement, start-up behavior or a so-called spindle monitoring, it is possible to compare with non-ferromagnetic metal. Because of their material properties, non-ferromagnetic metals offer the advantage that they do not show any such effects and therefore should be used for such measuring tasks.

Non-ferromagnetic metals on average have less mechanical strength; this means that the selection of materials is of crucial significance.

Proposed materials	AlZnMgCu1,5 (3.4365)	i Consider the material strength.
	AlMg1SiCu	
	Inconel, NiCr19NbMo (2.4668)	
	Bronze in general	

More details are available in the annex, [see A 6](#).

2.3 Structure of the Measuring System

The eddyNCDT series SGS 4701 is developed for recording the thermal and mechanical expansion of high-speed milling spindles. This enables the active compensation of the axial spindle expansion via e. g. a CNC machine tool.

The SGS 4701 consists of a sensor, a sensor cable and a controller which can be factory calibrated for ferromagnetic or non-ferromagnetic measurement objects. 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 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.

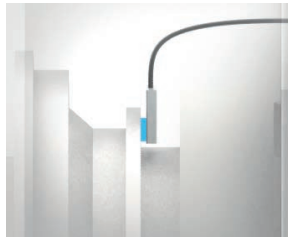


Fig. 1 Typical installation with measurement on the labyrinth ring

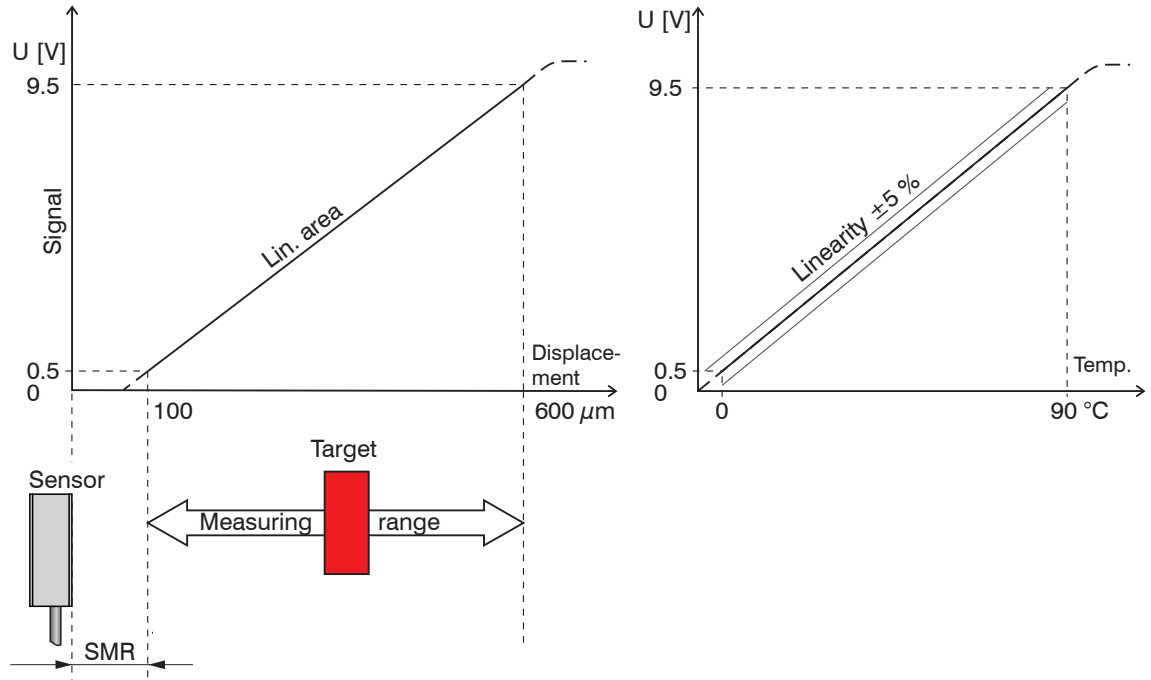


Fig. 2 Measuring system consisting of sensor and controller

Due to its compact size, the measurement technology (paired electronics and sensor) is fully integrated into the spindle head.

