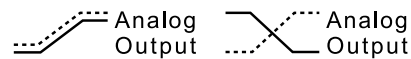


Inclinometers

For static applications 1- and 2-axis, metal housing	IN81	Analog
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The inclinometers of the IN81 series allow measuring 2-axis inclinations in the range of $\pm 85^\circ$ or 1-axis inclinations up to 360° . With their high robustness, their protection level up to max. IP69k and their wide temperature range from -40°C to $+85^\circ\text{C}$, these devices are ideally suitable for outdoor use – e.g. for mobile automation applications.



Features and benefits

- **Analog sensor for precise measurement**
 - Stable accuracy over the entire temperature range
 - Analog interface for different current and voltage ranges
- **Individual “Easy-Teach” settings via Teach Adapter**
 - Define preset (zero point / midpoint position)
 - Scaling of the analog measuring range (start/end position)
 - Setting the sensor filter
 - Setting the switching points of the optional switching outputs
 - Resetting to factory settings
- **Redundant measurement**

The housing offers the option of mounting sensors in stacks in order to easily implement redundant measurement in the application.
- **Simple start-up and diagnostics**

LED display for quick and visual detection of the operating status.
- **Precise measurement even under harsh environmental conditions**
 - Temperature range -40°C ... $+85^\circ\text{C}$ and protection class IP67 / IP69k
 - Protection against the influence of salt spray and rapid temperature changes
 - E1-approval
- **Maximum robustness**

The robust metal housing also protects the electronics from extreme mechanical influences.

Inclinometers

For static applications 1- and 2-axis, metal housing

IN81

Analog

Order code 1-axis

8.IN81.1.XXX.X2X
Type a b c d e

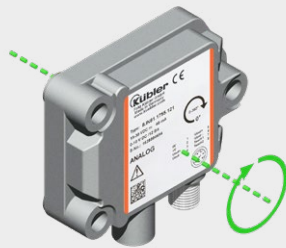
a Measuring range
7 = 0 ... 360° (±180°)
8 = 0 ... 180° (±90°)

b Analog interface
1 = 4 ... 20 mA / 12 bit
2 = 0.1 ... 4.9 V / 11 bit
3 = 0.5 ... 4.5 V / 11 bit
4 = 0 ... 5 V / 11 bit
5 = 0 ... 10 V / 12 bit

c Filter
1 = no filter
2 = filter value 0.1 Hz
3 = filter value 0.3 Hz
4 = filter value 0.5 Hz
5 = filter value 1.0 Hz
6 = filter value 2.0 Hz
7 = filter value 5.0 Hz
8 = filter value 10.0 Hz

d Optional switching outputs
1 = none
2 = 2 switch outputs ¹⁾

e Type of connection
1 = 1 x M12 connector, 8-pin
2 = 1 x M12 connector, 5-pin
3 = 2 x M12 connector, 8-pin + 5-pin ²⁾



Order code 2-axis

8.IN81.2.XXX.X2X
Type a b c d e

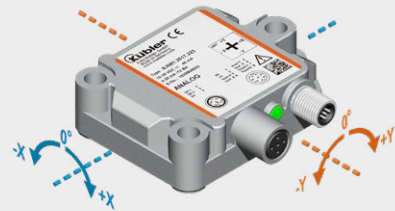
a Measuring range
1 = ± 10°
2 = ± 15°
3 = ± 30°
4 = ± 45°
5 = ± 60°
6 = ± 85°

b Analog interface
1 = 4 ... 20 mA / 12 bit
2 = 0.1 ... 4.9 V / 11 bit
3 = 0.5 ... 4.5 V / 11 bit
4 = 0 ... 5 V / 11 bit
5 = 0 ... 10 V / 12 bit

c Filter
1 = no filter
2 = filter value 0.1 Hz
3 = filter value 0.3 Hz
4 = filter value 0.5 Hz
5 = filter value 1.0 Hz
6 = filter value 2.0 Hz
7 = filter value 5.0 Hz
8 = filter value 10.0 Hz

d Optional switching outputs
1 = none
2 = 2 switch outputs ¹⁾

e Type of connection
1 = 1 x M12 connector, 8-pin
2 = 1 x M12 connector, 5-pin
3 = 2 x M12 connector, 8-pin + 5-pin ²⁾



1) Can only be ordered in conjunction with type of connection **e** = 3.
2) Can only be ordered in conjunction with optional switching output **d** = 2.

