

# Inclinometers

<b>For dynamic applications 1- and 2-axis measurement</b>	<b>IN78</b>	<b>IO-Link</b>
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The inclinometers of the IN78 series are used to determine 2-axis inclinations in the measuring range of  $\pm 85^\circ$  or 1-axis inclinations up to  $360^\circ$  via a sensor fusion of acceleration and rotation rate measuring cell (gyroscope). Various parameters can be customized for individual requirements (e.g. via the PACTware software). Thanks to their high robustness, the inclinometers are also ideally suited for outdoor use.



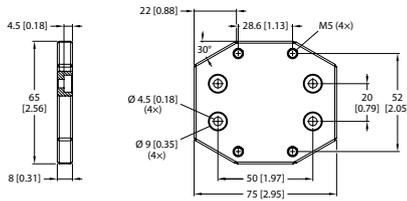
## Features and benefits

- **IO-Link interface**  
For easy integration into Industry 4.0 / IIoT networks.
- **Individual setting options via IO-Link Master**
  - Reset to factory setting
  - Center of the measurement as well as start and end point for 1-axis measurement
  - Switching the spirit level function on/off
  - Settings on the measuring range
  - Filter settings
- **Fast measurement result and high accuracy**  
Thanks to sensor fusion of acceleration and rotation rate measuring cell (gyroscope). This also minimizes the effects of vibrations and interfering accelerations.
- **Simple start-up and diagnostics**  
LED display for operating status and FDT/IODD communication as well as for setting the center point position (spirit level function).
- **Precise measurement even under harsh environmental conditions**
  - Temperature range  $-40^\circ\text{C} \dots +85^\circ\text{C}$  and protection level IP68 / IP69k
  - Protection against the influence of salt spray and rapid temperature changes

<b>Order code</b>	<b>8.IN78.1741.114</b>
<b>1-axis</b>	Type    a    b
<p><b>a</b> Measuring range 7 = <math>0^\circ \dots 360^\circ (\pm 180^\circ)</math></p> <p><b>b</b> Interface 4 = IO-Link</p> <p>Stock types 8.IN78.1741.114</p>	

<b>Order code</b>	<b>8.IN78.2641.114</b>
<b>2-axis</b>	Type    a    b
<p><b>a</b> Measuring range 6 = <math>\pm 85^\circ</math></p> <p><b>b</b> Interface 4 = IO-Link</p> <p>Stock types 8.IN78.2641.114</p>	

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<b>Accessories</b>			Order no.
<b>IO-Link Master USB</b> 	For parameterizing device settings via FDT/IODD communication. USB interface for easy connection to a PC and for power supply. Adapter cable suitable for IN68: 05.00.6061.6462.002M (see below)		<b>IOL1A. 1K1341.ZZ1UU1</b>
<b>Adapter plate</b> 	For using existing mounting holes when replacing with an IS40 inclinometer		<b>8.0010.4066.0000</b>
<b>EMC shield terminal</b> 	For an EMC-compliant installation of the cable - top-hat rail mounting - spring steel, galvanized - shield diameter 3.0 ... 12.0 mm		<b>8.0000.4G06.0312</b>
<b>Cables and connectors</b>			Order no.
<b>Preassembled cables</b>	M12 female connector with coupling nut, 4-pin, A coded, straight single ended 2 m [6.56'] PUR cable		<b>05.00.6061.6211.002M</b>
	M12 female connector with coupling nut, 4-pin, A coded, straight M12 male connector with external thread, 4-pin, A coded, straight 2 m [6.56'] PUR cable		<b>05.00.6061.6462.002M</b>
<b>Connectors</b>	M12 female connector with coupling nut, 4-pin, A coded, straight (plastic)		<b>05.B8141-0</b>

Further Kübler accessories can be found at: [kuebler.com/accessories](http://kuebler.com/accessories)

Further Kübler cables and connectors can be found at: [kuebler.com/connection-technology](http://kuebler.com/connection-technology)

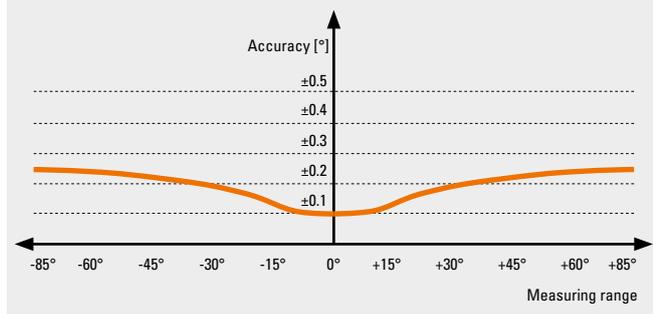
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## Technical data