2.4 Glossary

- SMR Start of measuring range.
Minimum distance between sensor front and target
- MMR Midrange
- EMR End of measuring range (start of measuring range + measuring range)
Maximum distance between sensor front and target
- MR Measuring range



2.5 Technical Data

Sensor system		SGS4701
Measuring range		500 μm (option 250 μm ²⁾)
Offset		100 μm (option 50 μm ²⁾)
Linearity		$\pm 2 \mu\text{m}$
Resolution ¹⁾		0.5 μm
Bandwidth		2000 Hz
Target		ferromagnetic / non-ferromagnetic
Minimum target diameter		6 mm (option 3.5 mm ²⁾)
Operating temperature	Sensor	0 ... +90 °C (+32 ... +194 °F)
	Controller	+10 ... +70 °C (+50 ... +158 °F)
Temperature stability	Sensor	± 150 ppm FSO/°C (MMR)
	Controller	± 500 ppm FSO/°C (MMR)
Temperature compensation range	Sensor	+10 ... +80 °C (+50 ... +176 °F)
	Controller	+10 ... +70 °C (+50 ... +158 °F)
Supply voltage		12 ... 32 VDC
Analog out	Displacement	0.5 - 9.5 V \pm 100 - 600 μm (option 50 - 300 μm ²⁾)
	Temperature	0.5 - 9.5 V (\pm 0 ... +90 °C)
	Load resistor	≥ 10 kOhm
Protection class	Sensor / controller	IP 67 (in plugged state)
Dimensions	EMU04(10x/11x/14x/15x)	12 x 10 x 4.5 mm ³
	EMU04(12x/13x/16x/17x)	10 x 4 x 4 mm ³
Sensor cable	Diameter	\varnothing 1.13 mm
	Length	1000 mm (400 - 1500 mm on request)
	Min. bending radius	12 mm
	Coating	FEP

Sensor system	SGS4701
Shock	DIN EN 60068-2-27 (50 g, 6 ms, 3 cycles in each direction)
Vibration	DIN EN 60068-2-6 (20 g, 10 - 3000 Hz)

FSO = Full Scale Output; MMR = Midrange

1) Static at midrange (MMR)

2) For OEM modifications: sensor with 250 μ m measuring range and 50 μ m SMR distance

3. Delivery

3.1 Unpacking, Included in Delivery

1 SGS 4701(xxx)

1 Test report

1 Operating instructions

➡ Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.

➡ Check the delivery for completeness and shipping damage immediately after unpacking.

➡ If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Optional accessories are available in the appendix, [see A 3](#).

3.2 Storage

Temperature range storage: 0 ... +70 °C (+32 ... +158 °F)

Humidity: 5 - 95 % (non-condensing)

4. Installation and Assembly

4.1 Precautions

No sharp or heavy objects should be allowed to affect the cable sheath of the sensor cable, the power supply cable and the output cable.

➡ Check all plug-in connections for firm seating before starting operation.

NOTICE

Destruction of the controller by electrostatic discharge via the sensor. Please observe the notes regarding electrostatic discharge, [see A 4.](#)

