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

The inclinometers of the IN81 series allow measuring 2-axis inclinations in the range of ±85° 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 °C, these devices are ideally suitable for outdoor use – e.g. for mobile automation applications.

Analog Output

Analog Output

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 °C and protection class IP68 / 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.

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

IN81 | **Analog**

Order code 1-axis

8.IN81 . 1 X X X . X 2 X
Type — a b c — d — e

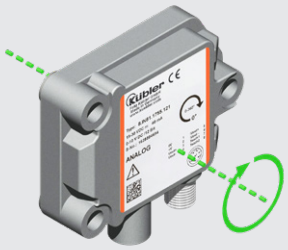
a *Measuring range*
7 = 0 ... 360° (±180°)
8 = 0 ... 180° (±90°)

b *Analog interface*
1 = 4 ... 20 mA / 12 bit
2 = 0.1 ... 4.9 V / 12 bit
3 = 0.5 ... 4.5 V / 12 bit
4 = 0 ... 5 V / 12 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 X X X . X 2 X
Type — a b c — d — e

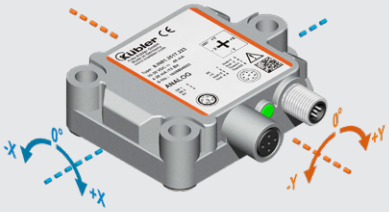
a *Measuring range*
1 = ± 10°
2 = ± 15°
3 = ± 30°
4 = ± 45°
5 = ± 60°
6 = ± 85°

b *Analog interface*
1 = 4 ... 20 mA / 12 bit
2 = 0.1 ... 4.9 V / 12 bit
3 = 0.5 ... 4.5 V / 12 bit
4 = 0 ... 5 V / 12 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		Order no.
Teach-Adapter 	for controlling the control inputs for the following functions: - Preset (reference point setting) - Teaching (measuring range) - Filter setting - Switching points setting	**8.0010.9000.0017**
Adapter plate	for installation identical to Kübler inclinometer IS40	**8.0010.4062.0000**
Cables and connectors		**Order no.**
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**

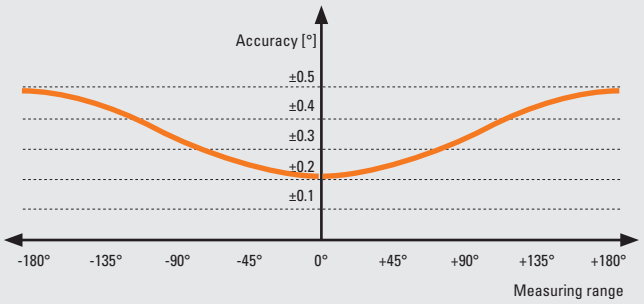
Further Kübler accessories can be found at: kuebler.com/accessories
Further Kübler cables and connectors can be found at: kuebler.com/connection-technology

For static applications
1- and 2-axis, metal housing | **IN81** | **Analog**

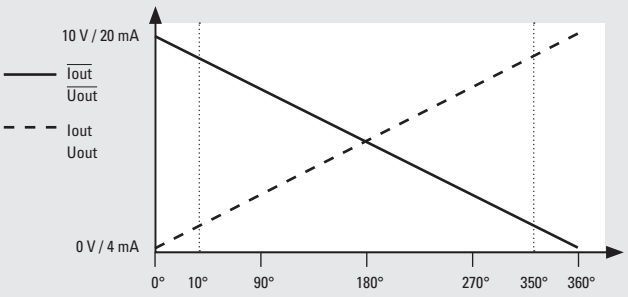
Technical data

General data 1-axis measurement

Measuring range	0 ... 360°	
Resolution		
current interface	0.01°	internal sensor
	12 bit	D/A converter
voltage interface	12 bit	0 ... 5 V / 0 ... 10 V
	11 bit	0.1 ... 4.9 V / 0.5 ... 4.5 V
Repeat accuracy	±0.2°	
Temperature coefficient		
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	

