For dynamic applications
1- and 2-axis measurement | **IN78** | **IO-Link**

The inclinometers of the IN78 series are used to determine 2-axis inclinations in the measuring range of ±85° or 1-axis inclinations up to 360° 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
  - Filtereinstellungen
- **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 °C ... +85 °C and protection level IP68 / IP69k
  - Protection against the influence of salt spray and rapid temperature changes

Order code 1-axis

Type	8.IN78	.	1	7 (a)	4 (b)	1	.		114

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

(b) *Interface*
4 = IO-Link

Order code 2-axis

Type	8.IN78	.	2	6 (a)	4 (b)	1	.		114

(a) *Measuring range*
6 = ± 85°

(b) *Interface*
4 = IO-Link

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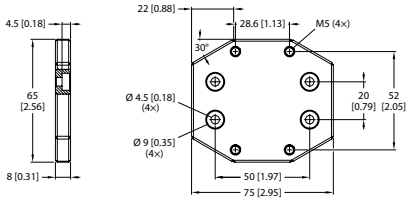
Accessories		Order no.
IO-Link Master USB 	For parameterizing device settings via FDT/IODD communication. USB interface for easy connection to a PC and for power supply. Adapter cable suitable for IN68: 05.00.6061.6462.002M (see below)	**8.IO.1K1341.ZZ1UU1**
Adapter plate	For using existing mounting holes when replacing with an IS40 inclinometer 	**8.0010.4066.0000**
EMC shield terminal 	For an EMC-compliant installation of the cable - top-hat rail mounting - spring steel, galvanized - shield diameter 3.0 ... 12.0 mm	**8.0000.4G06.0312**

Cables and connectors		Order no.
Preassembled cables	M12 female connector with coupling nut, 4-pin, A coded, straight single ended 2 m [6.56'] PUR cable	**05.00.6061.6211.002M**
	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	**05.00.6061.6462.002M**
Connectors	M12 female connector with coupling nut, 4-pin, A coded, straight (plastic)	**05.B8141-0**

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

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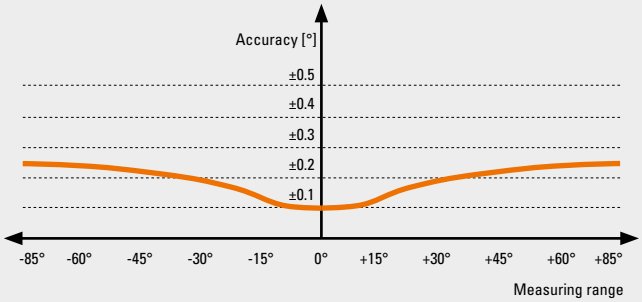
Technical data

General data 1-axis measurement

Measuring range	0 ... 360°
Resolution	0.01°
Repeat accuracy	≤0.1°
Temperature drift	≤ ±0.02 %/K
Linearity deviation	≤ ±0.15%
Accuracy (at 25°C)	≤ ±0.54°

General data 2-axis measurement

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



Mechanical characteristics

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

Electrical characteristics

Supply voltage	18 ... 30 V DC
Residual ripple	≤ 10 % Uss
Isolation test voltage	≤ 0.5 kV
Wire breakage / Reverse polarity protection	yes
Current consumption	max. 50 mA

Interface characteristics IO-Link

Communication mode	COM 3 (230.4 kBaud)
Minimum cycle time	1.3 ms
Function pin 4	IO-Link

Approvals

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

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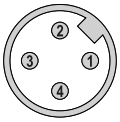
Terminal assignment

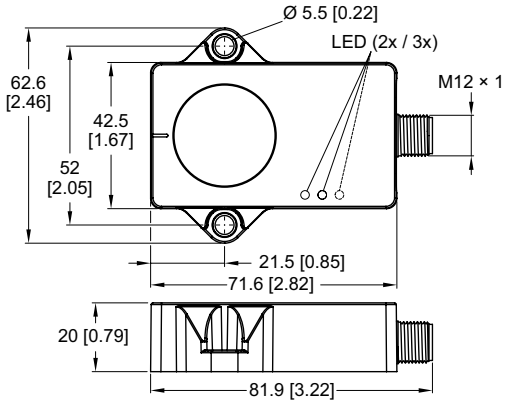
Interface	M12 connector, male contacts, 4-pin, A-coded				
4 IO-Link	Signal 1-axis:	+V	n.c.	0 V	IOL
	Pin:	1	2	3	4



