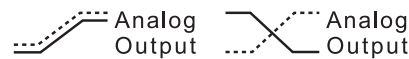


# Inclinometers

|   |             |               |
|---|-------------|---------------|
| <b>For dynamic applications<br/>1- and 2-axis measurement</b> | <b>IN71</b> | <b>Analog</b> |
|---|-------------|---------------|



The inclinometers of the IN71 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

- **Analog sensor with integrated IO-Link communication**
  - Configurable interfaces
  - Parameterization via IO-Link
  - Redundant / counter-rotating signals possible (1-axis)
- **“Easy-Teach” settings via Teach Adapter**
  - Reset to factory setting
  - Center of the measurement as well as start and end point for 1-axis measurement
- **Individual setting options via IO-Link Master**

In addition to the „Easy-Teach“ functions:

  - Switching the spirit level function on/off
  - Settings on the measuring range
  - Type of output signals
  - 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.IN71.17X1.112</b> |
| <b>1-axis</b>     | Type    a    b         |

**a** Measuring range  
7 =  $0^\circ \dots 360^\circ (\pm 180^\circ)$




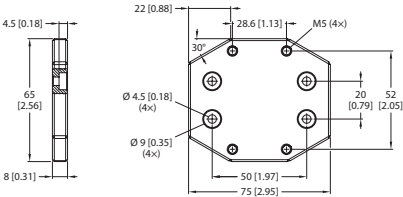
**b** Analog interface  
(as factory setting)  
1 = 4 ... 20 mA  
5 = 0 ... 10 V

|                   |                        |
|-------------------|------------------------|
| <b>Order code</b> | <b>8.IN71.2XX1.112</b> |
| <b>2-axis</b>     | Type    a    b         |

**a** Measuring range  
1 =  $\pm 10^\circ$   
2 =  $\pm 15^\circ$   
A =  $\pm 20^\circ$   
3 =  $\pm 30^\circ$   
4 =  $\pm 45^\circ$   
5 =  $\pm 60^\circ$   
6 =  $\pm 85^\circ$

**b** Analog interface  
(as factory setting)  
1 = 4 ... 20 mA  
5 = 0 ... 10 V

# Inclinometers

| For dynamic applications<br>1- and 2-axis measurement  |   | IN71 | Analog   |
|--|---|------|--|
| <b>Accessories</b>   |   |      | Order no.  |
| <b>Teach adapter</b><br>      | for activating the control inputs for the following functions:<br>- Reset to factory setting<br>- Center point of the measurement<br>- Start and end point for 1-axis measurement   |      | <b>05.TX40.1</b>                                       |
| <b>IO-Link Master USB</b><br> | For parameterizing device settings via FDT/IODD communication.<br>USB interface for easy connection to a PC and for power supply. <b>Can only be used for IN71 in conjunction with adapter cable 05.00.60H1.H4H2.01M5.S004.</b> |      | <b>8.IO.1K1341.ZZ1UU1</b>                              |
| <b>Adapter-Kabel</b><br>     | For connecting the sensor to the IO-Link Master USB.  |      | <b>05.00.60H1.H4H2.01M5.S004</b>                       |
| <b>Adapter plate</b><br>    | For using existing mounting holes when replacing with an IS40 inclinometer  |      | <b>8.0010.4066.0000</b>                                |
| <b>Cables and connectors</b>   |   |      | Order no.  |
| <b>Preassembled cables</b>   | M12 female connector with coupling nut, 5-pin, A coded, straight single ended<br>2 m [6.56'] PVC cable  |      | <b>05.00.6021.E211.002M</b>                            |
| <b>Connectors</b>  | M12 female connector with coupling nut, 5-pin, A coded, straight (metal)<br>M12 female connector with coupling nut, 5-pin, A coded, straight (stainless steel V4A)  |      | <b>8.0000.5116.0000</b><br><b>8.0000.5116.0000.V4A</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)

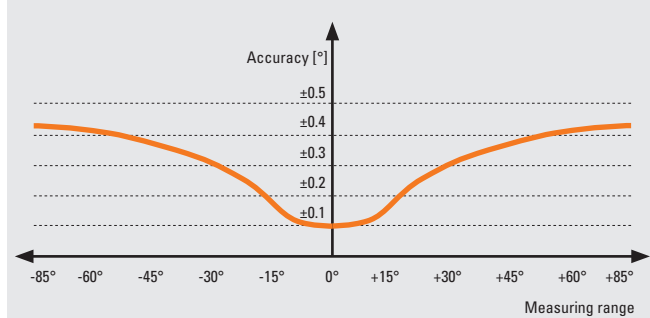
# Inclinometers

|   |             |               |
|---|-------------|---------------|
| <b>For dynamic applications<br/>1- and 2-axis measurement</b> | <b>IN71</b> | <b>Analog</b> |
|---|-------------|---------------|