General data 1-axis measurement	
<b>Measuring range</b>	0 ... 360°
<b>Resolution</b>	0.01°
<b>Repeat accuracy</b>	≤ 0.1°
<b>Temperature drift</b>	≤ ±0.02 %/K
<b>Linearity deviation</b>	≤ ±0.15%
<b>Accuracy (at 25°C)</b>	≤ ±0.54°

General data 2-axis measurement	
<b>Measuring range (max.)</b>	-85 ... +85°
<b>Resolution</b>	0.01°
<b>Repeat accuracy</b>	≤ 0.1°
<b>Temperature drift</b>	≤ ±0.02 %/K
<b>Linearity deviation</b>	≤ ±0.15%
<b>Accuracy (at 25°C)</b>	≤ ±0.1° depending on the measuring range



Mechanical characteristics	
<b>Electrical connection</b>	M12 connectors, 4-pin
<b>Weight</b>	89 g [3.14 oz]
<b>Protection acc. to EN 60529</b>	IP68 / IP69k
<b>Working temperature range</b>	-40 °C ... +85 °C [-40 °F ... +185 °F]
<b>Material</b>	housing Plastic, polyetherimide
<b>Vibration resistance (EN 60068-2-6)</b>	20 g; 5 h/axis; 3 axes
<b>Shock resistance (EN 60068-2-27)</b>	150 g; 4 ms 1/2 sine
<b>MTTF</b>	548 years
<b>Dimensions</b>	71.6 x 62.6 x 20 mm [2.82 x 2.46 x 0.79"]

Electrical characteristics	
<b>Supply voltage</b>	18 ... 30 V DC
<b>Residual ripple</b>	≤ 10 % U <sub>ss</sub>
<b>Isolation test voltage</b>	≤ 0.5 kV
<b>Wire breakage / Reverse polarity protection</b>	yes
<b>Current consumption</b>	max. 50 mA

Interface characteristics IO-Link	
<b>Communication mode</b>	COM 3 (230.4 kBaud)
<b>Minimum cycle time</b>	1.3 ms
<b>Function pin 4</b>	IO-Link

Approvals	
<b>UL compliant</b> in accordance with	File-Nr. E539414
<b>CE compliant</b> in accordance with	
EMV Directive	2014/30/EU
RoHS Directive	2011/65/EU

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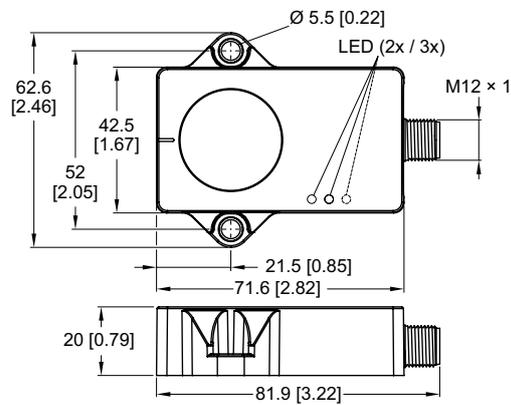
## Terminal assignment

Interface	M12 connector, male contacts, 4-pin, A-coded					
4 IO-Link	Signal 1-axis:	+V	n.c.	0 V	IOL	
	Pin:	1	2	3	4	

- +V : Supply voltage +V DC
- 0 V : Supply voltage ground GND (0 V)
- IOL : IO-Link input

## Dimensions

Dimensions in mm [inch]