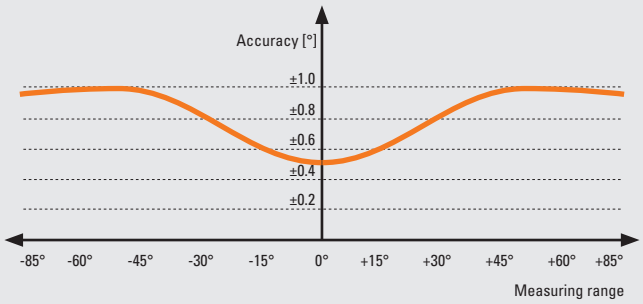


Course of the output signal – factory setting

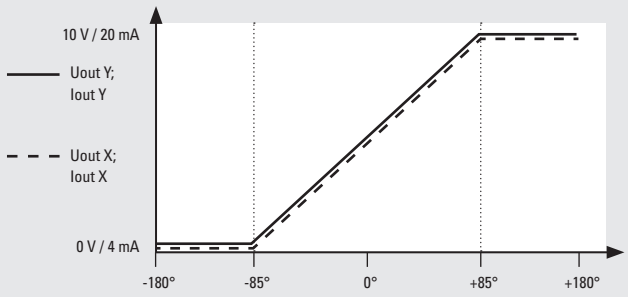


General data 2-axis measurement

Measuring range	-85 ... +85°	
Resolution		
current interface	0.01°	internal sensor
	12 bit	D/A converter
voltage interface	12 bit	0 ... 5 V / 0 ... 10 V
	11 bit	0.1 ... 4.9 V / 0.5 ... 4.5 V
Repeat accuracy	±0.2°	
Temperature coefficient		
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



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 at 24 VDC at 30 VDC	max. 200 Ohm max. 900 Ohm 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 0 ... 10 V		10 ... 30 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 1 x M12 connector 2 x M12 connector	8-pin, male connector 5-pin, female 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/s², 6 ms
Vibration resistance acc. to EN 60068-2-6		100 m/s², 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 Low	min. +V - 3.0 V 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 Low	min. 60% von +V, max. +V 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

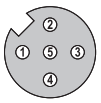
1) Max. 270 mA under full load on both switching outputs.
2) The IP protection class is not UL-tested. Verified by Kübler.
3) Without pulse 5.

For static applications 1- and 2-axis, metal housing | IN81 | Analog

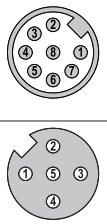
Terminal assignment, 1 dimensional

Type of connection	M12 connector, 8-pin								
1	Signal – Interface 1 (current):	0 V	+V	Iout+	Iout-	$\overline{\text{Iout+}}$	$\overline{\text{Iout-}}$	Teach 1	Teach 2
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+	Uout-	$\overline{\text{Uout+}}$	$\overline{\text{Uout-}}$	Teach 1	Teach 2
	Pin:	1	2	3	4	5	6	7	8

Type of connection	M12 connector, 5-pin						
2	Signal – Interface 1 (current):	+V	$\overline{\text{Iout+}}$	0 V	Iout+	Teach	
	Signal – Interface 2, 3, 4, 5 (voltage):	+V	$\overline{\text{Uout+}}$	0 V	Uout+	Teach	
	Pin:	1	2	3	4	5	



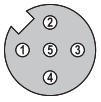
Type of connection	M12 connector, 8-pin								
3	Signal – Interface 1 (current):	0 V	+V	Iout+	Iout-	$\overline{\text{Iout+}}$	$\overline{\text{Iout-}}$	Teach 1	Teach 2
	Signal – Interface 2, 3, 4, 5 (voltage):	0 V	+V	Uout+	Uout-	$\overline{\text{Uout+}}$	$\overline{\text{Uout-}}$	Teach 1	Teach 2
	Pin:	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			



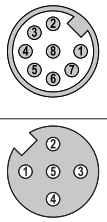
Terminal assignment, 2 dimensional

Type of connection	M12 connector, 8-pin								
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	M12 connector, 5-pin						
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	M12 connector, 8-pin								
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
0V Supply voltage ground GND (0 V)