4.2 Sensor

4.2.1 Frame Size 10 x 4 x 4 mm

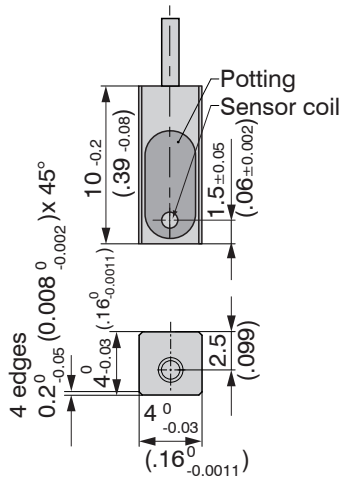


Fig. 3 Dimensional drawing

Dimensions in mm (inches), not to scale

Sensors with integrated cable with miniature connector

EMU04(121)-C100 standard

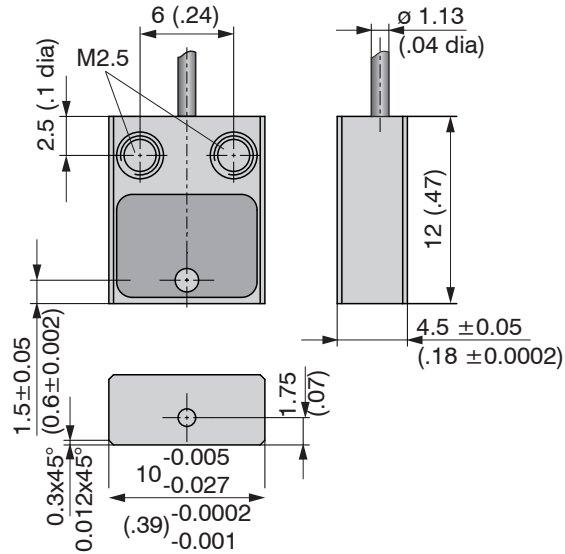
Sensors with integrated cable with open ends

EMU04(160)-C150 standard

C = Cable length in cm

Cable lengths between 40 ... 150 cm are possible in 10 cm increments.

4.2.2 Frame Size 12 x 10 x 4.5 mm



Sensors with integrated cable with miniature connector

EMU04(102)-C100 standard

Sensors with integrated cable with open ends

EMU04(140)-C150 standard

C = Cable length in cm

Cable lengths between 40 ... 150 cm are possible in 10 cm increments.

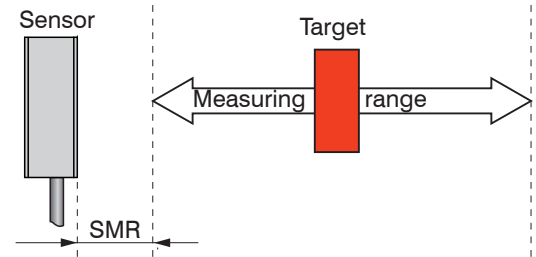
Fig. 4 Dimensional drawing

Dimensions in mm (inches), not to scale

Start of measuring range

For each sensor a minimum distance to the target must be maintained. This avoids a measurement uncertainty due to the sensor pressing on the target and mechanical damage to the sensor/ target.

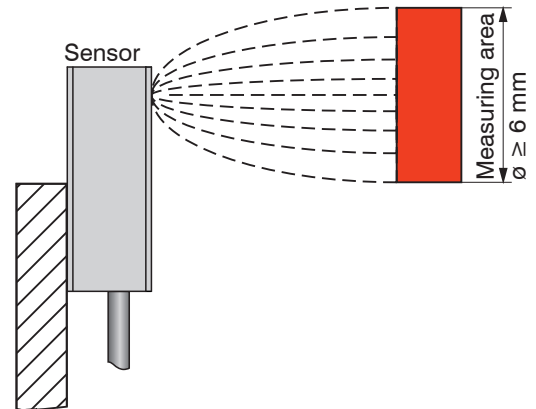
Fig. 5 Start of measuring range (SMR), the smallest distance between sensor face and target



Measuring area

The minimum measuring area must have a diameter of 6 mm or greater for an eddy-current sensor. Optional sensors are available with a minimum area diameter of 3.5 mm. If you underrun the minimum measuring area nor reproducibly measurements are possible.

Fig. 6 Minimum measuring area for eddy-current sensor



4.3 Sensor Cable

Operating temperature	-40 ... +90 °C
Mating life	20 cycles
Cable retention	12.74 N
Inner conductor	silver-coated annealed copper wire
Min. bending radius	12 mm
Outer conductor	silver-coated annealed copper wire
Dielectric core	FEP
Jacket	FEP
Fire resistance	VM-1

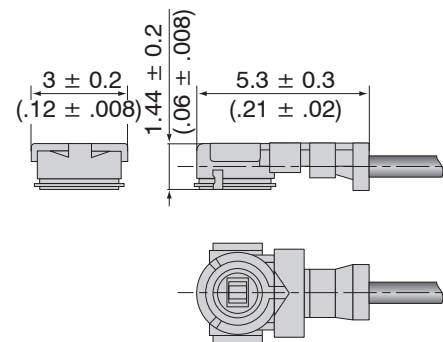


Fig. 7 Dimensional drawing sensor cable, dimensions in mm (inches), not to scale

Sensor cable lengths between 40 ... 150 cm are possible in 10 cm increments.