## Technical data

| General data 1-axis measurement |                |
|---------------------------------|----------------|
| <b>Measuring range</b>          | 0 ... 360°     |
| <b>Resolution</b>               | 16 bit         |
| <b>Repeat accuracy</b>          | ≤ 0.03 % v. E. |
| <b>Temperature drift</b>        | ≤ ± 0.006 %/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>               | 16 bit                                       |
| <b>Repeat accuracy</b>          | ≤ 0.06 % v. E.                               |
| <b>Temperature drift</b>        | ≤ ± 0.012 %/K                                |
| <b>Linearity deviation</b>      | ≤ ± 0.25%                                    |
| <b>Accuracy (at 25°C)</b>       | ≤ ± 0.1°<br>depending on the measuring range |



| Specifications for preset measuring ranges (see order code <b>a</b> ) |                 |                   |                     |           |
|---|-----------------|-------------------|---------------------|-----------|
| Measuring range   | Repeat accuracy | Temperature drift | Linearity deviation | Accuracy  |
| ±10°  | ≤ 0.50 % v. E.  | ≤ ± 0.1 %/K       | ≤ ± 0.5 %           | ≤ ± 0.10° |
| ±15°  | ≤ 0.65 % v. E.  | ≤ ± 0.07 %/K      | ≤ ± 0.5 %           | ≤ ± 0.15° |
| ±20°  | ≤ 0.50 % v. E.  | ≤ ± 0.05 %/K      | ≤ ± 0.5 %           | ≤ ± 0.20° |
| ±30°  | ≤ 0.35 % v. E.  | ≤ ± 0.04 %/K      | ≤ ± 0.45 %          | ≤ ± 0.27° |
| ±45°  | ≤ 0.12 % v. E.  | ≤ ± 0.025 %/K     | ≤ ± 0.4 %           | ≤ ± 0.36° |
| ±60°  | ≤ 0.085 % v. E. | ≤ ± 0.020 %/K     | ≤ ± 0.3 %           | ≤ ± 0.36° |
| ±85°  | ≤ 0.060 % v. E. | ≤ ± 0.012 %/K     | ≤ ± 0.25 %          | ≤ ± 0.43° |

| Mechanical characteristics                 |   |
|--|---|
| <b>Electrical connection</b>               | M12 connectors, 5-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>                                | 297 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>                              | 15 ... 30 V DC         |
| <b>Residual ripple</b>                             | ≤ 10 % U <sub>ss</sub> |
| <b>Isolation test voltage</b>                      | ≤ 0.5 kV               |
| <b>Short-circuit protection</b>                    | yes                    |
| <b>Wire breakage / Reverse polarity protection</b> | yes                    |
| <b>Current consumption</b>                         | max. 80 mA             |

| Interface characteristics analog output |  |
|---|--|
| <b>Current/voltage output</b>           | factory setting 4 ... 20 mA or 0 ... 10 V<br>adjustable 0 ... 20 mA<br>0.1 ... 4.9 V / 0.5 ... 4.5 V / 0 ... 5 V |
| <b>Load resistance voltage output</b>   | ≥ 4.7 kΩ   |
| <b>Load resistance current output</b>   | ≤ 0.4 kΩ   |

| 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       |

# Inclinometers

|   |             |               |
|---|-------------|---------------|
| <b>For dynamic applications<br/>1- and 2-axis measurement</b> | <b>IN71</b> | <b>Analog</b> |
|---|-------------|---------------|

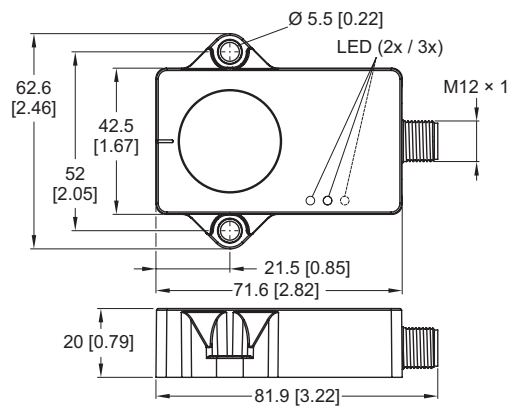
## Terminal assignment

|           |  |    |                    |     |                   |           |  |
|-----------|--|----|--------------------|-----|-------------------|-----------|--|
| Interface | M12 connector, male contacts, 5-pin, A-coded |    |                    |     |                   |           |  |
| Analog    | Signal 1-axis:                               | +V | Out <sub>ccw</sub> | 0 V | Out <sub>cw</sub> | Teach/IOL |  |
|           | Signal 2-axis:                               | +V | Out y              | 0 V | Out x             | Teach/IOL |  |
|           | Pin:   | 1  | 2                  | 3   | 4                 | 5         |  |

