



# More Precision

**mainSENSOR** // Magneto-inductive displacement sensors





- *Selectable measuring ranges up to 55mm*
- *Linear output signal*
- *High basic sensitivity and temperature stability*
- *Completely non-contact*
- *Wear-free*
- *High dynamics*
- *Scalable to all quantities*

#### Measuring principle

mainSENSOR is based on an innovative measuring principle, which has been developed by Micro-Epsilon in order to combine the advantages of both inductive and magnetic sensors.

For the measuring, the magnet is fixed to the measuring object. The movement of the magnet results in a change of the magnetic flux within the sensor element, which is detected by a sensor coil. Due to countervailing physical effects in the sensor, a linear relationship between the displacement and output signal is achieved. As different strength magnets are applied, measuring ranges of up to 55mm can be realized. However, for changing measurement set up, it is only necessary to change the magnet. As well as distance and displacement measurement, the sensor can be used for rotational speed measurements of axes or toothed racks.

#### Flexible sensor concept

Due to their flexible concept, the sensors are ideal for a wide range of applications, particularly where high volumes are required.

The standard sensors are designed in a stainless steel M12, M18 and M30 or a flat plastic housing suitable for industrial applications. The integrated evaluation electronics is situated on a compact PCB. In high volume production, customer-specific modifications to the PCB and sensor housing can be easily implemented.

#### No calibration required

Due to the automatic linearisation of the sensor, no calibration is required. This offers a decisive benefit when installing multiple sensors. Before starting the operation, a zero point has to be set by positioning the sensor and the magnet. Consequently, the sensors are ready for use within a short time.

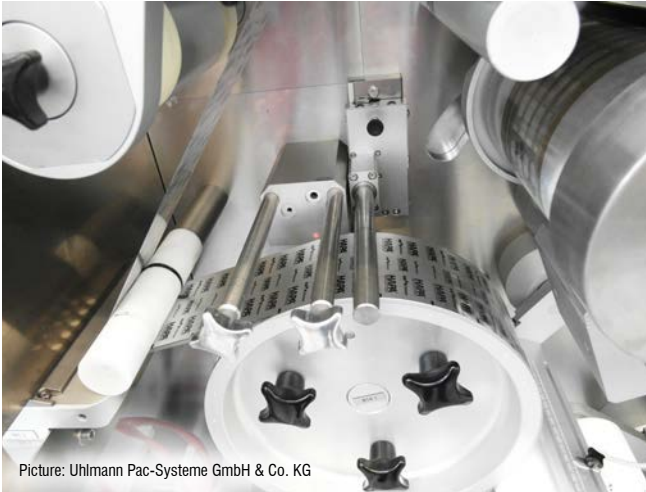
#### Robust sensor design:

- Stainless steel housing, insensitive to dirt, dust, oil etc.
- Protection class up to IP67 and P69K
- Pressure resistant
- Suitable for use in food processing



### Application in automation, machine building and OEM

Magneto-inductive sensors from Micro-Epsilon have many potential areas of use, including individual applications in conventional machine building to measurements in automated processes and cost-sensitive high volume production.



Picture: Uhlmann Pac-Systeme GmbH & Co. KG



Picture: SIG Combibloc Group AG

### Foreign body detection in medical technology

In this application, the MDS sensor recognises foreign bodies in blister machines during the tablet packaging process. Via the movement of overhead touching rollers, foreign bodies between the blister packaging and covering material can be detected. Exceeding a pre-defined point triggers an alarm.

### Valve lift measurement in the food industry

During the filling of drinks cartons, the exact dosage is a critical factor. The sensor measures the valve lift of the filling line and requests several switching points in a measuring range of 35mm. The sealed stainless steel housings of the MDS-45-Mxx series are ideal for the food industry.



### Rotational speed measurement in marine diesel

Integrating the magnet into the sensor housing (magnetic pre-tension) enables the detection of large ferromagnetic particles. This effect is useful for measuring the rotational speed of gear wheels in marine diesel engines. This special arrangement can be found in one of the customer-specific sensors.



### Unbalance and load detection in washing machines

Integrating displacement measurement into the washing machine damper helps to detect the imbalance and the loading of the drum. This measurement is performed using the cost-effective MDS-40-LP series sensor. A conventional hard ferrite magnet is integrated into the damper while the sensor board can later be clipped on from the outside.

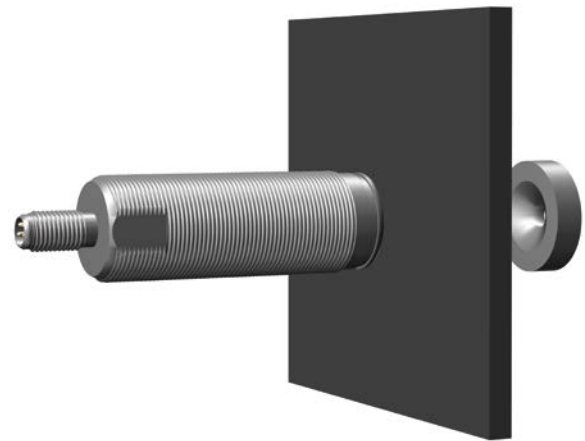
### Mounting options

Micro-Epsilon's magneto-inductive sensors can be applied in many different applications. In the case of non-ferromagnetic objects, the sensor can either be countersunk, flush mounted or protruding without any effects on the measurements. The magnet is mounted to the measurement object using a stainless steel screw, which is supplied with the sensor.