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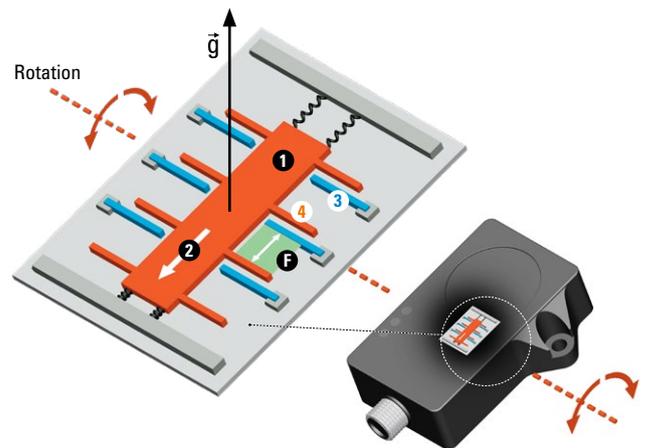
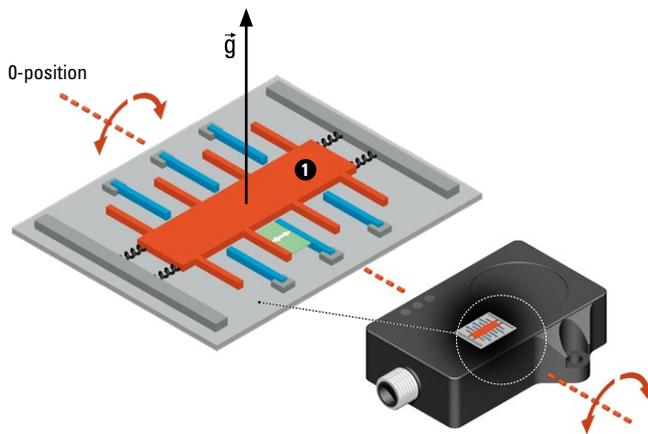
## Technology in detail

### Fast measurement results and maximum accuracy thanks to sensor fusion of acceleration and rotation rate 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.



#### Rotation rate measurement

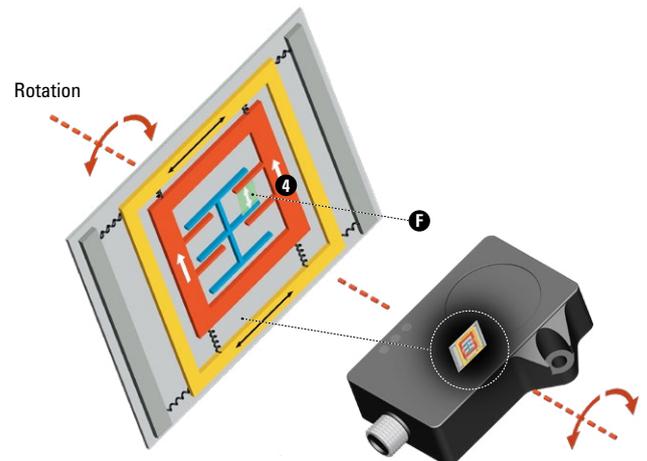
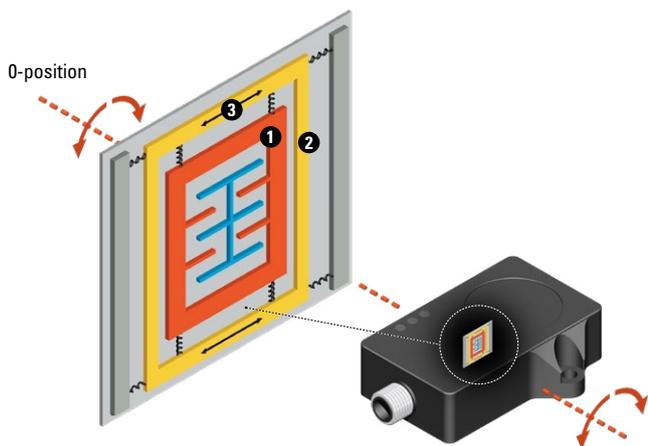
In the rotation rate measuring cell (gyroscope), the Coriolis force resulting from a rotation is evaluated in order to determine the angle of rotation in relation to the starting position.

This displacement is also determined by the change in capacity **F** between fixed and moving electrodes and is directly related to the rotational speed (rotation rate).

An arrangement of frame **2** and test mass **1** is in a permanent linear movement **3** (oscillating).

The angle of rotation is determined from the speed of rotation and the duration of rotation.

If this system is brought into rotation, this results in a force (Coriolis force) **4** that leads to a displacement of the test mass.



#### Intelligent sensor fusion of acceleration and rotation rate measurement

Both measured values are combined in the inclinometers for dynamic applications. The effect is even faster and more accurate output results.