Accessories

Teach-Adapter



for controlling the control inputs for the following functions:
- Preset (reference point setting)
- Teaching (measuring range)
- Filter setting
- Switching points setting

Order no.

8.0010.9000.0017

Adapter plate

for installation identical to Kübler inclinometer IS40

8.0010.4062.0000

Cables and connectors

Preassembled cables

M12 female connector with coupling nut, 8-pin, A coded, straight
single ended
5 m [16.40'] PVC cable

05.00.6041.8211.005M

M12 male connector with external thread, 5-pin, A coded, straight
single ended
5 m [16.40'] PVC cable

05.00.6091.A411.005M

Connectors

M12 female connector with coupling nut, 8-pin, A coded, straight (metal)

05.CMB 8181-0

M12 male connector with external thread, 5-pin, A coded, straight (metal)

8.0000.5111.0000

Further Kübler accessories can be found at: kuebler.com/accessories
Further Kübler cables and connectors can be found at: kuebler.com/connection-technology

Inclinometers

For static applications
1- and 2-axis, metal housing

IN81

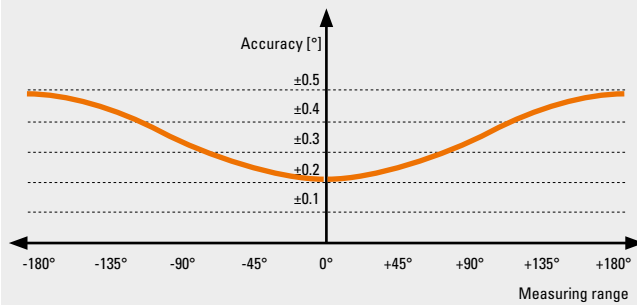
Analog

Technical data

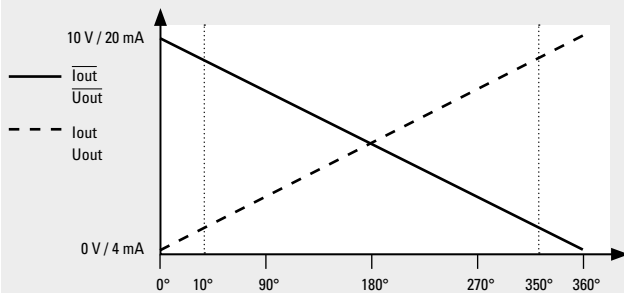
General data 1-axis measurement

Measuring range	0 ... 360°								
Resolution	<table border="0"> <tr> <td>current interface</td> <td>0.01° internal sensor</td> </tr> <tr> <td></td> <td>12 bit D/A converter</td> </tr> <tr> <td>voltage interface</td> <td>12 bit 0 ... 10 V</td> </tr> <tr> <td></td> <td>11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V</td> </tr> </table>	current interface	0.01° internal sensor		12 bit D/A converter	voltage interface	12 bit 0 ... 10 V		11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V
current interface	0.01° internal sensor								
	12 bit D/A converter								
voltage interface	12 bit 0 ... 10 V								
	11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V								
Repeat accuracy	±0.2°								
Temperature coefficient	<table border="0"> <tr> <td>current interface</td> <td>typ. ±0.005 % / K</td> </tr> <tr> <td>voltage interface</td> <td>typ. ±0.0015 % / K</td> </tr> </table>	current interface	typ. ±0.005 % / K	voltage interface	typ. ±0.0015 % / K				
current interface	typ. ±0.005 % / K								
voltage interface	typ. ±0.0015 % / K								