### Measuring through non-ferromagnetic materials

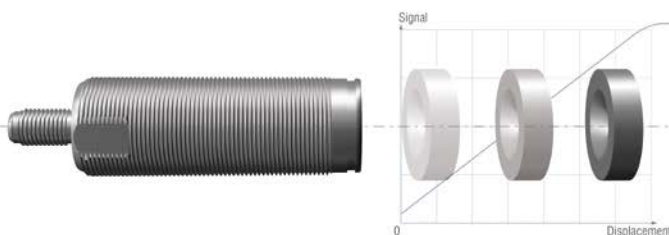
Unlike conventional measuring methods, the magneto-inductive sensors enable measurements through non-ferromagnetic materials such as aluminium or stainless steel. A clear benefit is provided here as the sensor and the magnet can be installed separately in applications with closed systems or housings. It is therefore possible to mount the magnet safely in harsh environments and the sensor in protected areas.



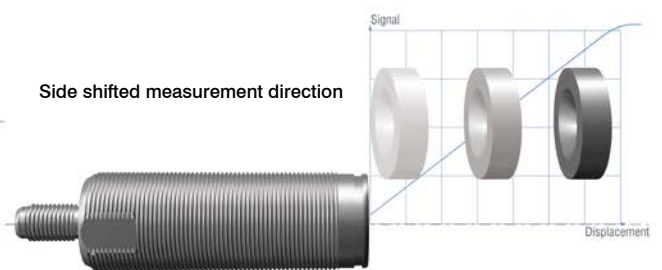
### Axial and side shifted distance and displacement measurement

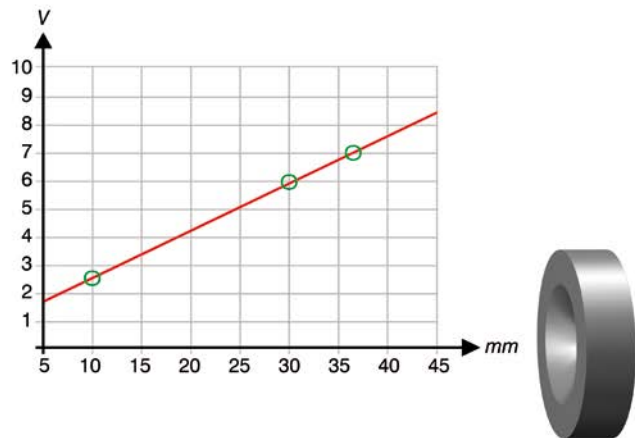
mainSENSOR detects the position of a magnet, which is fixed to the measurement object. The magnet can be applied to the sensor either axially or side on. Especially in the case of limited installation spaces, side shifted measurement offers a spacesaving alternative.

Axial measurement direction



Side shifted measurement direction





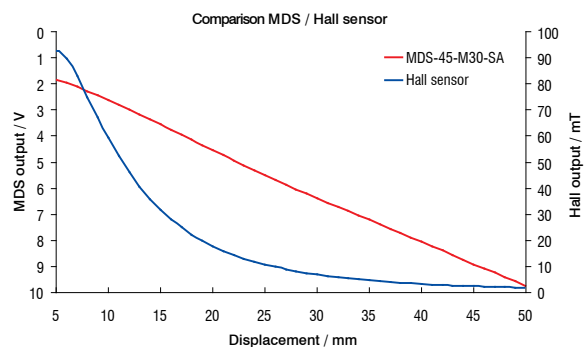
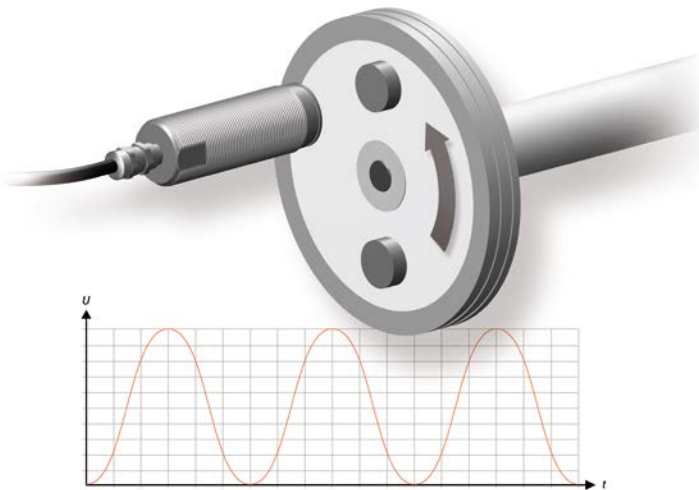
#### Advantages over inductive sensors

- Constant high sensitivity, even at the end of measuring range
- High protection class (fully metal housing)
- Compact design for large measuring ranges (e.g. M18 at 55mm measuring range)
- Flush mounting in non-magnetic materials
- Measurements on electrically conductive and non-magnetic materials (stainless steel, aluminium...)
- Excellent linearity

#### Ideal replacement for switches and proximity sensors

Magneto-inductive sensors are the preferred alternative for switching elements. The user can generate as many switching points as desired from the continuous analogue signal.

- No complex, mechanical adjustments are required for setting the switching point
- Definition of almost any number of switching points
- One sensor model suitable for many different distances



#### Rotational speed measurement

As well as distance and displacement measurement, mainSENSOR is also used for rotational speed measurement. In order to do so, one or two magnets are mounted on the rotating measuring object. Regardless of the direction of rotation, the sensor measures the speed of the target object. In the case of customer-specific solutions, the direction of rotation itself can also be detected. Therefore, two sensor components that detect and evaluate the direction of rotation increase are installed.