Teach 1 Input 1 for various teaching functions
Teach 2 Input 2 for various teaching functions

DO1 Digital output 1
DO2 Digital output 2

Uout+ X X axis voltage output
Uout- X X axis voltage output GND
Uout+ Y Y axis voltage output
Uout- Y Y axis voltage output GND

1-axis version
Uout+ Voltage output
Uout- Voltage output GND
$\overline{\text{Uout+}}$ Inverted voltage output
$\overline{\text{Uout-}}$ Inverted voltage output GND

Iout+ X X axis current output
Iout- X X axis current output GND
Iout+ Y Y axis current output
Iout- Y Y axis current output GND

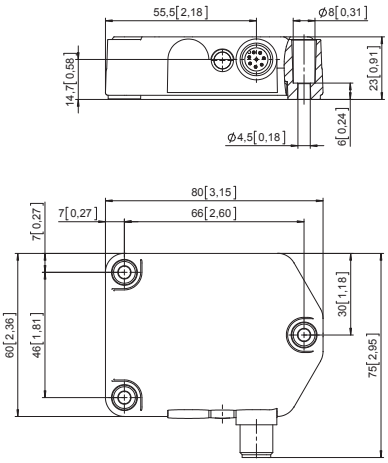
1-axis version
Iout+ Current output
Iout- Current output GND
$\overline{\text{Iout+}}$ Inverted current output
$\overline{\text{Iout-}}$ Inverted current output GND

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

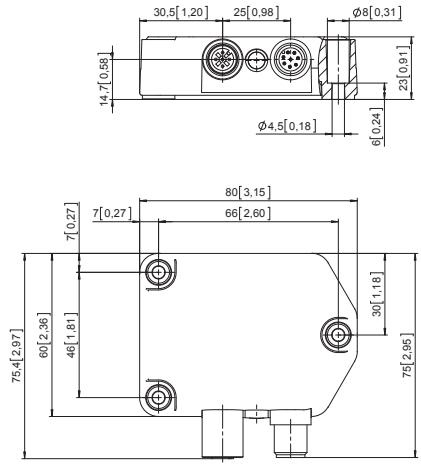
IN81 | **Analog**

Dimensions
Dimensions in mm [inch]

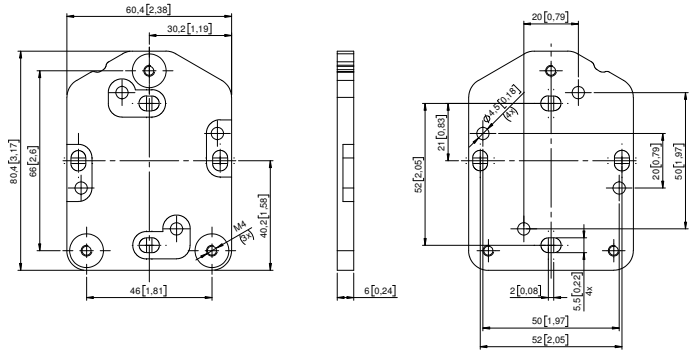
1 x M12 connector 8-pin, male contacts



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



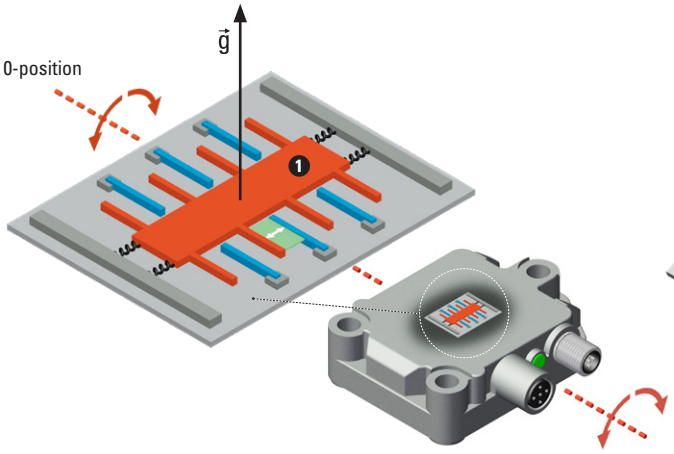
For static applications
1- and 2-axis, metal housing | **IN81** | **Analog**