Accuracy (at 25°C) ±0.2 ... ±0.5°
 depending on the measuring range



Course of the output signal – factory setting



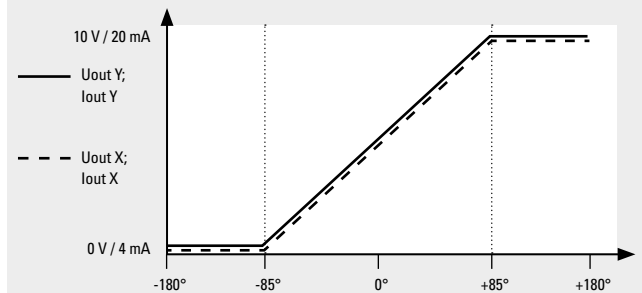
General data 2-axis measurement

Measuring range	-85 ... +85°								
Resolution	<table border="0"> <tr> <td>current interface</td> <td>0.01° internal sensor</td> </tr> <tr> <td></td> <td>12 bit D/A converter</td> </tr> <tr> <td>voltage interface</td> <td>12 bit 0 ... 10 V</td> </tr> <tr> <td></td> <td>11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V</td> </tr> </table>	current interface	0.01° internal sensor		12 bit D/A converter	voltage interface	12 bit 0 ... 10 V		11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V
current interface	0.01° internal sensor								
	12 bit D/A converter								
voltage interface	12 bit 0 ... 10 V								
	11 bit 0 ... 5 V / 0,1 ... 4,9 V / 0,5 ... 4,5 V								
Repeat accuracy	±0.2°								
Temperature coefficient	<table border="0"> <tr> <td>current interface</td> <td>typ. ±0.015 % / K</td> </tr> <tr> <td>voltage interface</td> <td>typ. ±0.005 % / K</td> </tr> </table>	current interface	typ. ±0.015 % / K	voltage interface	typ. ±0.005 % / K				
current interface	typ. ±0.015 % / K								
voltage interface	typ. ±0.005 % / K								
Transverse sensitivity	typ. ±0.3°								

Accuracy (at 25°C) ±0.5 ... ±1.0°
 depending on the measuring range



Course of the output signal – factory setting



Inclinometers

For static applications 1- and 2-axis, metal housing

IN81
Analog

Electrical characteristics current interface

Supply voltage	10 ... 30 V DC	
Current consumption (no load)	max. 40 mA ¹⁾	
Reverse polarity protection of the supply voltage	yes	
PowerON Time (PowerOn until valid output value)	< 0.5 s	
Output load	at 10 VDC	max. 200 Ohm
	at 24 VDC	max. 900 Ohm
	at 30 VDC	max. 1200 Ohm
Setting time	< 1 ms (R _{Burden} = 900 Ohm, 25 °C)	
Sampling rate	50 Hz (20 ms)	
Limit frequency with Butterworth filter	0.1 ... 10 Hz, 8th order	

Electrical characteristics voltage interface

Supply voltage	4 ... 20 mA / 0.1 ... 4.9 V / 0.5 ... 5 V / 0 ... 5 V	10 ... 30 V
	0 ... 10 V	15 ... 30 V
Current consumption (no load)	max. 40 mA ¹⁾	
Reverse polarity protection of the supply voltage	yes	
PowerON Time (PowerOn until valid output value)	< 0.5 s	
Output load	max. 10 mA	
Setting time	< 1 ms (R _{Burden} = 1000 Ohm, 25 °C)	
Sampling rate	50 Hz (20 ms)	
Limit frequency with Butterworth filter	0.1 ... 10 Hz, 8th order	

Mechanical characteristics

Connection	1 x M12 connector	8-pin, male connector
	1 x M12 connector	5-pin, female connector
	2 x M12 connector	8-pin, male / 5-pin, female connector
Weight	approx. 185 g [6.53 oz]	
Protection acc. to EN 60529	IP67 + IP69k ²⁾	
Working temperature range	-40 °C ... +85 °C [-40 °F ... +185 °F]	
Material	housing	aluminum
Shock resistance acc. to EN 60068-2-27	1000 m/s ² , 6 ms	
Vibration resistance acc. to EN 60068-2-6	100 m/s ² , 10 ... 2000 Hz	
Dimensions	80 x 60 x 23 mm [3.15 x 2.36 x 0.91"]	

Characteristic optional switching outputs

Number	2	
Permissible load	max. 100 mA	
Signal level (under max. load)	High	min. +V - 3.0 V
	Low	max. 0.5 V
Short circuit proof outputs	yes	