+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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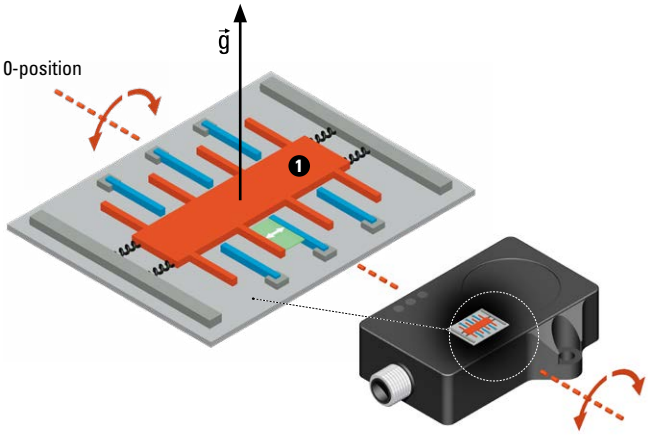
Technology in detail

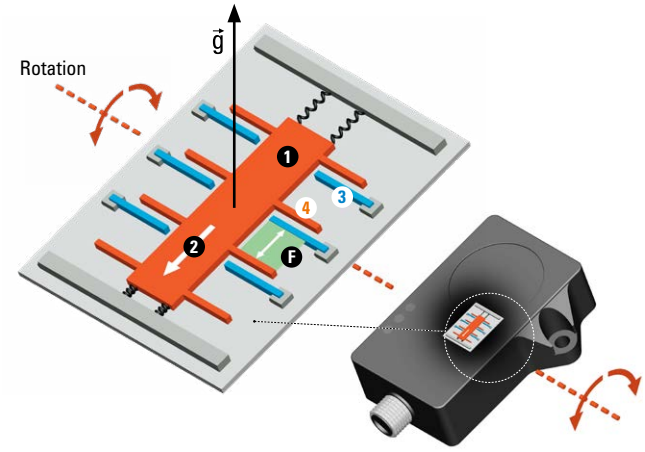
Fast measurement results and maximum accuracy thanks to sensor fusion of acceleration and rotation rate measurement

Acceleration measurement

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

The displacement 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.

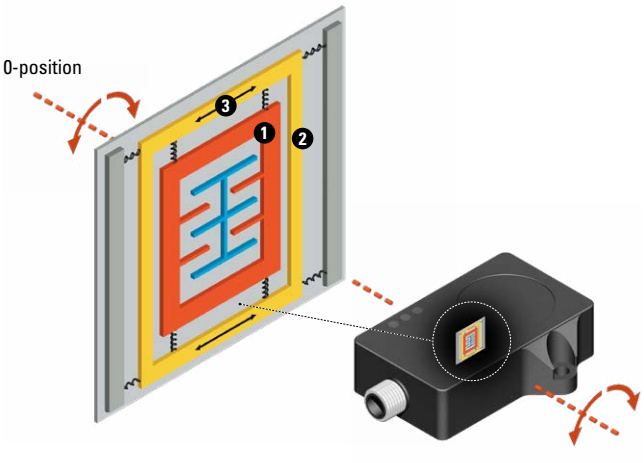


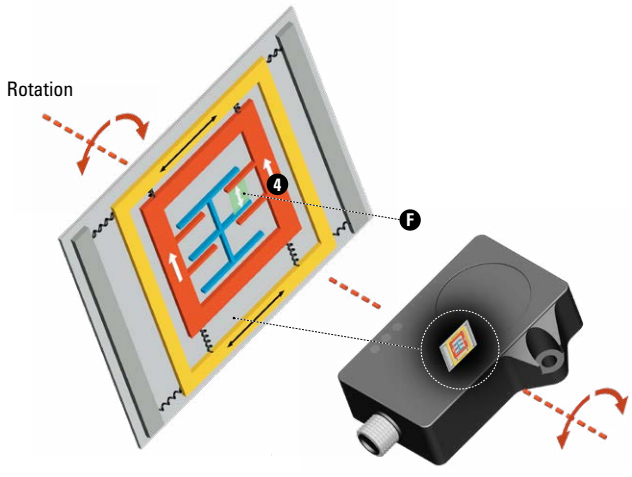


Rotation rate measurement

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.
An arrangement of frame ❷ and test mass ❶ is in a permanent linear movement ❸ (oscillating).
If this system is brought into rotation, this results in a force (Coriolis force) ❹ that leads to a displacement of the test mass.