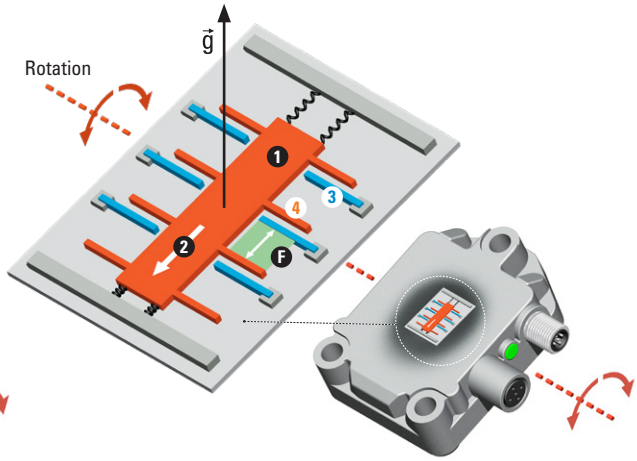
Technology in detail

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

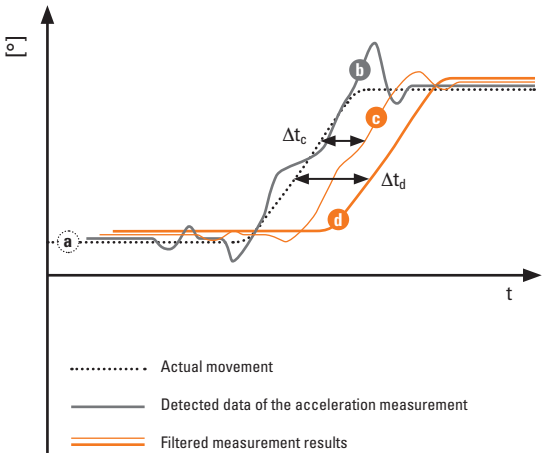




Optimization of the measurement using filter functions
The inertia of the test mass, particularly in the case of fast or rapidly changing rotations and vibrations, can lead to inaccuracies in the detected measurement data ⓑ compared to the actual movement ⓐ. To compensate for these undesirable effects,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

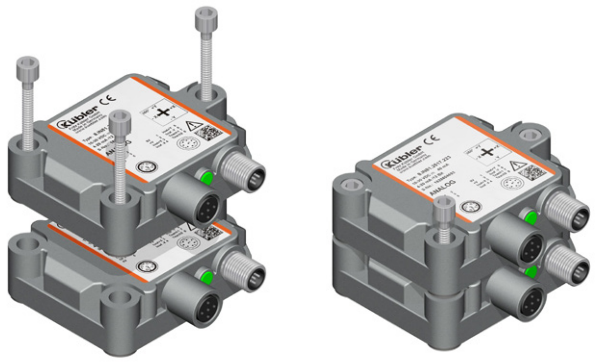


For static applications
1- and 2-axis, metal housing | **IN81** | **Analog**

Technology in detail

Simple redundancy thanks to stackability

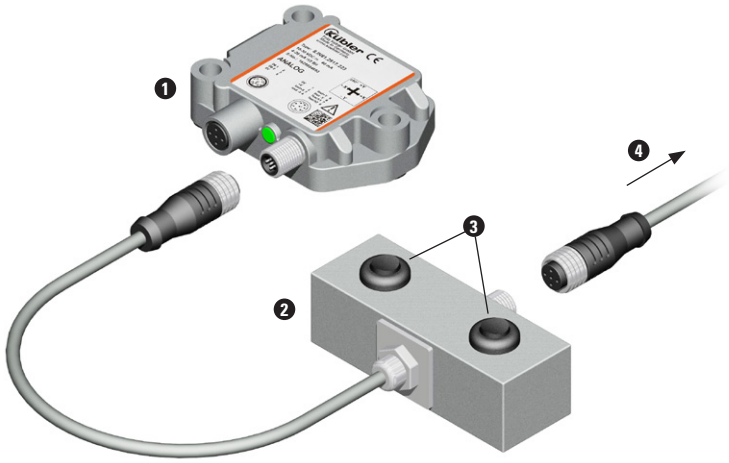
Using the same fastening devices on the application,
2 inclinometers type IN81 can be mounted stacked.