#### Advantages over magnetic sensor based on Hall Effect components

- Significantly longer measuring range
- Permanent output signal that is linear to the distance due to the measuring principle
- Significant advantages with regard to price for large measuring ranges
- Signal stability when magnet is not centered



MDS-45 is the industry-standard version of the magneto-inductive sensor. These stand out due to the common characteristics of this product series and also because of their very robust standard housing.

The sensors are available in M12, M18 and M30 stainless steel housings, as well as with a flat plastic housing. The stainless steel housing is ideally suited to demanding environments (dirt, oil, chemicals) and the food industry.

Model	MDS-45-M12-CA	MDS-45-M18-SA	MDS-45-M18-HP-SA	MDS-45-M30-SA	MDS-45-K-SA
Measuring range (standard) <sup>1)</sup>	45mm (further measuring ranges see accessories)				
Offset distance <sup>1)</sup>	5mm	2.25mm		4mm	
Linearity <sup>1)2)</sup>	< ±3% FSO				
Temperature stability	±0.025 % FSO/K				
Resolution <sup>3)</sup>	<0.05 % FSO				
Frequency response (-3dB)	1000Hz				
Electrical connection	integr. cable 3m	M8x1, 4 pin, connector (screw and snap-on)			
Physical output parameter	Voltage	2V ±0.3V ... 9.6V ±0.4V		2V ±0.2V ... 9.6V ±0.4V	2V ±0.4V ... 9.6V ±0.4V
		load (11.5V supply) ≥30KΩ load (24V supply) ≥10KΩ			
	Current	-		4 mA ±0.4mA ... 19.2mA ±0.8mA	4mA ±0.8mA ... 19.2mA ±0.8mA
				resistance (11.5V supply) ≤400Ω resistance (24V supply) ≤ 800Ω	
Storage temperature	-20°C ... +80°C				
Operating temperature	-20°C ... +80°C				
Power supply	11.5V <sub>DC</sub> ... 30V <sub>DC</sub>				
Current consumption	max. 20mA			max. 20mA (with voltage output); max. 40mA (with voltage output)	
Protection class	IP67 (with plug variants only in mated condition) higher protection class on request				
Pressure resistance (static)	100 bar (at the front)	100 bar (at the front)	400 bar (at the front)	40 bar (at the front)	-
Vibration	DIN EN 60068-2-6 (20g, 58 - 500Hz)				
Shock	DIN EN 60068-2-29 (40g, 6ms, 1000 cycles) DIN EN 60068-2-27 (100g, 6ms, 3 cycles)				
EMC	EN 61326-1:2006; EN 61326-2-3:2007				-
Housing material	Stainless steel				Plastics / nickel plated brass
Weight (excluding screw nuts)	appr. 60g	appr. 40g		appr. 110g	appr. 25g

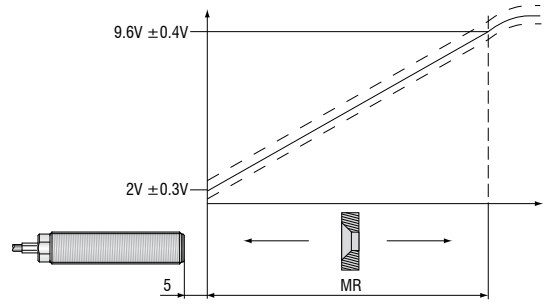
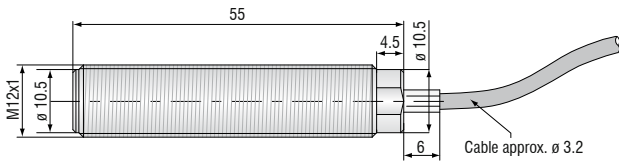
FSO = Full Scale Output

<sup>1)</sup> Measuring changes by using other magnets (see page 14); External magnetic fields and/or ferromagnetic material in the measuring range of the sensor system affect the sensor characteristic line and the measuring range.

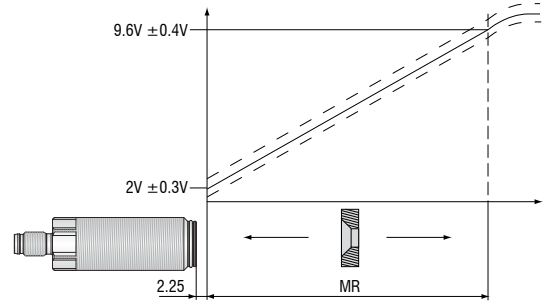
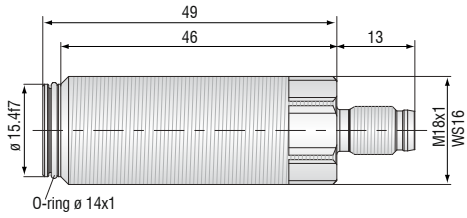
<sup>2)</sup> Deviation to the regression curve according to the method of the least squares

<sup>3)</sup> Peak-Peak; external low pass; frequency response 5kHz

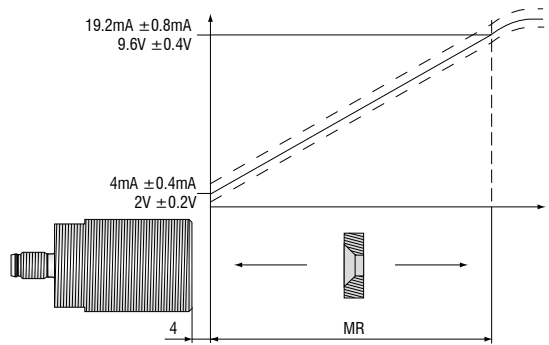
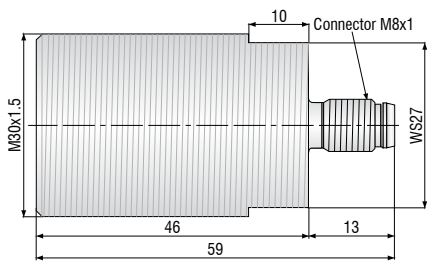
**MDS-45-M12-CA**



