



- Certified PROFINET interface
- Number of measurement axes: 1 or 2
- Selectable measuring range:  $\pm 5^\circ$  to  $\pm 90^\circ$
- With preset function
- Housing: aluminium or stainless steel
- Protection type: up to IP69K
- Option: Filter measures for masking interference vibrations and interference shocks



## KEY INFORMATION OVERVIEW

### DESIGN & FUNCTION

Measurement of inclination in the gravitational field by means of MEMS sensors (Micro-Electro-Mechanical-System) with subsequent digitisation and linearisation via controllers.

The inclinometer (model NBT 65) has a stable aluminium housing (optionally stainless steel) and is highly-resistant to vibration and shock. Casting measures in the housing lead to the achievement of protection class IP 69K.

MEMS sensors are integrated circuits manufactured using silicon bulk micromechanical technology. Double capacities are formed with moveable micromechanical structures. If these structures are bend due to acceleration, e.g. through gravitational forces, this results in capacity changes, which can be electronically measured and processed. MEMS sensors are precise, have a long service life and are very robust. The measuring axes operate independently of each other.

### FEATURES INTERFACE

The Profinet interface according to IEC 61158 / 61784 or PNO specifications order No. 2.712 and 2.722, version 2.3, is integrated into the inclinometer series NBT.

Real time classes 1 and 3 are supported, i.e. Real Time (RT) and Isochronous Real Time (IRT) plus the requirements of conformance class C. The integrated 2-fold switch enables the TWK PROFINET inclinometer to be used in star, tree and line network topologies.

An exhaustive description of integration into a PROFINET network can be found in the manual [NBT14636](#).

- Real Time (RT) and Isochronous Real Time (IRT)
- Device exchange without interchangeable medium or programming device
- Prioritised start-up (Fast Start Up)
- Media redundancy possible
- Firmware update via Profinet

## GENERAL INFORMATION

### BEHAVIOUR IN THE EVENT OF A MEASURED VALUE CHANGE DUE TO AVERAGING

Dynamic, arithmetic averaging of the measured values is implemented in the inclinometer. This involves linear averaging over 1000 values, whereby a new value is recorded every millisecond. This results in a low-pass effect. In the event of an abrupt change in the measuring angle, the end value is reached after approx. 1 second. In the event of a linear change in the measuring angle, the relevant output signal follows after a delay of approx. 0.6 seconds. Other, e.g. shorter, values may be set depending on application conditions. However, the output signal then tends to have a higher noise factor.

### BEHAVIOUR IN THE CASE OF LATERAL INCLINATION

The following must be noted for single-axis devices: If the inclination sensor is inclined in two axes simultaneously, the measuring axis is switched off if the sensor is inclined in another axis by more than 15° (transverse inclination). Switching off means that the output value of the measuring axis assumes the overflow value (+180°). The bit "Out\_of\_range" is set in the status word. This switch-off is necessary because the measuring accuracy decreases with increasing cross slope.

### BEHAVIOUR IN THE CASE OF INTERFERENCE ACCELERATIONS (SHOCKS AND VIBRATIONS)

In certain applications, in normal operating conditions, the following disturbances can occur: acceleration due to jolts, blows, etc. or any subsequent oscillation processes resulting from it. These disturbances are limited in time and can lead to excess of the measuring range of the internal MEMS sensor (2,2 g). In the event of such disturbances, the position output value is set to -180° and in the status word the bit "Position\_not\_valid" is set. This tells the control that due to shock and vibration interferences a reliable inclination measurement is currently not possible.

As soon as there is no further interference acceleration due to shock and vibrations, regular inclination data are output again, and not -180°.

Depending on the current measuring range, interferences with an amplitude of less than 2.2 g are interpreted by the NBT as a measuring range overshoot (the MEMS sensor is an acceleration sensor). In this case, the overflow value of +180° and the bit "Out\_of\_range" are output.