- +V : Supply voltage +V DC
- 0 V : Supply voltage ground GND (0 V)
- Out x / Out y : Current/voltage output for 2-axis measurement
- Out<sub>ccw</sub> / Out<sub>cw</sub> : Redundant current/voltage output for 1-axis measurement
- Teach/IOL : Teach input/ IO-Link Master USB input

## Dimensions

Dimensions in mm [inch]



# Inclinometers

|   |             |               |
|---|-------------|---------------|
| <b>For dynamic applications<br/>1- and 2-axis measurement</b> | <b>IN71</b> | <b>Analog</b> |
|---|-------------|---------------|

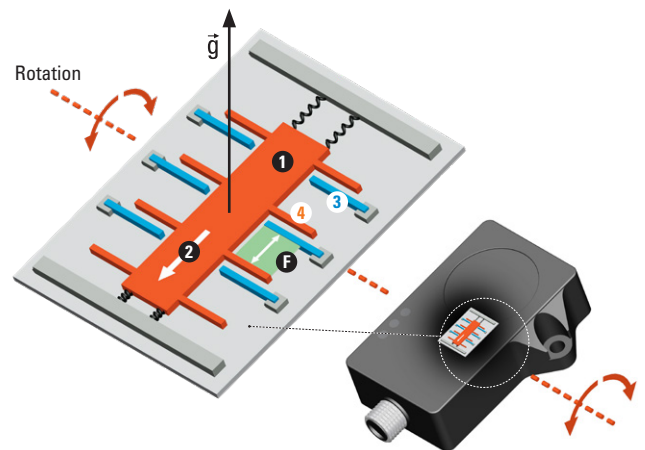
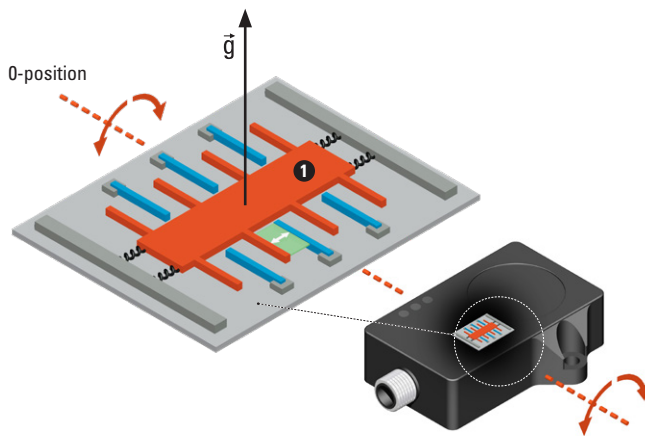
## Technology in detail

### 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

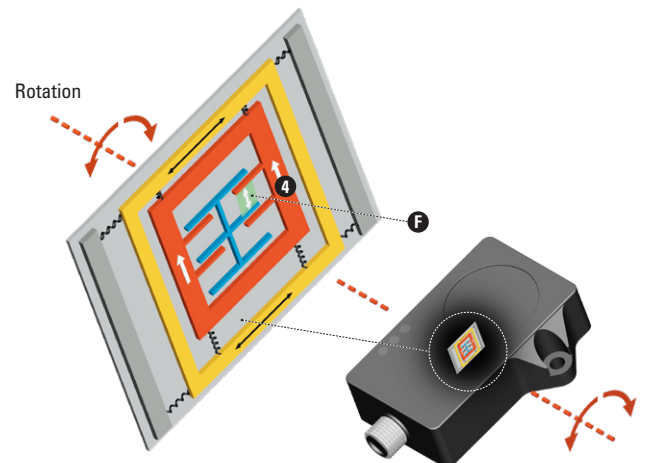
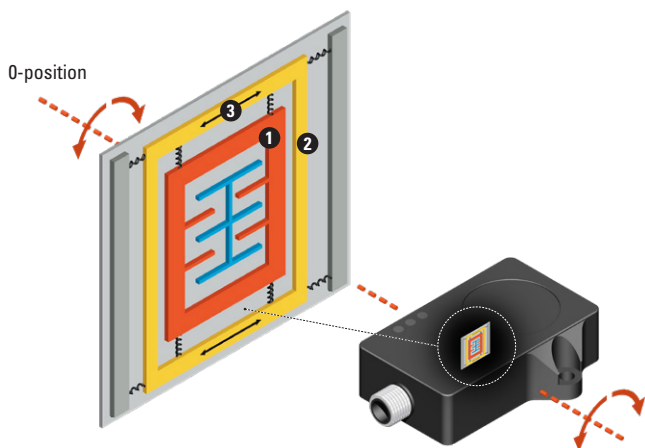
In the rotation rate measuring cell (gyroscope), the Coriolis force resulting from a rotation is evaluated in order to determine the angle of rotation in relation to the starting position.