**MDS-45-M18-SA / MDS-45-M18-HP-SA**

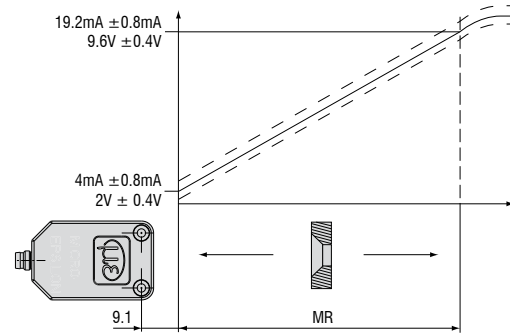
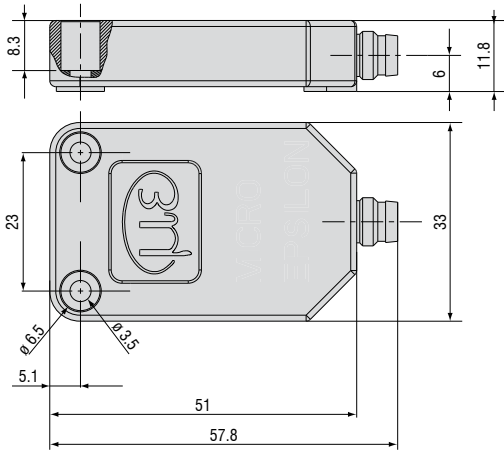


**MDS-45-M30-SA**





**MDS-45-K-SA**



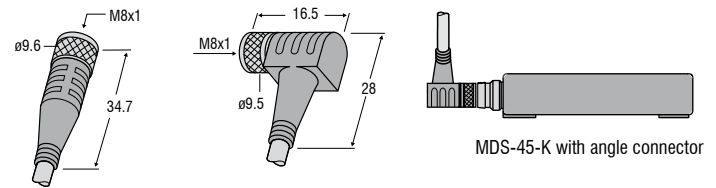
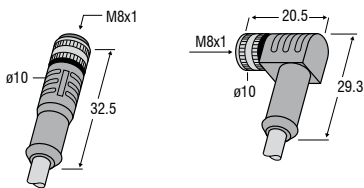
**Accessories**

**Power and output cable for fully metal sensors**

- Art.No. 2901617 PC5/4 (5m, shielded, straight connector, PUR, open ends)
- Art.No. 2901600 PC5/4/90 (5m, shielded, 90° connector, PUR, open ends)

**Power and output cable for sensors made from plastics**

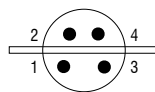
- Art.No. 2901599 PC5/4(01) (5m, unshielded, straight connector, PUR, open ends)
- Art.No. 2901600.01 PC5/4/90(01) (5m, unshielded, 90° connector, PUR, open ends)



Pin	Function	Colour	Description
1	V <sub>cc</sub>	brown	Power supply 11.5V...30V
2*	I <sub>out</sub>	white	Output signal 4mA...20mA
3	GND	blue	Ground
4	U <sub>out</sub>	black	Output signal 2V...10V
Shield			Please connect the shield to the ground

\* Pin only used for sensors with current output

**Pin assignment  
View connector side**





The sensors of the MDS-40-MK series are a new generation of cost-effective and flexible magneto-inductive sensors. In addition to the pre-configured preferred types, a combination of further options (power supply, output, plug,...) for serial or industrial applications is possible.

**Possible combinations**

The following combinations are possible from a quantity of 200 pieces.

**Selectable options**

MDS - 40 - MK - SA8 - I - 1130 - IP20 - FIX

**FIX:** supporting surface for curved surfaces

**Protection class:** IP67 (casting)  
IP20V (partial casting)  
IP20 (not moulded)

**Supply:** 1130 (11 - 30V)  
5 (5V)  
33 (3.3V)

**Output:** I (4 - 20mA)  
U10 (2 - 10V)  
U45 (0.5 - 4.5V)  
U45R (0.5 - 4.5V, ratiometric)  
F (Frequency: time measurement)

**Connector:** SA8 (M8x1, axial)  
SR7 (JST JWPF, radial)  
SR0 (JST PA, radial)

		Supply		
		1130	5	33
Output	I	•	-	-
	U10	•	-	-
	U45	•	•	-
	U45R	-	•	•
	F	•	•	•

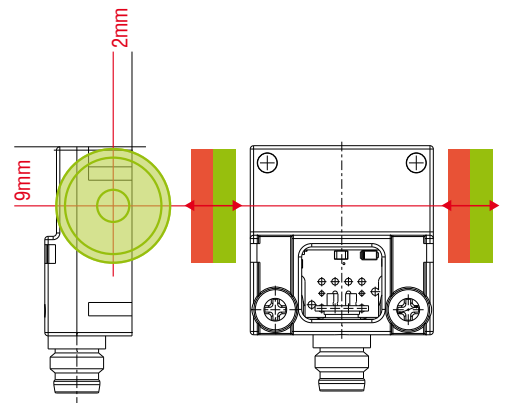
  

		Connector / cable		
		SA8	SR7	SR0
Protection class	IP20	•	•	•
	IP67	•	•	-

• Combination possible  
- Combination not possible

**Main measurement direction**

The above-mentioned data refer to the main measurement direction; however, other magnet arrangements and directions of movement are possible and can result in a change of the characteristic line.