## TECHNICAL DATA

### ELECTRICAL DATA

Sensor system	MEMS acceleration sensor
Operating voltage	9 to 36 VDC
No. measuring axes	1 or 2
Measuring range	± 5° to ± 90° (selectable for example ± 5°, ± 10° .... ± 85°, ± 90°)
Resolution	0.01°
Power consumption	< 3 W
Current	approx. 90 mA (at 24V)
Absolute accuracies	< ± 0.5° (see below)
Repeatability	± 0.05°
Noise	± 0.05°
Zero error	± 0.5°
Signal path	ascending values with CCW
Reaction time	1 s (for 100 % of the current end value)

### MEASURING ACCURACY: DEVICE WITH 1 OR 2 AXES, ± 20° MEASURING ANGLE

Accuracy	± 0.25° (cross tilt ± 5°), otherwise ± 0.5°
Drift	± 0.3°; range [-10 °C to +60 °C] ± 0.5°; range [-40 °C to +85 °C]

### MEASURING ACCURACY: DEVICE WITH 1 AXIS, ± 90° MEASURING ANGLE

Accuracy	± 0.5° (cross tilt ± 3°) ± 0.25° within 20° (cross tilt ± 3°)
Drift	± 0.3°; range [-10 °C to +60 °C] for ± 60° ± 0.4°; range [-40 °C to +65 °C] for ± 90° ± 0.5°; range [-40 °C to +85 °C] for ± 60° ± 0.6°; range [-40 °C to +85 °C] for ± 90°

## TECHNICAL DATA

### INPUT DATA \*

2 byte status word  
3x2 byte position data

### OUTPUT DATA \*

2 byte control word  
2 byte preset word

### PROFINET DATA

MAC address . . . . . 00:0E:CF:XX:XX:XX  
The relevant, current MAC address is located on the model plate.  
Transfer technology . . . . . 100 Base-TX  
Transfer rate . . . . . 10 / 100 MBit/s  
Line length . . . . . Max. 100 m (between two subscribers)  
Minimum transmission cycle . . . . . 250 µs

### DIAGNOSIS LEDS

LED 1 (VS, green) . . . . . Operating voltage available  
LED 2 (L1, green) . . . . . Link 1: Network connection established  
LED 3 (L2, green) . . . . . Link 2: Network connection established  
LED 4 (NS, green/red) . . . . . Device Status & error modes

### ENVIRONMENTAL DATA

Temperature range . . . . . - 40 °C ... + 85 °C  
Storage temp. range . . . . . - 20 °C ... + 60 °C (due to packaging)  
Resilience . . . . . To shock: . . . . . 200 m/s²; 11 ms, DIN EN 60068-2-27  
To vibration: . . . . . 100 m/s²; 10 ... 2000 Hz, DIN EN 60068-2-6  
Protection grade . . . . . IP 66 / IP 67  
IP 69K (option), IP 68 with cable outlet  
EMC standards . . . . . EN 61000-4-2 (ESD)  
EN 61000-4-4 (Burst)  
EN 61000-6-3(4) (Emission) (shielded cables must be used for power supply and PROFINET)  
Salt mist test . . . . . Test Kb according to IEC 60068-2-52  
Weight . . . . . Approx. 0.3 kg (aluminium), Approx. 0.65 kg (stainless steel)

### PROGRAMMABLE PARAMETERS (REFER TO HANDBOOK NBT14636 FOR DETAILS)

Scaling . . . . . Switches parameterisation on / off  
Preset . . . . . Sets the output value of x, y, or z  
Firmware download . . . . . Sets NBT in the state „firmware download mode“