Characteristic control inputs

Funktions	Preset (reference point setting) Teaching (measuring range) Filter setting Switching points setting	
Input	active HIGH	
Signal level	High	min. 60% von +V, max. +V
	Low	max. 30% von +V
Min. pulse duration	+V for min. 1 s	

EMC

Relevant standards	EN 61326-1	Electrical equipment for measurement, control and laboratory use
	EN 61000-6-2	Immunity for industrial environments
	EN 55011 Klasse B, EN 61000-6-3	Emitted interferences for residential environments
	EN ISO 14982	Agricultural and forestry machinery, electromagnetic compatibility, test methods and acceptance criteria ³⁾
	EN 13309	Construction machinery - Electromagnetic compatibility of machines with internal supply voltage ³⁾

Approvals

E1 compliant in accordance with	ECE guideline	
UL compliant in accordance with ²⁾	File no. E224618	
CE compliant in accordance with	EMC Directive	2014/30/EU
	RoHS Directive	2011/65/EU

1) Max. 270 mA under full load on both switching outputs.

2) The IP protection class is not UL-tested. Verified by Kübler.

3) Without pulse 5.

Inclinometers

For static applications 1- and 2-axis, metal housing	IN81	Analog
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Terminal assignment, 1 dimensional

Type of connection										
1	Signal – Interface 1 (current):	0 V	+V	Iout+	Iout-	Iout+	Iout-	Teach 1	Teach 2	
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+	Uout-	Uout+	Uout-	Teach 1	Teach 2	
	Pin:	1	2	3	4	5	6	7	8	
Type of connection										
2	Signal – Interface 1 (current):	+V	Iout+	0 V	Iout+	Teach				
	Signal – Interface 2, 3, 4, 5 (voltage):	+V	Uout+	0 V	Uout+	Teach				
	Pin:	1	2	3	4	5				
Type of connection										
3	Signal – Interface 1 (current):	0 V	+V	Iout+	Iout-	Iout+	Iout-	Teach 1	Teach 2	
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+	Uout-	Uout+	Uout-	Teach 1	Teach 2	
	Pin:	1	2	3	4	5	6	7	8	
Switching outputs option – M12 connector, 5-pin										
Signal:	n.c.	DO1	DO2	n.c.	0 V					
Pin:	1	2	3	4	5					

Terminal assignment, 2 dimensional

Type of connection										
1	Signal – Interface 1 (current):	0 V	+V	Iout+ X	Iout- X	Iout+ Y	Iout- Y	Teach 1	Teach 2	
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+ X	Uout- X	Uout+ Y	Uout- Y	Teach 1	Teach 2	
	Pin:	1	2	3	4	5	6	7	8	
Type of connection										
2	Signal – Interface 1 (current):	+V	Iout+ Y	0 V	Iout+ X	Teach				
	Signal – Interface 2, 3, 4, 5 (voltage):	+V	Uout+ Y	0 V	Uout+ X	Teach				
	Pin:	1	2	3	4	5				
Type of connection										
3	Signal – Interface 1 (current):	0 V	+V	Iout+ X	Iout- X	Iout+ Y	Iout- Y	Teach 1	Teach 2	
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+ X	Uout- X	Uout+ Y	Uout- Y	Teach 1	Teach 2	
	Pin:	1	2	3	4	5	6	7	8	
Switching outputs option – M12 connector, 5-pin										
Signal:	n.c.	DO1	DO2	n.c.	0 V					
Pin:	1	2	3	4	5					

+V:	Supply voltage +V DC	Uout+ X	X axis voltage output	Iout+ X	X axis current output
0V	Supply voltage ground GND (0 V)	Uout- X	X axis voltage output GND	Iout- X	X axis current output GND
Teach 1	Input 1 for various teaching functions	Uout+ Y	Y axis voltage output	Iout+ Y	Y axis current output
Teach 2	Input 2 for various teaching functions	Uout- Y	Y axis voltage output GND	Iout- Y	Y axis current output GND
1-axis version					
DO1	Digital output 1	Uout+	Voltage output	Iout+	Current output
DO2	Digital output 2	Uout-	Voltage output GND	Iout-	Current output GND
		Uout+	Inverted voltage output	Iout+	Inverted current output
		Uout-	Inverted voltage output GND	Iout-	Inverted current output GND