**Preferred types**

Modell	MDS-40-MK-SA8-I	MDS-40-MK-SR7-U10	MDS-40-MK-SR7-U45R	MDS-40-MK-SR0-F	MDS-40-MK-XXX
Measuring range <sup>1)</sup>	RL21 magnet: 30mm (further measuring ranges see accessories)				
Offset distance <sup>1)</sup>	RL21 magnet: 1.5mm				
Linearity <sup>1) 2)</sup>	< ±3% ... ±5% FSO				
Temperature stability	±500 ppm FSO / K				
Resolution <sup>3)</sup>	<0.05 % FSO				
Frequency response / Square frequency	1000Hz (-3dB)			typ. 402 - 285 Hz (square)	
Electrical connection	connector axial, M8x1, 4 pin	connector radial, JST JWPF, 4 pin		connector radial, JST PA, 4 pin	selectable
Output	4...20mA	2...10V	0.5V...4.5V (ratiometric)	frequency (time measurement, p.15)	selectable
Storage temperature	-20°C...80°C				
Operating temperature	-20°C...80°C				
Power supply	11...30 VDC			5 VDC	selectable
Protection class	IP67 (casting)			IP20 (partial casting)	selectable
Housing materials	PA 66 / brass / PUR				
Packaging unit	1 pc		10 pc		from 200 pc

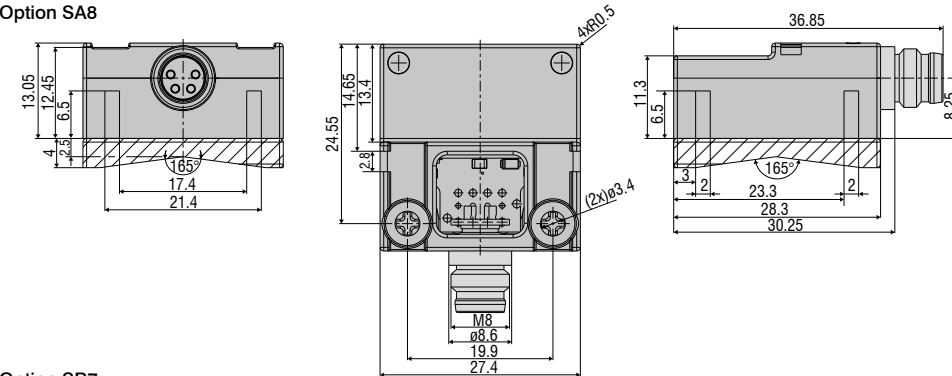
FSO = Full Scale Output

<sup>1)</sup> Measuring changes by using other magnets (see page 14); external magnetic fields and/or ferromagnetic material in the measuring range of the sensor system affect the sensor characteristic line and the technical data

<sup>2)</sup> Deviation to the regression curve according to the method of the least squares

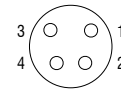
<sup>3)</sup> Peak-Peak; external low pass; frequency response 5kHz

**Option SA8**



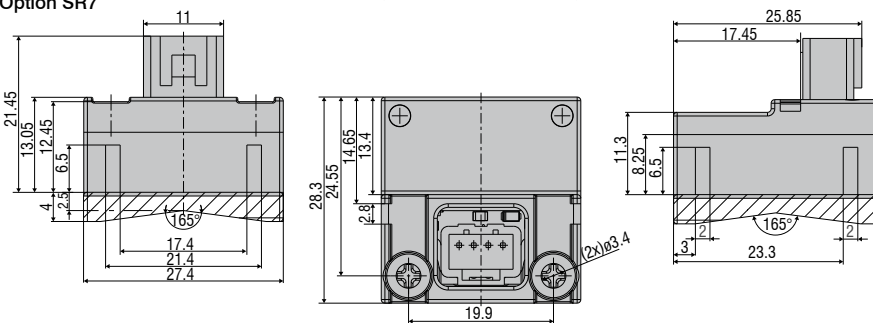
**Pin assignment**

View connector side



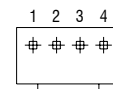
- 1: + supply
  - 2: GND Out
  - 3: GND
  - 4: + Out
- GND pins internally connected

**Option SR7**



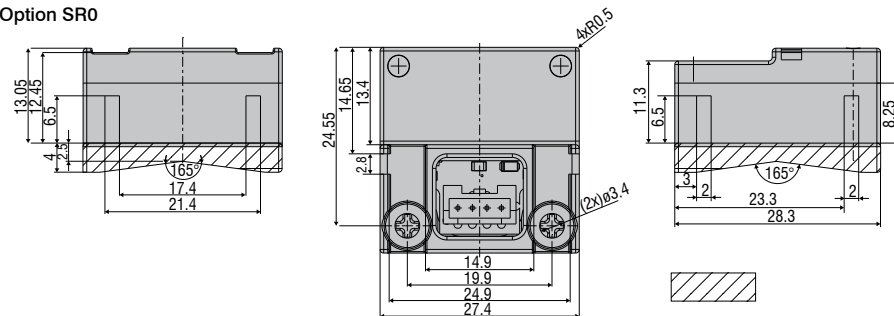
**Pin assignment**

View connector side



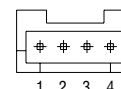
- 1: + supply
  - 2: GND Out
  - 3: GND
  - 4: + Out
- GND pins internally connected