\* From the perspective of the control system

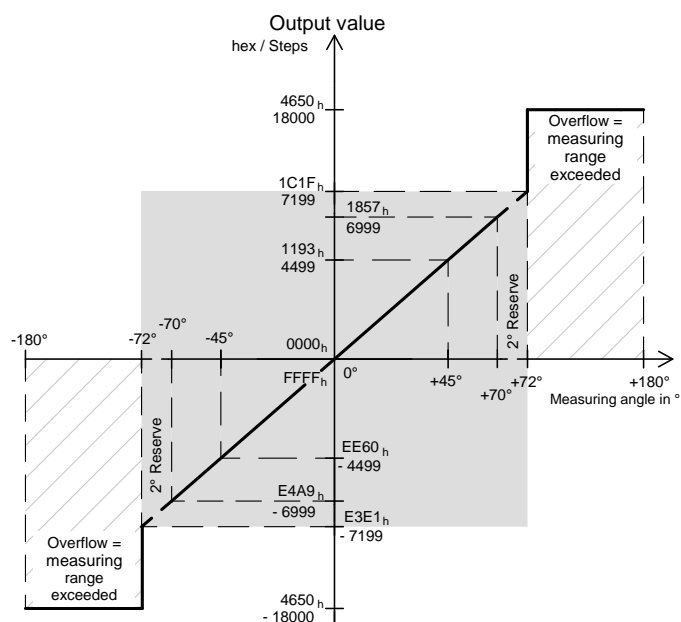
## PRODUCT CHARACTERISTICS

### CHARACTERISTIC CURVE (EXAMPLE)

Example .....  $\pm 70^\circ \triangleq 2 \times 7000$  steps with resolution  $0.01^\circ$

Data format ..... Signed 16-bit.

When exceeding the selected range (eg  $\pm 70^\circ$ ), plus about  $2^\circ$  the output value is set to  $4650_{\text{hex}}$  ( $= 18,000_{\text{dez}} = 180^\circ$ ) in order to signal the controller that the inclinometer is tilted out of the selected scale.



## PRODUCT CHARACTERISTICS

### INSTALLATION POSITIONS AND MEASUREMENT AXIS ASSIGNMENT

**Installation position TOP 1... 6** of the 1- or 2-axis inclinometer must be taken into consideration on assignment or selection of the measurement axes. The installation positions specified below define the **measurement axes** and measuring range centre for x, y and z. Which of housing surfaces 1 to 6 is to point upwards must be specified in the order number for the NBN. The installation position is clearly marked on each device ('TOP'). This surface/edge must point upwards.

The definition of the side of the housing facing upwards (TOP1 to 6) refers to the side of the connector outlet. This applies to

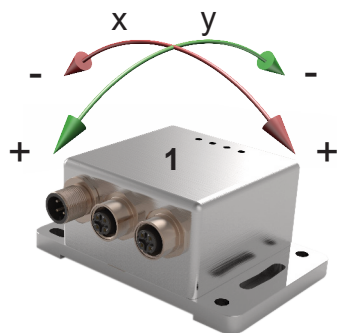
design form 65 (pictures below) and also to design form 90, e.g.: Side TOP5 is to the left of the connector side, TOP4 = connector side, etc. Only 2 of 3 axes are selectable. The installation position determines these axes x, y and z.

Signal path: with the CW setting, the prefixes in the figures below specify the direction of rotation in which the output values increase positively during inclination measurement. This is accordingly reversed with the setting CCW.

See [page 8](#): Available types (standard).