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.



# Inclinometers

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

IN71

Analog

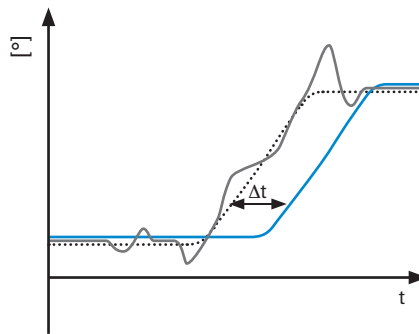
## Technology in detail

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

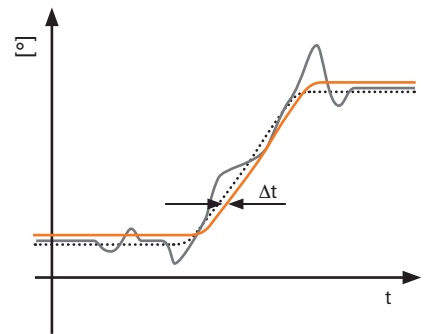
#### Fast measurement

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.

Acceleration measuring cell (static)

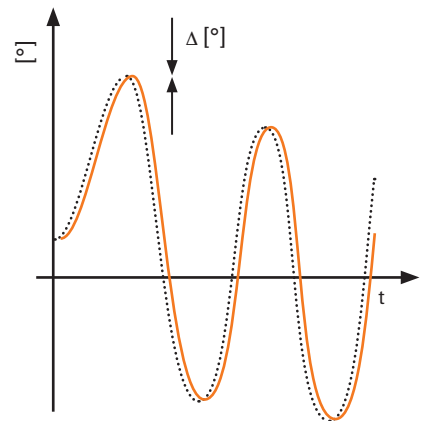
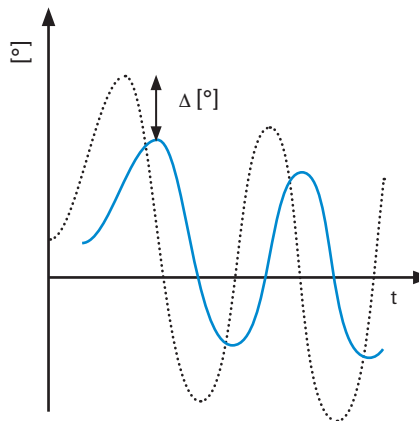


Sensor fusion (dynamic)



#### 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



# Inclinometers

|   |             |               |
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|---|-------------|---------------|

## Technology in detail

**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 switch **3** :

- Start/end point of the measuring range (for 1-axis measurement)
- Midpoint of the measuring range
- Reset to factory setting

**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):

| Setting options            |  |
|----------------------------|--|
| Spirit level function      | Can be activated as an assembly aid  |
| Easy Teach                 | Parameterization via Easy Teach can be deactivated   |
| Direction of rotation      | Setting the direction of rotation of the axes. Output of the increasing analog values clockwise or counterclockwise.   |
| Analog output              | Possible analog outputs independent of the factory setting:<br>Current outputs: 0 ... 20 mA<br>4 ... 20 mA<br>Voltage outputs: 0.1 ... 4.9 V<br>0.5 ... 4.5 V<br>0 ... 5 V<br>0 ... 10 V               |
| Starting point / End point | The start/end point of the output characteristic curve can be defined by entering the angle or the current tilt angle; for 2-axis devices, a different measuring range can be set using this function. |
| Filters                    | Balanced / Very slow / Slow<br>Fast / Very fast (factory setting)  |