**Option SR0**



**Pin assignment**

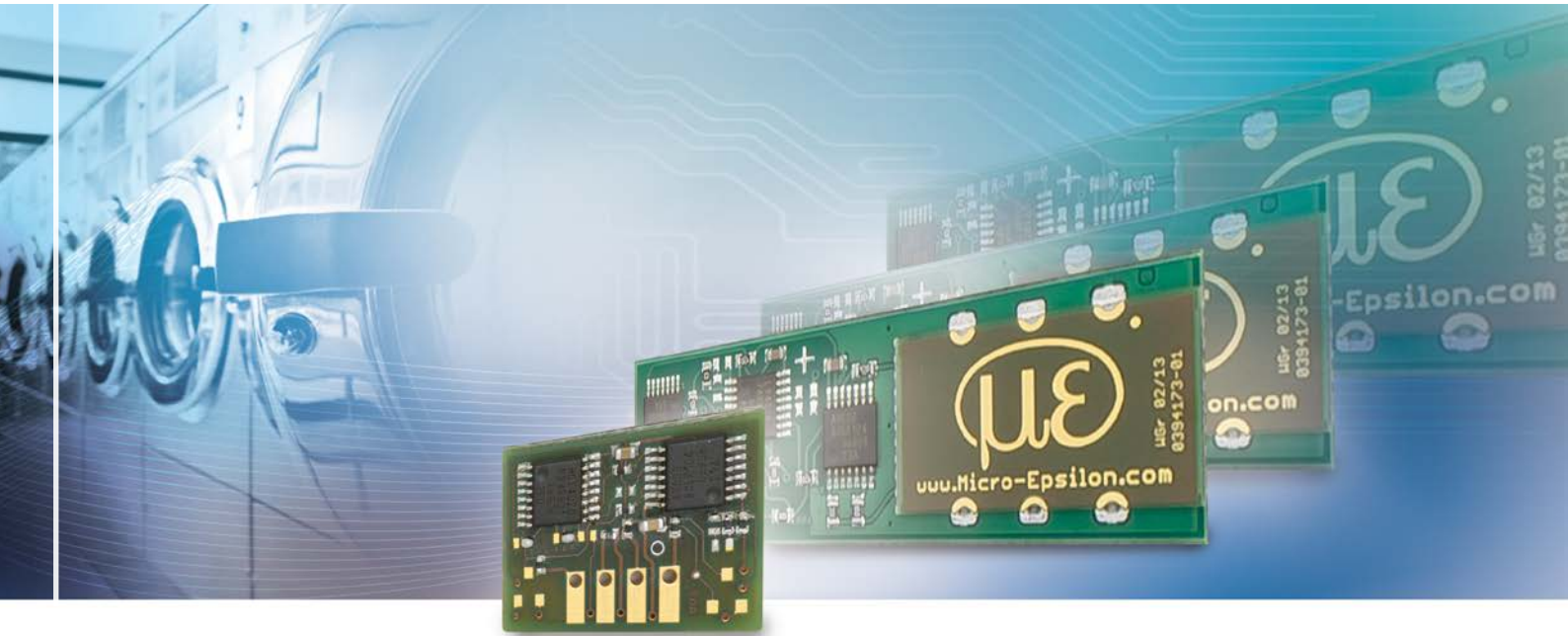
View connector side



- 1: + supply
  - 2: GND Out
  - 3: GND
  - 4: + Out
- GND pins internally connected

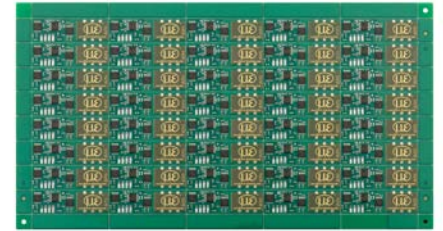


Optional retaining plate not included in delivery



The MDS-40-LP sensors are specially designed for large volume production from 2,000 pieces or more. As these sensors are reduced to pure measurement technology, the creation of cost-effective PCB sensors was possible. Their flat design and flexible arrangement of the magnets allows easy integration in restric-

ted spaces. Measured values are output via a rectangular signal, which is easily evaluated via, for example, digital inputs from micro-controllers.



OEM sensor example	MDS-40-LP-SUS	MDS-40-LP-F
Measuring range <sup>1)</sup>	40mm	40mm
Linearity <sup>2)</sup>	±6 % FSO	±9 % FSO
Temperature stability	±0.06% FSO/K	±0.2% FSO/K
Resolution	<0.05% FSO	<0.05% FSO
Physical output parameter	Period duration Rectangle: typ. 2.0ms ... 3.3ms (p.15)	Period duration Rectangle: typ. 1.6ms ... 1.7ms (p.15)
Operating temperature	-20°C ... +85°C	
Supply voltage <sup>3)</sup>	3.6V <sub>dc</sub> ... 5.3V <sub>dc</sub>	
Power consumption <sup>4)</sup>	typ. 15mA (5V) 12mA (3.6V)	
Typ. dimensions	50 x 15 x 3mm	20.8 x 14.8 x 3mm
Electrical connection	Plug-in connection to a PCB; grid size 2.5mm	
Minimum quantity	2,000 pc	5,000 pc

FSO = Full Scale Output

<sup>1)</sup> Measuring changes by using other magnets (see page 14); external magnetic fields and/or ferromagnetic material in the measuring range of the sensor system affect the sensor characteristic line and the technical data

<sup>2)</sup> Deviation to the regression curve according to the method of the least squares

<sup>3)</sup> Without inverse polarity protection, without overvoltage protection

<sup>4)</sup> Without output load



Application example: Integration into a washing machine damper

### Sensors for customer-specific requirements

Sensors can be adapted in many different ways to suit customer-specific applications. Particularly in the case of high volume orders, customised sensors can be produced efficiently, which results in considerable cost reductions.