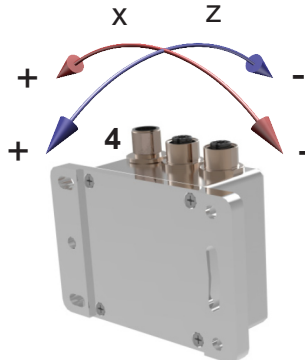
#### INSTALLATION POSITION TOP 1

NBT65 - A xx/xx/0 C1 - 1 - S3 T01



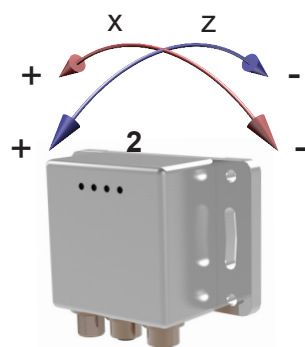
#### INSTALLATION POSITION TOP 4

NBT65 - A xx/0/xx C1 - 4 - S3 T01



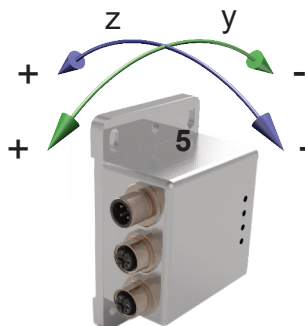
#### INSTALLATION POSITION TOP 2

NBT65 - A xx/0/xx C1 - 2 - S3 T01



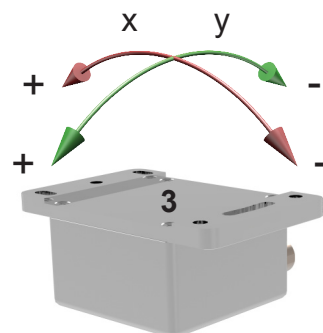
#### INSTALLATION POSITION TOP 5

NBT65 - A 0/xx/xx C1 - 5 - S3 T01



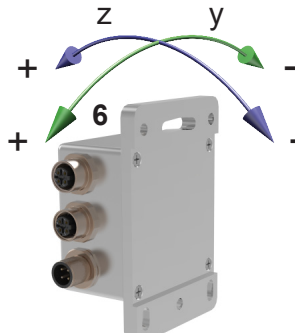
#### INSTALLATION POSITION TOP 3

NBT65 - A xx/xx/0 C1 - 3 - S3 T01



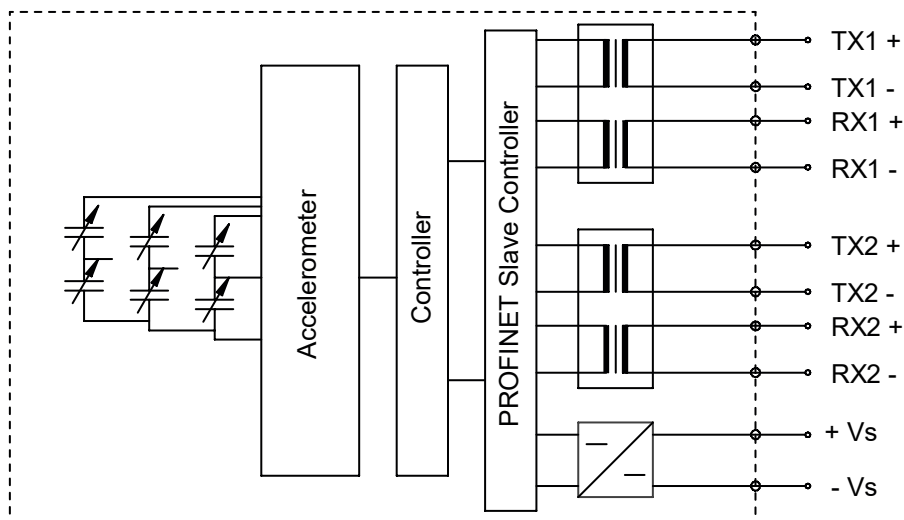
#### INSTALLATION POSITION TOP 6

NBT65 - A 0/xx/xx C1 - 6 - S3 T01



## TECHNICAL DATA

### PRINCIPAL CIRCUIT DIAGRAM



## ELECTRICAL CONNECTION

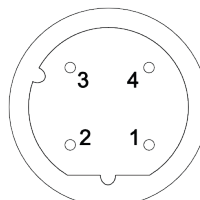
### ELECTRICAL CONNECTION

PROFINET ..... M12 connector D-coded 4-pin for bus in / bus out, socket or cable output via cable glands  
Supply ..... M12 connector A-coded 4-pin, pins or cable output via cable glands

### PROFINET CONNECTOR, 2 X M12, D-CODED, SOCKET/FEMALE

#### PIN.....Function

1 ..... TX+  
2 ..... RX+  
3 ..... TX-  
4 ..... RX-



### PROFINET CABLE OUTPUT (2X)

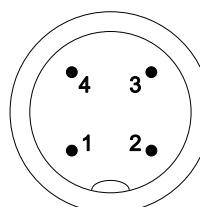
#### Colour\*.....Function

Yellow ..... TX+  
White ..... RX+  
Orange ..... TX-  
Blue ..... RX-

### SUPPLY CONNECTOR, M12, A-CODED, PINS/MALE

#### PIN.....Function

1 ..... +UB (+24 VDC)  
2 ..... not used  
3 ..... -UB (0 VDC)  
4 ..... not used



### SUPPLY CABLE OUTPUT

#### Colour.....Function

White ..... +UB (+24 VDC)  
Brown ..... -UB (0 VDC)

### REMARK

Only use shielded cable for power supply and PROFINET

\* Industrial Ethernet cable colours according to ISO / IEC 8802-3.