- ➡ Lay the sensor cable in such a way that no sharp-edged or heavy objects can affect the cable sheath. Do not kink the cable. Details to the sensor cable are listed in the appendix, [see A 4](#).

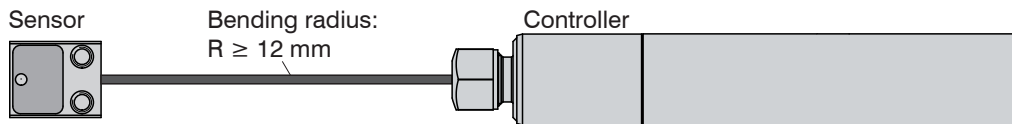
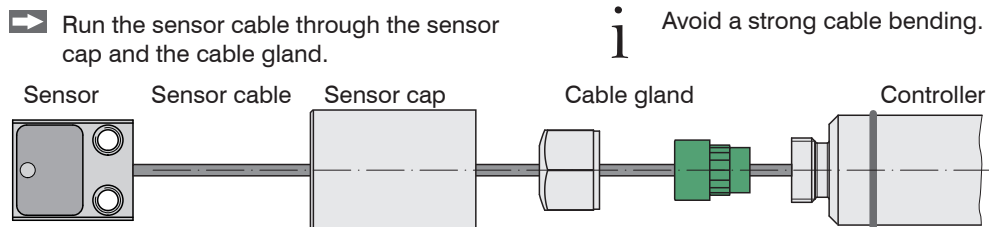


Fig. 8 Minimum bending radius for sensor cable

NOTICE

Do not shorten the sensor cable. Loss of functionality. Removing the connector is only permitted behind the plug-sided crimp when using the solder connections.

- ➡ Remove the sensor cap from the controller.
- ➡ Open the cable gland on the controller.



➔ Bend up the green cable seal easily and insert the sensor cable.

➔ Connect the sensor cable to the controller, [see Fig. 9](#).

Solder connection	Plug connection
<p>Shield</p> <p>Signal</p>	
<p>➔ Solder the sensor cable to the connection board.</p>	<p>➔ Connect the sensor cable to the female connector.</p> <p>i Connector mating life is 20 cycles.</p>
<p>➔ Close the cable gland.</p>	
<p>➔ Push the sensor cap onto the controller housing until it snaps in place.</p>	

Fig. 9 Connection sensor cable

4.4 Controller

NOTICE

Do not clamp the controller outside the installation area. The controller may be damaged.

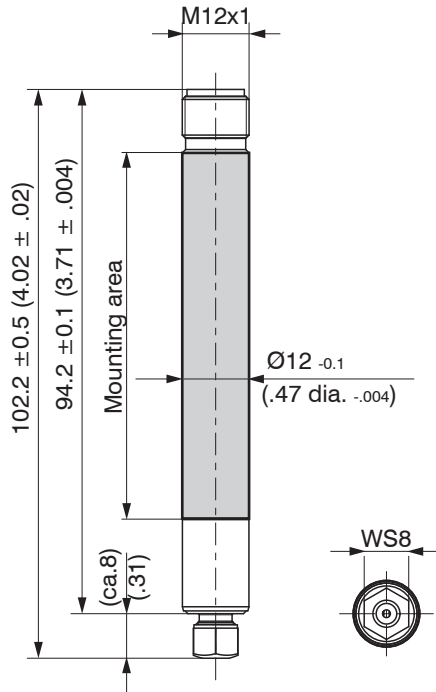


Fig. 10 Dimensional drawing of controller, dimensions in mm (inches), not to scale

The controller is mounted laminar with a circumferential clamping on housing or with an optional clamping flange.

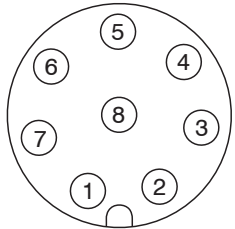
4.5 Connecting the Measuring System

- ➡ Provide the power supply for the controller.
- ➡ Connect the 8-pin M12 connector to the controller with a power supply 24 VDC.

i Optional accessories:
 PC4701-10 power supply and output cable, 10 m long, with 8-pin. female connector respectively with free ends.