The compact PCB which contains the sensor element and the evaluation electronics, is responsible for the signal preparation, signal evaluation and signal output. Furthermore, the PCB is adapted to customer-specific requirements. This means that the measurement mode (distance or speed measurement) and the accuracy requirements, as well as the required frequency response, can be selected. In addition, the interfaces offer numerous connectivity options. There are several outputs such as current, voltage, PWM and further digital outputs. The design of the housing, the material and the protection class can be adapted to the specific requirements. In cases where space is limited, the side shifted measurement offers a spacesaving alternative. For harsh environments, the sensor is designed with a fully sealed stainless steel housing that withstands high pressure, dirt, aggressive chemicals (acids) and solvents.

### Overview of customer-specific solutions

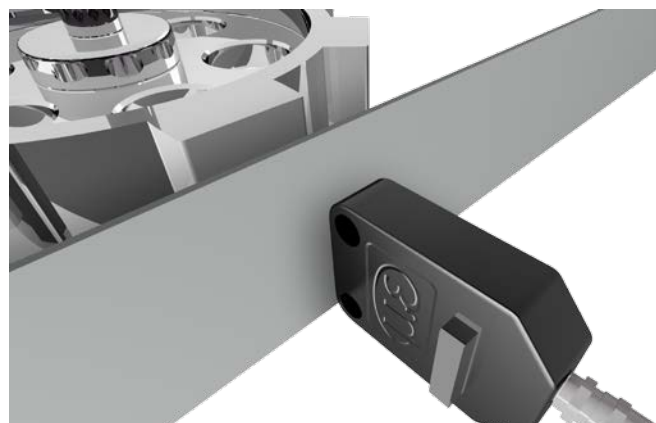
- High cost efficiency in the case of high-volume production
- Ideal for miniature applications
- Flexible design (sensor on PCB)
- Side shifted measurement (dampers arrangement)
- Output signal (current, voltage, PWM...)
- Increased pressure resistance
- Frequency response up to 20kHz



The PCB can be easily integrated and modified for customer-specific solutions – even in limited spaces.

### Customer-specific versions for rotational speed measurement with pre-tensioned sensors

For rotational speed measurements of ferromagnetic objects such as toothed racks, the sensor can be pre-tensioned. This means that the magnet is integrated to the housing. For this customer-specific solution a factory calibration is required. The movement of the toothed racks affects the magnetic field, which is required for the speed measurement. The speed measurement can also be carried out through non-ferromagnetic materials.



Pre-tensioned sensor for speed measurement of toothed racks

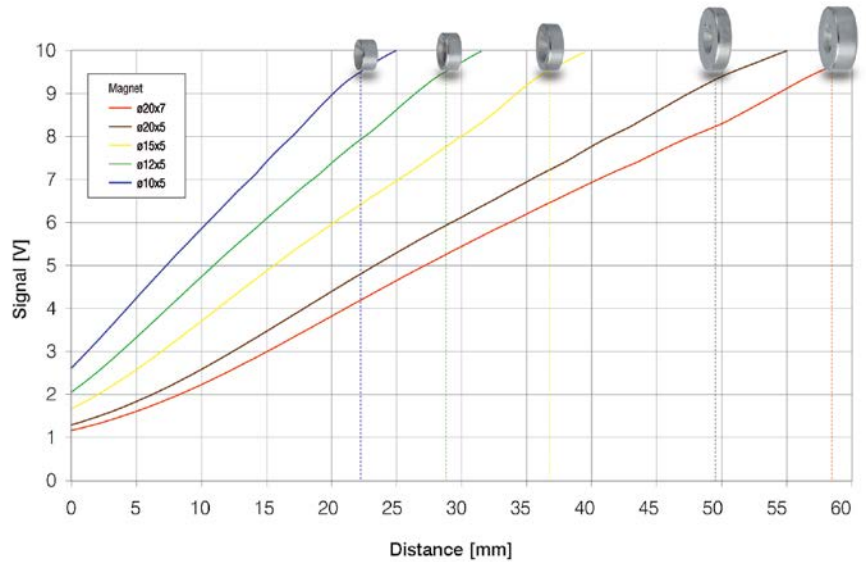
**Magnets**

The magnets are critical components of the magneto-inductive measuring principle.

Many shapes and materials are available. Application, installation space, temperature and cost factors must be considered. A decisive advantage is that the measuring range of the sensor can be defined by selecting the appropriate magnet. Adapting or set up of the sensor are unnecessary.

Therefore, measuring ranges of 20 to 55mm can be achieved using only one sensor.