## ELECTRICAL CONNECTION

### CABLE OUTPUT PROFINET (OPTION)

Cable type . . . . . PROFINET Type-C, 4 x 0,36 mm<sup>2</sup> (AWG22)  
Cable jacket. . . . . PUR, color: green  
Temperatur range . . . . . - 40 °C to + 70 °C  
Outer diameter . . . . . 6.5 mm ± 0.2 mm  
Min. bend radius . . . . . 5 x d fixed installation, 10 x d freely movable

### CABLE OUTPUT POWER SUPPLY (OPTION)

Cable type . . . . . 2 x 0,75 mm<sup>2</sup>, shielded  
Cable jacket. . . . . PUR, color: gray  
Temperatur range . . . . . - 40 °C to + 80 °C fixed installation, - 5 °C to + 70 °C freely movable  
Outer diameter . . . . . 6 mm  
Min. bend radius . . . . . 6 x d fixed installation, 15 x d freely movable

## ORDER CODE FORMAT

**NBT**   **90 -**   **A**   **20 /**   **20 /**   **0**   **V**   **C1**   **- 1 -**   **S**   **3**   **T**   **01**   **STANDARD VERSION**

NBT	Inclination sensor with PROFINET interface		
<b>90</b>	Design form	65 90	Design form 65 mm Design form 90 mm
<b>A</b>	Housing material***	A V	Aluminium (see <a href="#">page 10</a> ) Stainless steel 1.4404
<b>20</b>	Measuring range**	± x°	x-axis (see below: Available types. Other types on request.)
<b>20</b>	Measuring range**	± y°	y-axis (see below: Available types. Other types on request.)
<b>0</b>	Measuring range**	± z°	z-axis (see below: Available types. Other types on request.)
<b>V</b>	Behaviour during disturbance acceleration	V G	Standard (see <a href="#">page 2</a> ) "interference accelerations" Dynamic compensation with gyroscope data (on request)
<b>C1</b>	Profile	C1	Standard PROFINET
<b>1</b>	Installation position	1, 2, 3, 4, 5, 6	TOP position: see below: Available types and <a href="#">page 5</a>
<b>S</b>	Electrical connection***	S K	Connector M12 Cable
<b>3</b>	Electrical connection	1 2 3 X	1 x connector (Hybrid connector) 2 x connector (1 x PROFINET, 1 x power supply) 3 x connector (2 x PROFINET, 1 x power supply) Cable length in m (for cable output)
<b>T</b>	Output	T	PROFINET
<b>01</b>	Electrical and mechanical variants*	01	Standard

## AVAILABLE TYPES

(Standard versions. Other measuring ranges and installation positions on request)

NBTxx-A20/20/0 V C1-1-xx T01

NBTxx-A90/0/0 V C1-2-xx T01

\* The basic versions according to the data sheet bear the number 01. Deviations are identified with a variant number and are documented at TWK.

\*\* The measuring ranges for the various measurement axes can be selected in 5° steps, whereby it must be noted that only 2 axes can be used at any one time. For the undesired axis please choose '0'. Accuracy differences may possibly arise in terms of the compatibility of the measuring ranges or the measuring angles. Please talk to one of our employees.