- ➡ Connect the measurement signal display respectively control unit to the controller.

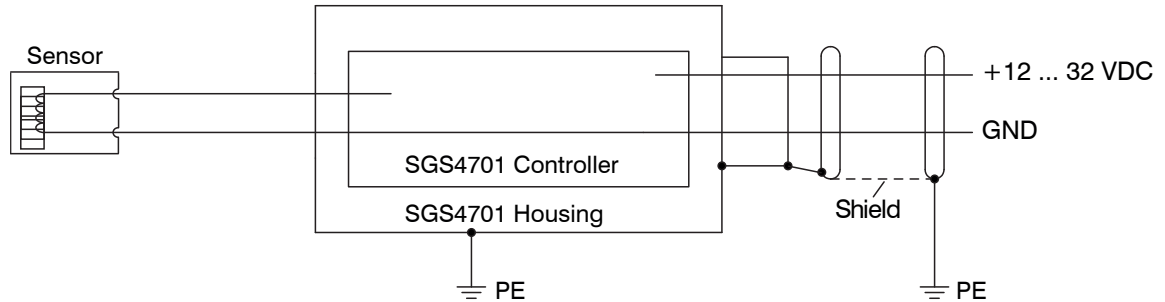
Pin	Comment	Color PC4701-10
1	Ground	white
2	12 ... 32 VDC	brown
3	Displacement signal (0.5 ... +9.5 V) at 100 ... 600 μm	green
4	Temperature signal (0.5 ... +9.5 V) at 0 ... +90 °C	yellow
5	NC	gray
6, 7	internally assigned	pink, blue
8	NC	red
Screen	Housing	-



8-pin. male connector controller, view on pin side

Fig. 11 Pin assignment for signal output

4.6 Ground Concept



5. Operation

The system is ready for operation. There are no adjustments which must be done by the user. MICRO-EPSILON recommends to let the system warm up for about 30 minutes.

6. Liability for Material Defects

All components of the device have been checked and tested for functionality at the factory. However, if defects occur despite our careful quality control, MICRO-EPSILON or your dealer must be notified immediately. The liability for material defects is 12 months from delivery. Within this period, defective parts, except for wearing parts, will be repaired or replaced free of charge, if the device is returned to MICRO-EPSILON with shipping costs prepaid. Any damage that is caused by improper handling, the use of force or by repairs or modifications by third parties is not covered by the liability for material defects. Repairs are carried out exclusively by MICRO-EPSILON.

Further claims can not be made. Claims arising from the purchase contract remain unaffected. In particular, MICRO-EPSILON shall not be liable for any consequential, special, indirect or incidental damage. In the interest of further development, MICRO-EPSILON reserves the right to make design changes without notification.

For translations into other languages, the German version shall prevail.

7. Service, Repair

If the sensor, controller or sensor cable is defective:

- Please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

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8. Decommissioning, Disposal

➡ Disconnect the power supply and output cable on the controller.

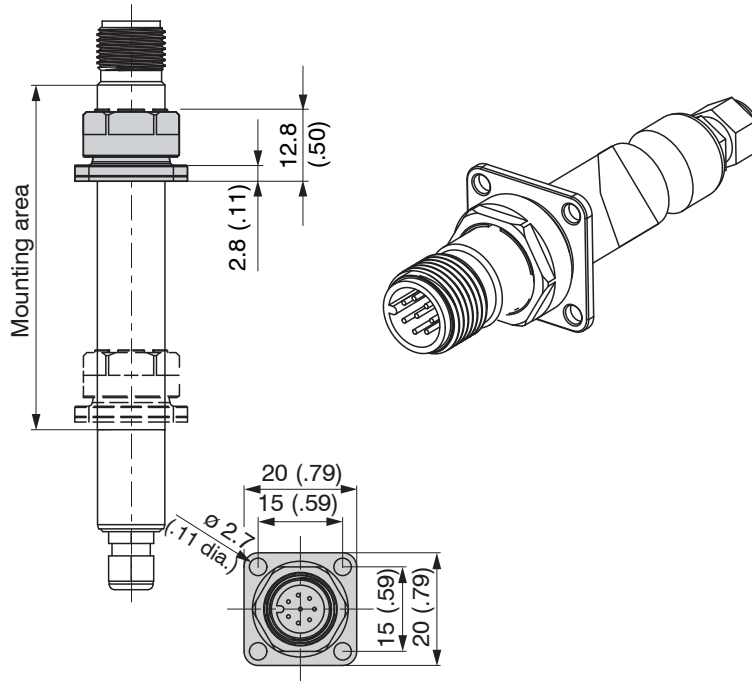
➡ Disconnect the sensor cable between sensor and controller.