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





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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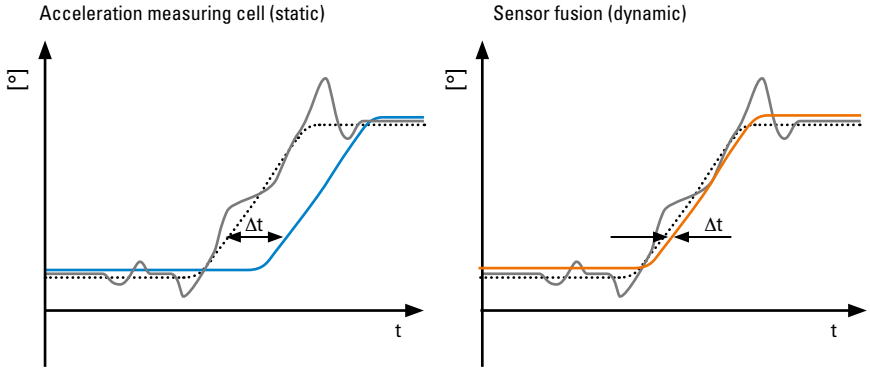
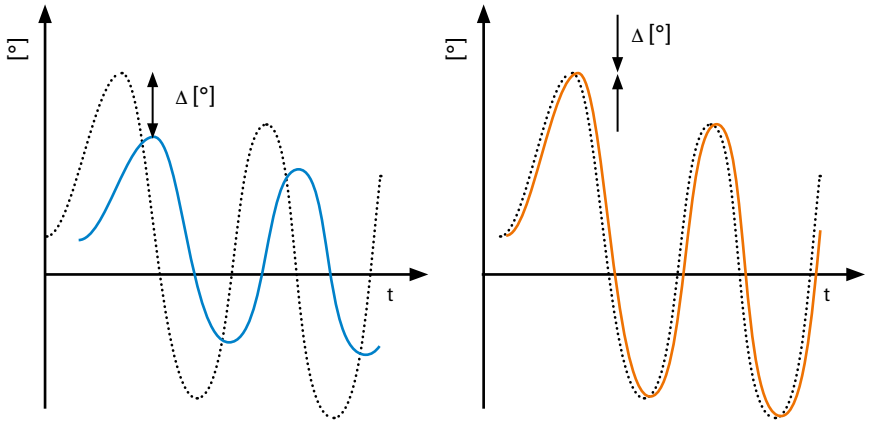
Technology in detail

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 Δt 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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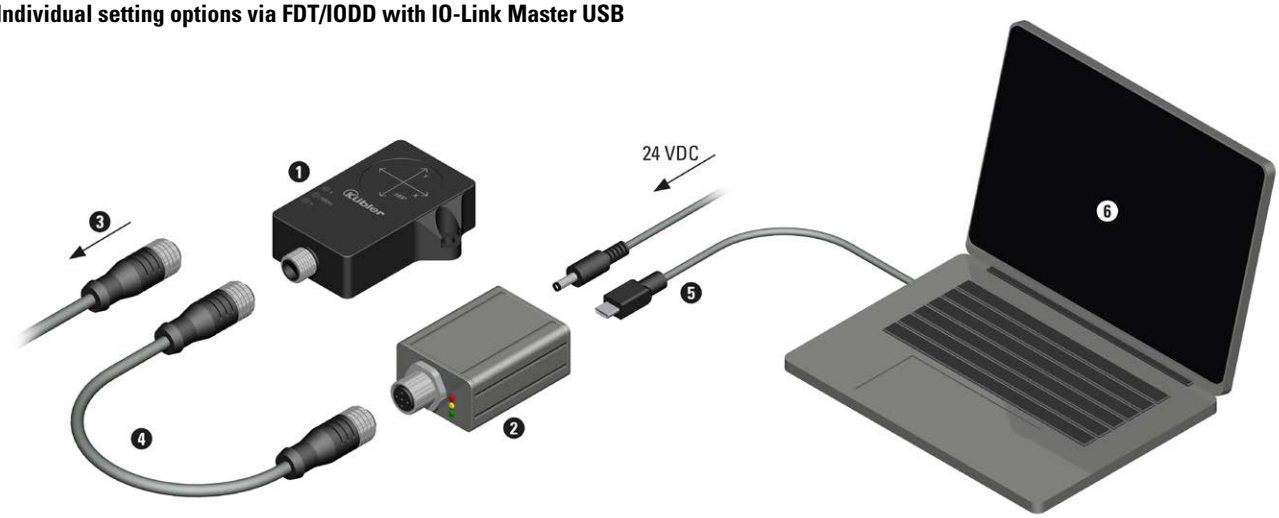
Technology in detail

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



Connection

The inclinometer ❶ is or will be disconnected from the application ❸.
The IO-Link Master USB ❷ is connected to the inclinometer with the adapter cable ❹ and connected to the PC via the USB interface ❺.
The following parameters can be set using the appropriate software ❻ (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)