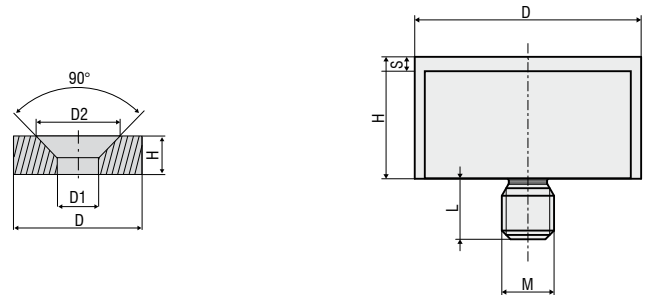
**Simple change of the measuring range by exchanging the magnet**



Description	Measuring range MDS-45 [mm]	Measuring range MDS-40-MK [mm]	T <sub>max</sub> [°C]	Standard magnets				Standard magnets with protection housing						
				Material	Dimensions [mm]				Material	Dimensions [mm]				
				D	D1	D2	H	D	H	L	M	S		
MB20	20	-	150	NeFeB, nickel-plated	10	4.3	8.6	5	1.3964 Nitronic 50HS	16	9.5	5	M4	2
MB27	27	~ 23	150	NeFeB, nickel-plated	12	4.3	8.6	5	1.3964 Nitronic 50HS	16	9.5	5	M4	2
MB35	35	~ 33	150	NeFeB, nickel-plated	15	4.3	8.6	5	1.3964 Nitronic 50HS	26	14	7	M6	3.5
MB45	45	~ 45	150	NeFeB, nickel-plated	20	4	8	5	1.3964 Nitronic 50HS	26	14	7	M6	3.5
MB55	55	~ 50	150	NeFeB, nickel-plated	20	4	8	7	1.3964 Nitronic 50HS	26	14	7	M6	3.5
RL21	33	~ 30	200	SrFe, hard ferrite	20	4.3	-	10	-	-	-	-	-	-
RL20	25	~ 25	200	SrFe, hard ferrite	20	4.3	-	6.5	-	-	-	-	-	-

**Magnets at higher temperatures**

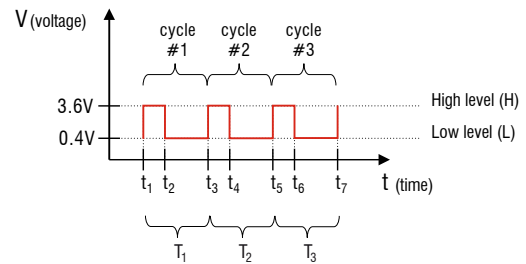
Permanent magnets present reversible and irreversible temperature dependence. With low temperatures, the magnetic field changes reversibly with the temperature. In the first approximation, this dependence is linear. Irreversible attenuations of the magnetic field are caused by rising temperatures. The main part of these attenuations arises when the temperature is reached for the first time. Therefore, it is recommended that when using magnets in high temperatures, they are heated up only once to the operating temperature or to around 20°C above the operating temperature, provided that the respective magnet specification allows this. Please refer to Micro-Epsilon TechNote T016 for further details.



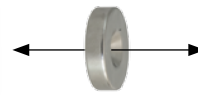
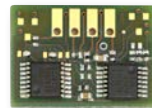
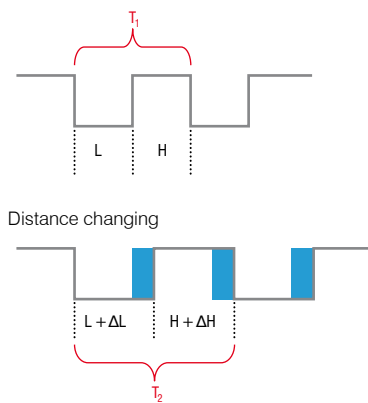
A pressure housing is a method of protecting a magnet from high pressure or aggressive media. This is made from robust stainless steel and resists pressures up to 400 bar.

**Rectangular output signals**

For OEM sensors an effective signal conditioning is mandatory to gain the best price/performance ratio. Therefore all sensors of the series MDS-40 are offering a rectangular output signal, that is easy to create, but also easy to evaluate. Important is the capability to measure times, e.g. with a micro controller. Depending on the type of magnet, the distance signal is proportional to the period of duration or the frequency of the rectangular signal.

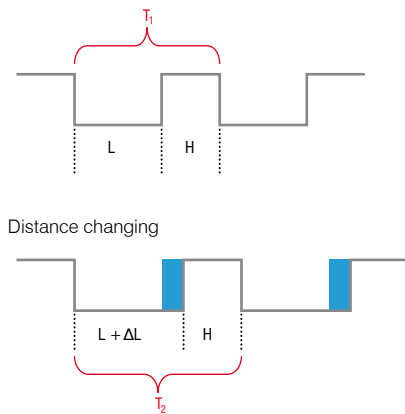


**Series MDS-40-LP-F**



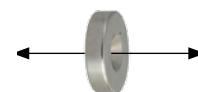
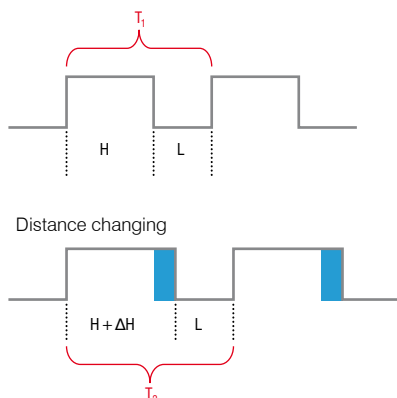
L = time at a low level  
 H = time at a high level  
 H and L ~ distance signal

**Series MDS-40-LP-SUS**



L = time at a low level  
 H = time at a high level  
 L ~ distance signal  
 Details about temperature compensation are available on request

**Series MDS-40-MK**



L = time at a low level  
 H = time at a high level  
 $1/(H+L) = f$  ~ distance signal

## 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, fibre optic sensors and fibre optics



Colour recognition sensors, LED analyzers and colour online spectrometer



Measurement and inspection systems