Incorrect disposal may cause harm to the environment.

➡ Dispose of the device, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.

Appendix

A 1 Clamping Flange Controller



Dimensions in mm (inches), not to scale

A 2 Tool Sensor Cable

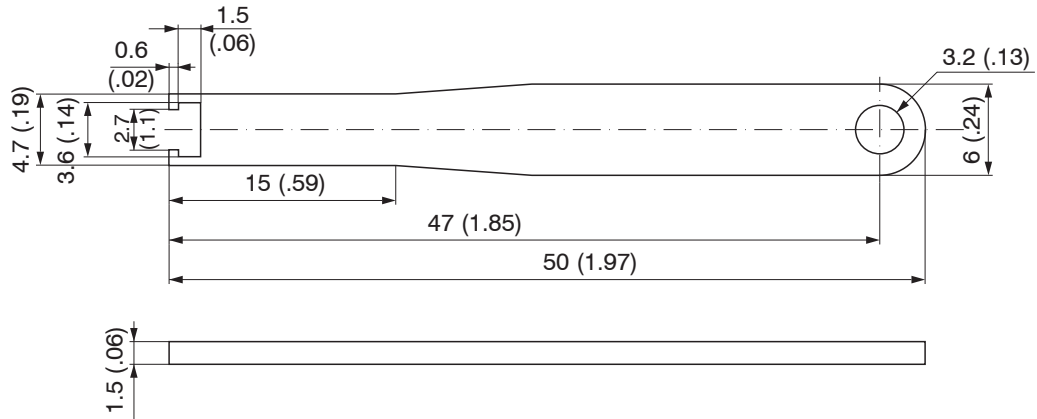


Fig. 12 MML extraction tool H2.5 & H2.0, part number R302309000

Dimensions in mm (inches), not to scale

A 3 Optional Accessories

- | | |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------|
| PC4701-10 | Power supply and output cable, 10 m long, with 8-pin. female connector respectively with open ends |
| PC4701-10/dragchain | Power supply and output cable, 10 m long, with 8-pin. female connector respectively with open ends, for use with drag cable |

A 4 Notes for Electrostatic Discharge

Electrostatic discharge (ESD) may lead to the destruction of the controller when

- connecting the sensor cable to the open controller,
- handling the sensor.

The working practices listed below reduce and avoid any electrostatic discharge:

- Wear a grounding bracelet that is conductive connected to an earthing point.
- The table surface should be conductive and connected to the earthing point.
- Wear appropriate shoes, ESD working clothes on the upper part of the body and the arms in order to avoid any static charging.

Further literature for the prevention of electrostatic phenomenon:

- EN 61340-5-1 Protection of electronic components against electrostatic phenomenon - General requirements
- EN 61340-5-2 Protection of electronic components against electrostatic phenomenon - User manual
- VDE publications 71 Electrostatics, reasons, effects, protective measures

A 5 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 default system works at a carrier frequency of 1 MHz.