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**For dynamic applications**  
1- and 2-axis measurement

IN78

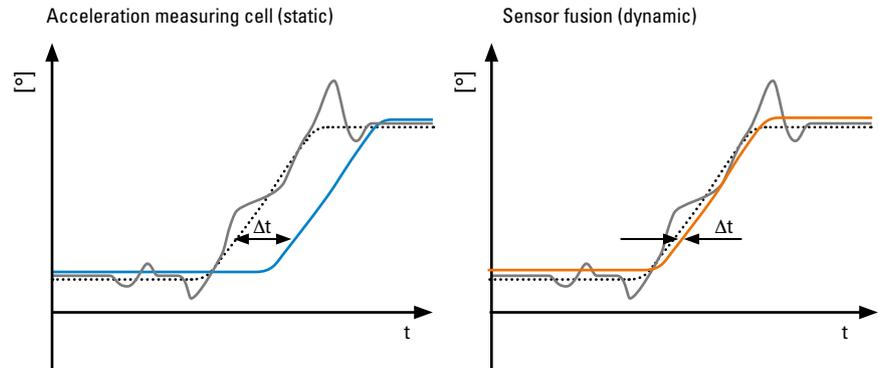
IO-Link

## Technology in detail

### Comparison static inclinometer (accelerometer only) - dynamic inclinometer (sensor fusion)

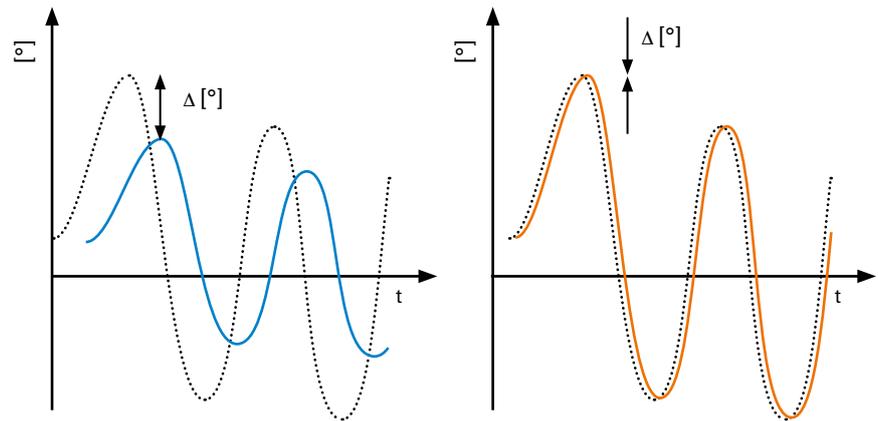
#### Fast measurement

Inaccuracies due to the inertia of the test mass can be compensated for in acceleration measurement via filters. However, there is a time delay  $\Delta t$  for the output of the measurement result. This time delay is minimized with sensor fusion.



#### Accurate measurement

The sensor fusion leads to more accurate measurement results when changing direction quickly.



- ..... Actual movement
- Detected data of the acceleration measurement
- Filtered measurement results of the acceleration measurement
- Result sensor fusion of acceleration and rotation rate measurement

### Easy start-up

#### Operating status – LED green

Permanent light	Appliance ready for operation
Blinking	FDT/IODD communication



#### Spirit level function – LED(s) yellow

Permanent light	Center position reached
Blinking with increasing frequency	Approaching the center position
Blinking with decreasing frequency	Move away from center position

1-axis = 2 LEDs



2-axis = 3 LEDs



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## Technology in detail

**Individual setting options via FDT/IODD with IO-Link Master USB**

**Connection**

The inclinometer **1** is or will be disconnected from the application **3**. The IO-Link Master USB **2** is connected to the inclinometer with the adapter cable **4** and connected to the PC via the USB interface **5**. The following parameters can be set using the appropriate software **6** (e.g. PACTware):

Spirit level function	Can be activated as an assembly aid
Center point	Set current inclination as new measuring range center point
Direction of rotation	Setting the direction of rotation of the axes. Output of the increasing analog values clockwise or counterclockwise.
Configuring process data	The process data is structured in accordance with the IO-Link Smart Sensor Profile. For 1-axis measurement, the angle value is transmitted twice (inverted once). Angle information can be transmitted with a sign (1 bit - sign / 15 bit - angle information) or without a sign (16 bit) with an accuracy of 0.01°.
Filters	Balanced / Very slow / Slow Fast / Very fast (factory setting)