Inclinometers

For static applications
1- and 2-axis, metal housing

IN81

Analog

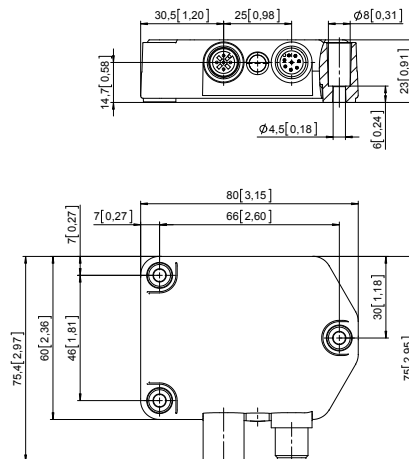
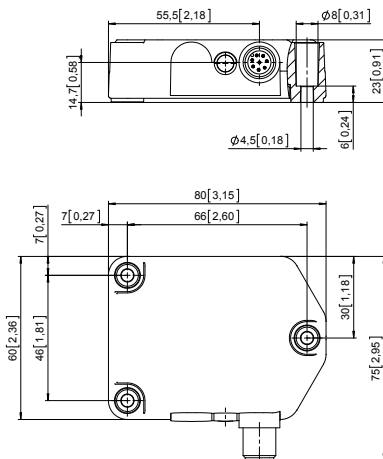
Dimensions

Dimensions in mm [inch]

1 x M12 connector 8-pin, male contacts

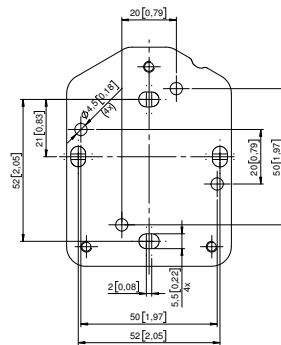
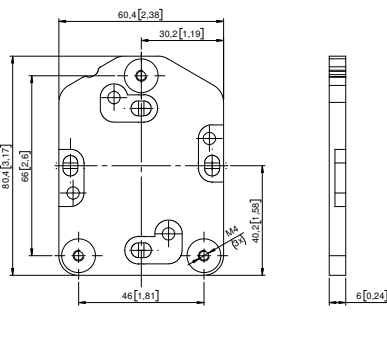
1 x M12 connector 8-pin, male contacts

1 x M12 connector 5-pin, female contacts



Adapter plate

for installation identical to Kübler inclinometer IS40



Inclinometers

For static applications 1- and 2-axis, metal housing	IN81	Analog
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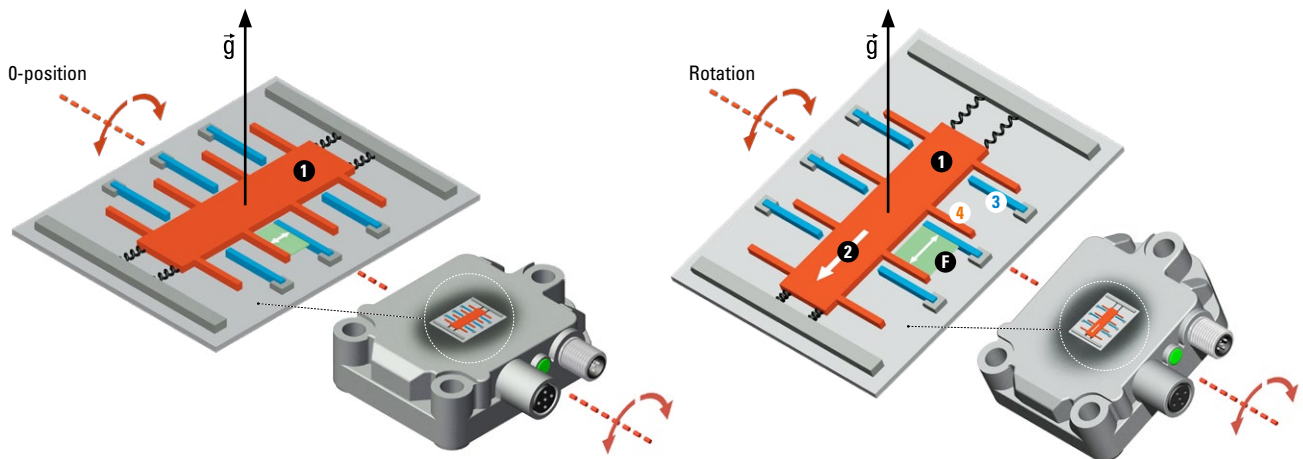
Technology in detail