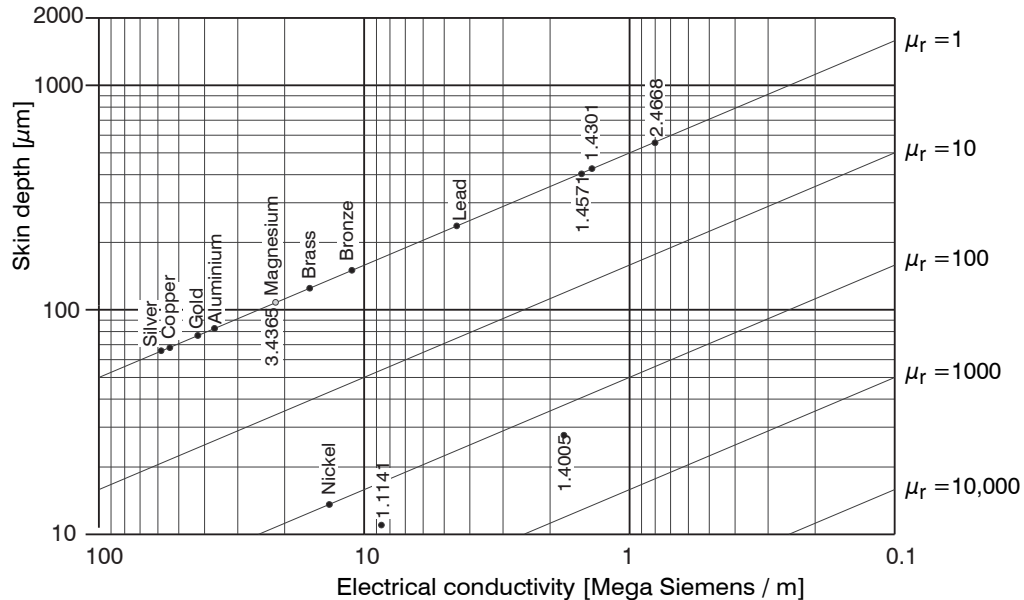


Fig. 13 Skin depth at 1 MHz compared to electrical conductivity

i

When measuring the path at variable temperatures, the minimum target thickness is three times the skin depth.

A 6 Non-ferromagnetic Target

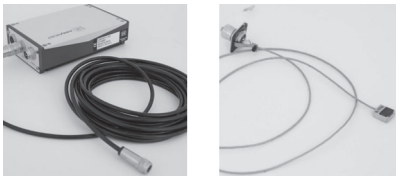

The list below includes recommendations for ways in which you may be able to switch to a non-ferromagnetic target.

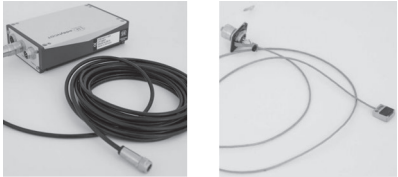

- Use a non-ferromagnetic stainless steel, such as 1.4571,
- Use alloys, such as AlZnMgCu1,5 (3.4365); consider the lower mechanical tensile strength,
- Apply non-ferromagnetic coats that are about 1 mm thick to the original target,
 - Apply bronze by laser welding,
 - Electroplate with copper and subsequently gold plate because of oxidation,
 - Shrink non-ferromagnetic metals in combination with gluing.

Proposed materials	AlZnMgCu1,5 (3.4365)	i Consider the material strength.
	AlMg1SiCu	
	Inconel, NiCr19NbMo (2.4668)	
	Bronze in general	

A 7 Change from SGS4311 to SGS4701

Tips and notes for a successful change between the model series.

SGS4311		SGS4701
		
	With a size of 4.5 x 10 x 12 mm, the sensors are compatible in terms of their construction.	
		The sensors for the SGS4701 controller cannot be exchanged. Sensor, sensor cable and controller are matched to each other.
		When the sensor, the cable or the controller are defect, a replacement system is required.

SGS4311		SGS4701
		The controller is mounted close to the spindle. Consider some space for it.
	Components of the SGS4311 are not compatible with the SGS4701 series.	
Voltage output 1.0 ... 9.0 V for 150 ... 550 μm	It is necessary to adapt the output scaling in the software/customer control system.	Voltage output 0.5 ... 9.5 V for 100 ... 600 μm
	The sensor cable length is permanently defined for each system and must not be changed.	
		
Bandwidth 100 Hz	It is necessary to adapt the averaging process in the software/customer control system.	Bandwidth 2000 Hz
	Cable length of max. 12 m at voltage output Optional accessories: - Supply and output cable PC4701-10 or PC4701-10/ for use with drag cable	
	You can assemble a power and output cable yourself using a conventional M12 connector.	
	Cable length > 12 m Micro-Epsilon recommends to convert the output signal from voltage to current.	



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