\*\*\* Aluminium housing with connector M12. When ordering a stainless steel housing, the connectors or cable glands will be of the same stainless steel quality or higher



## ACCESSORIES (TO BE ORDERED SEPARATELY)

### MATING CONNECTORS

Order number, Datasheet	Type	Design & wire fixing	Housing- material	Cable ø & wire size	Shielding & IP grade
<b>STK4GP81</b> <a href="#">STK14570</a>	M12-D, 4-pole, male	Straight, screws	Die-cast zinc nickel-plated	5 – 8 mm ≤ 0.75 mm <sup>2</sup>	On housing IP67
<b>STK4GP110</b> <a href="#">STK14569</a>	M12-D, 4-pole, male	Straight, screws	Stainless steel 1.4404	5.5 – 8.6 mm ≤ 0.75 mm <sup>2</sup>	On housing IP67
<b>STK4GS60</b> <a href="#">STK14572</a>	M12-A, 4-pole, female	Straight, screws	Die-cast zinc nickel-plated	4 – 6 mm ≤ 0.75 mm <sup>2</sup>	On housing IP67
<b>STK4GS104</b> <a href="#">STK14571</a>	M12-A, 4-pole, female	Straight, screws	Stainless steel 1.4404	5.5 – 8.6 mm ≤ 0.75 mm <sup>2</sup>	On housing IP67
<b>STK4WP82</b> <a href="#">STK14676</a>	M12-D, 4-pole, male	Angled, screws	Die-cast zinc nickel-plated	5 – 8 mm ≤ 0.75 mm <sup>2</sup>	On housing IP67
<b>STK4WS61</b> <a href="#">STK14675</a>	M12-A, 4-pole, female	Angled, screws	Polyamid (PA)	4 – 6 mm ≤ 0.75 mm <sup>2</sup>	- (due to PA) IP67

### CONNECTING CABLE - PROFINET

**KABEL-xxx-114** . . . . Industrial Ethernet data cable with M12 connectors, D-coded, moulded on at both ends,  
xxx = length in meters, standard lengths: 1, 2, 3, 5, 10, 15 and 20 m, see data sheet [KBL14673](#)

**KABEL-xxx-118** . . . . Industrial Ethernet data cable with M12 connector to RJ 45, IP 20,  
xxx = length in meters, standard lengths: 2, 3, 5, 10, 15 and 25 m, see data sheet [KBL14655](#)

### CONNECTING CABLE - POWER SUPPLY

**KABEL-xxx-191** . . . . With moulded M12 connector, A-coded, straight, 2. side open,  
xxx = length in meters, standard lengths: 2, 5, 10, 15, 20 and 25 m, see data sheet [KBL13411](#)