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

Connection
The teach adapter ❷ is connected between the sensor ❶ and the connection cable to the application ❹.

Parameterization
The following settings can be made quickly and easily by pressing the toggle switches ❸ :
- 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

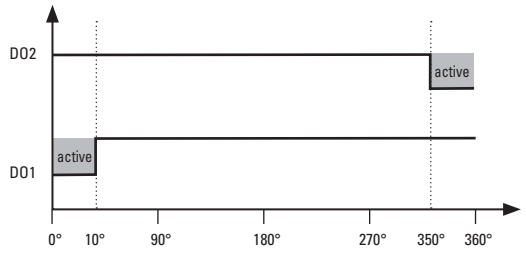


For static applications
1- and 2-axis, metal housing | **IN81** | **Analog**

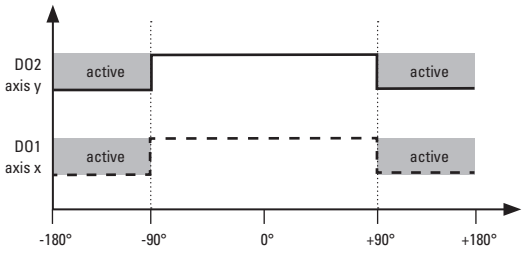
Technology in detail

Defining the switching points for the optional switching outputs

1-axis measurement – factory setting

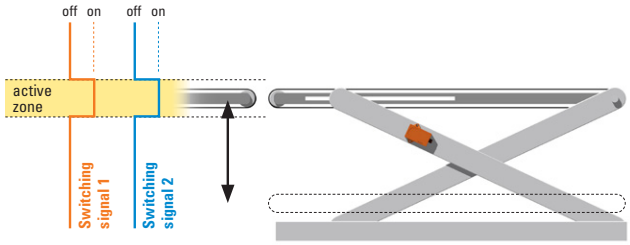


2-axis measurement – factory setting

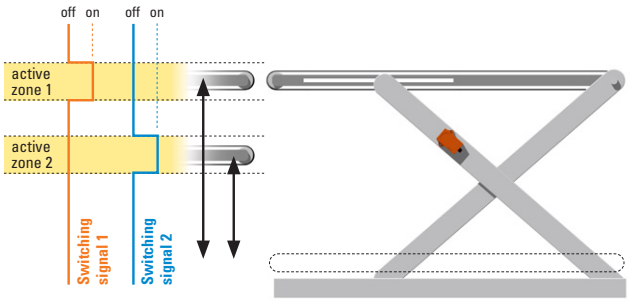


1-axis measurement – **individual setting** (examples)

Two identical switching ranges (redundancy)

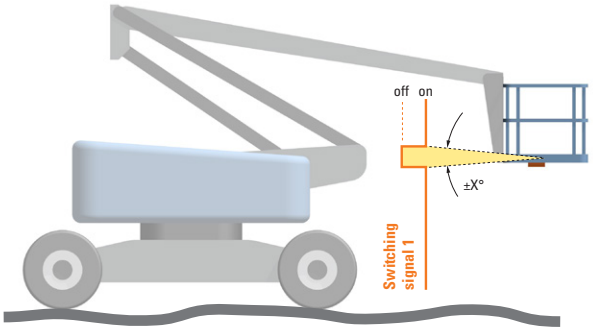


Two different switching ranges



2-axis measurement – **individual setting** (examples)

Switching range X-axis



Switching range Y-axis