Exact angular position via acceleration measurement

Acceleration measurement

In the acceleration measuring cell, the absolute angular position is determined capacitively in relation to the gravity acceleration \vec{g} .

The displacement **2** of a test mass **1** changes the distance and therefore also the capacity **F** between fixed **3** and moving **4** electrodes in the measuring cell. This measured capacity is directly related to the inclination of the sensor.



Optimization of the measurement using filter functions

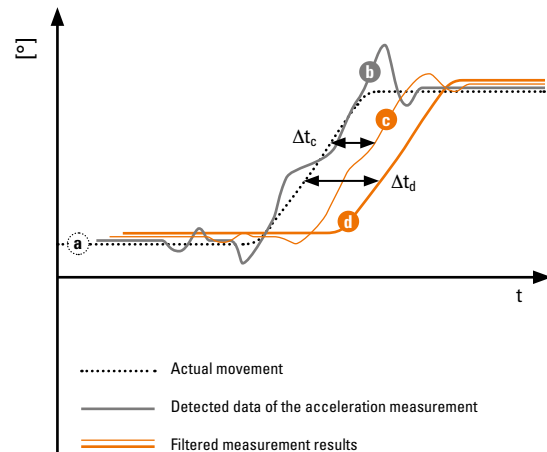
The inertia of the test mass, particularly in the case of fast or rapidly changing rotations and vibrations, can lead to inaccuracies in the detected measurement data **b** compared to the actual movement **a**. To compensate for these undesirable effects, various filters **c** + **d** can be parameterized in the inclinometer.

Restrictions due to filters

However, this leads to a time delay ($\Delta t_c + \Delta t_d$) for the output of the measurement result (the more precise the desired measurement, the greater the time delay).

Further optimization with dynamic inclinometers

This time delay is not relevant for many static applications (such as solar panels, crane masts, etc.). In dynamic applications (e.g. vehicles in motion), however, this can lead to problems, as a reaction to the movement can only occur with a delay. In this case, it is advisable to use a dynamic inclinometer IN71 with intelligent sensor fusion from Kübler for further optimization of the measurement result.



Inclinometers

For static applications
1- and 2-axis, metal housing

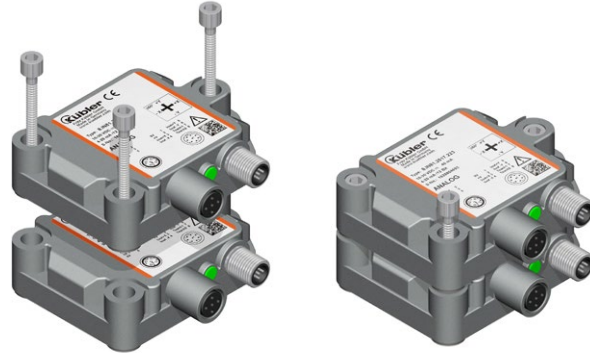
IN81

Analog

Technology in detail

Simple redundancy thanks to stackability

Using the same fastening devices on the application, 2 inclinometers type IN81 can be mounted stacked.



Quick setting options via the Easy-Teach function with teach adapter

Connection

The teach adapter **2** is connected between the sensor **1** and the connection cable to the application **4**.

Parameterization

The following settings can be made quickly and easily by pressing the toggle switches **3**:

- Define preset (zero point / midpoint position)
- Scaling of the analog measuring range (start/end position)
- Setting the sensor filter
- Setting the switching points of the optional switching outputs
- Resetting to factory settings