## DOCUMENTATION

### DOCUMENTATION

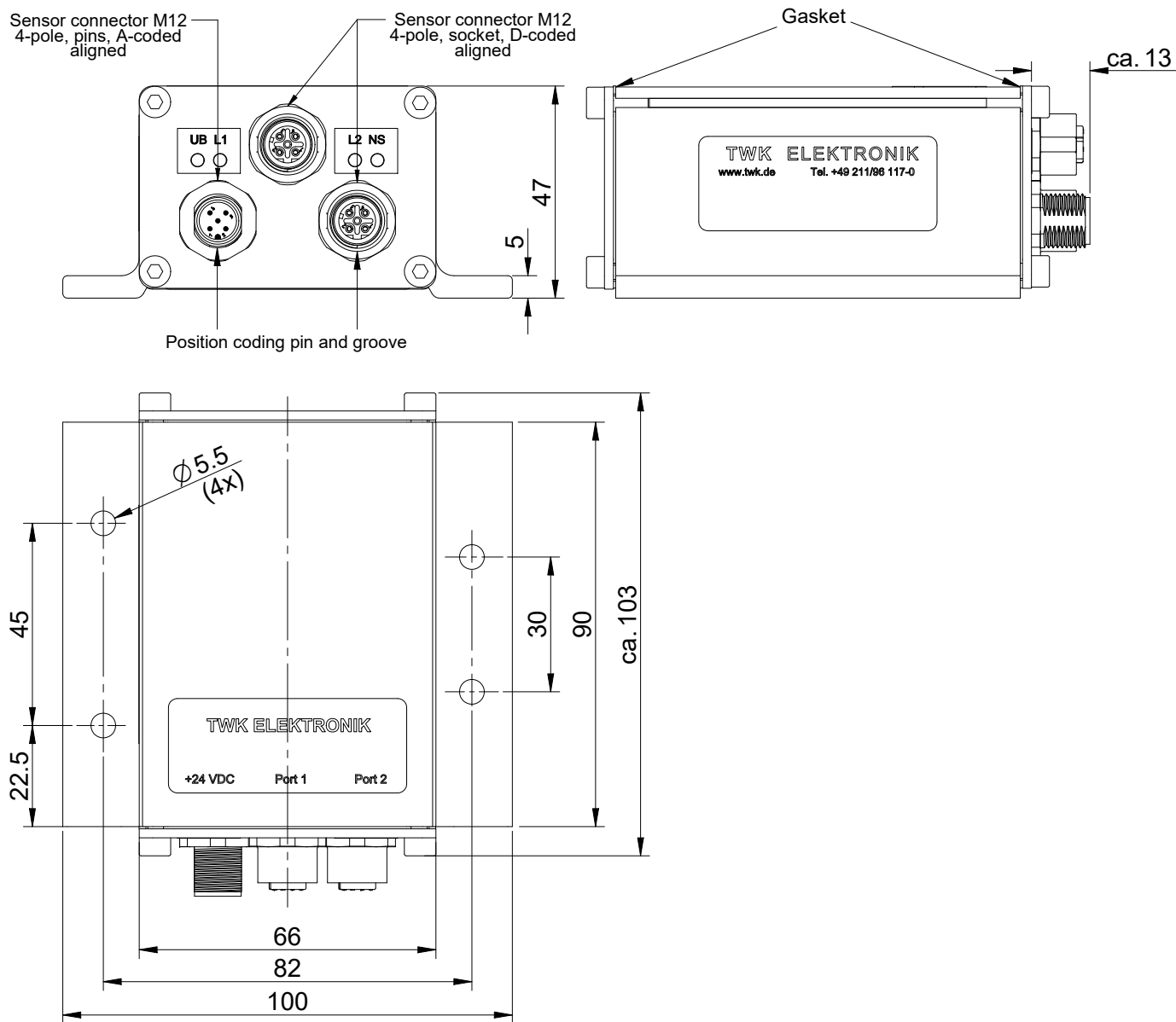
The following documents plus the GSD file and bitmap can be found in the Internet under [www.twk.de/en](http://www.twk.de/en) in the documentation area, model NBT

Data sheet . . . . .	<a href="#">NBT14635</a>
Manual . . . . .	<a href="#">NBT14636</a>
Certificate PROFINET . . . . .	<a href="#">NBT14716</a>
GSD file . . . . .	<a href="#">GSD file NBT</a>
Declaration of Conformity . . . . .	<a href="#">ZE16569</a>
Reach-compliant . . . . .	<a href="#">QS15286</a>
RoHS-compliant . . . . .	<a href="#">QS13284</a>
Installation instructions . . . . .	<a href="#">AN16169</a>

## INSTALLATION DRAWINGS

DESIGN FORM 90, ORDER NUMBER: NBT90-AXX/XX/XXVC1-X-S3T01 - STANDARD DESIGN FORM

Dimensions in mm



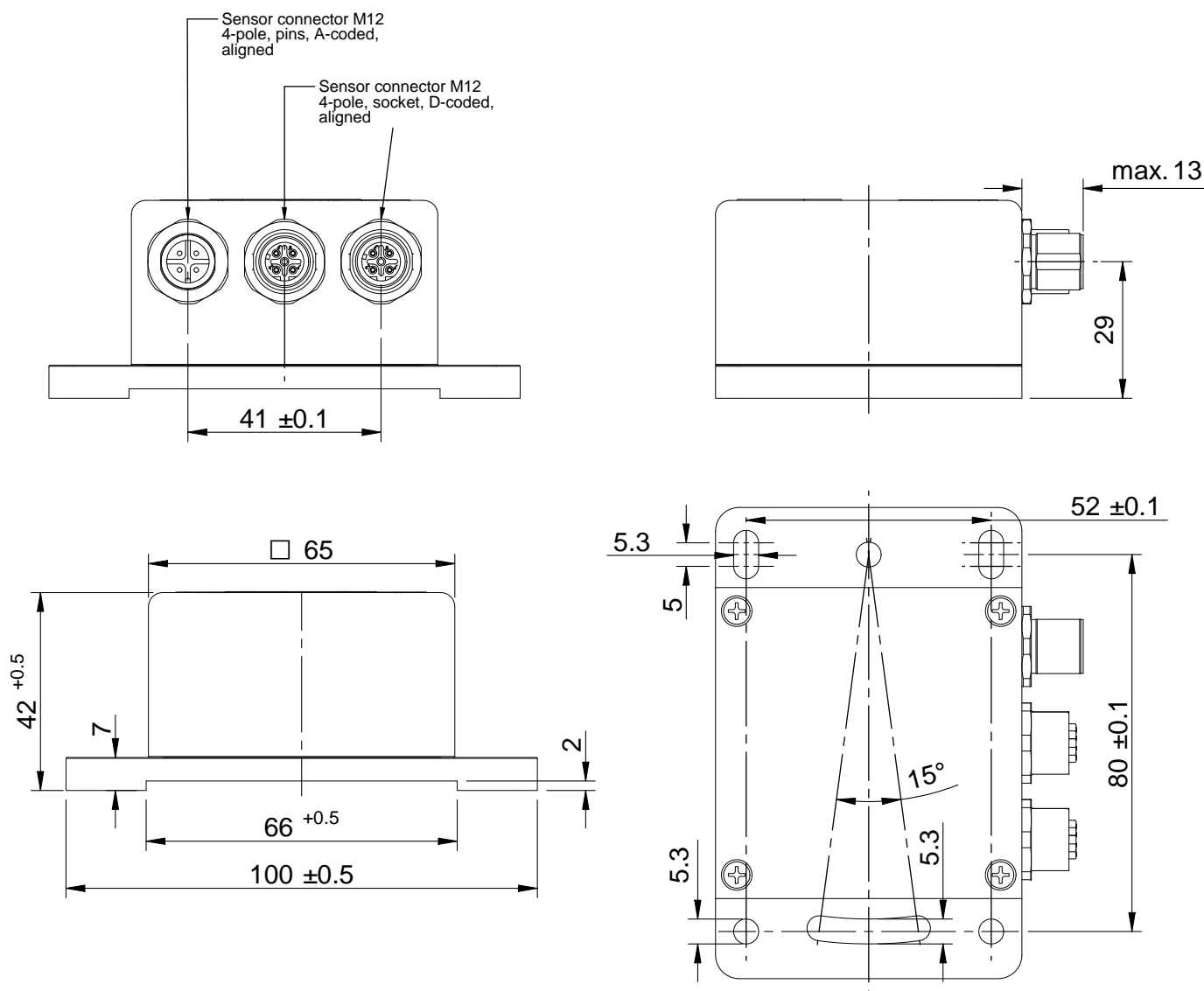
## MATERIALS USED

Aluminium housing	Aluminium 3.3206
Aluminium front plates	Aluminium 3.3316
Connectors	Brass, nickel plated or diecast zinc, nickel plated
Sealing rings	PTFE / NBR

## INSTALLATION DRAWINGS

### DESIGN FORM 65, ORDER NUMBER: NBT65-A XX/XX/XXVC1-X-S3T01 - NON-STANDARD DESIGN FORM

Dimensions in mm



The installation is done via round and slotted mounting holes for M5 bolts. The inclination sensor can be mechanically adjusted up to approx.  $\pm 7.5^\circ$  via the slots. Fasteners are not enclosed in the scope of delivery. When using the long holes additional security measures must be taken to prevent the device from any accidental displacement.

#### NOTE

The connectors of the stainless steel version are not aligned.

#### MATERIALS USED

Aluminium housing	AlMgSi1
Stainless steel housing	1.4404
Connector/cable gland	Die-cast zinc, nickel-plated (when ordering a stainless steel housing, the connectors or cable glands will be of the same stainless steel quality or higher.)
Sealing rings	NBR