# **Inclination sensor** on MEMS technology
# Interfaces**: CANopen** and **Analogue**
# Models **NBN** and **NBA**

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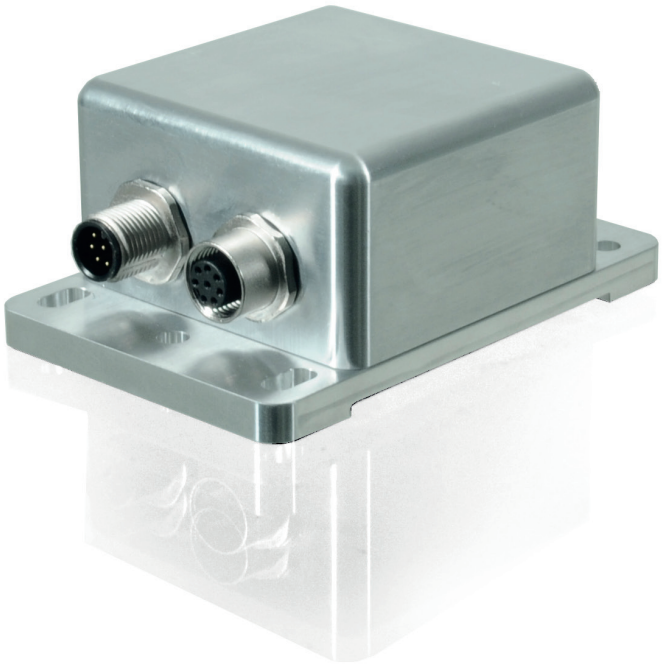

- **Number of measuring axes: 1 or 2**
- **Selectable Measuring range: ± 5° to ± 90° and 360° ***
- **Programmable**
- **High vibration and shock resistance**
- **Options:**
  - **SIL2 certificate: see datasheet NBN 12054**
  - **Output of acceleration† (Special version NVA65...Bxx)**
  - **Correction of tilt output signal due to implemented gyroscope sensor (only at NBN - version 'G')**
  - **Output of a velocity signal °/s (only at NBN - version 'D')**

## Contents



## Design and function

Registration of inclination in the gravitation field using MEMS sensors (Micro-Electro-Mechanical-System) with subsequent digitisation and linearisation via a controller. Data output is carried out via the CANopen interface or as an analogue signal.

The inclination sensor has a stable aluminium housing (optionally stainless steel). Slots are available for mechanical alignment (up to approx. ± 7.5°). In the case of CANopen, one connector or one male/female connector combination can be selected optionally for connection purposes. Casting measures in the housing lead to the achievement of protection class IP 69K, e.g. for use under water.

MEMS sensors are integrated circuits manufactured using silicon bulk micromechanical technology. These micromechanical structures are used to form dual capacities. If these structures are deflected in the case of acceleration, e.g. gravitational acceleration **(g)**, this results in capacity changes, which are registered and further processed using measuring technology. Due to the differential capacity dependency described here, the output voltage follows the function $\mathbf{U} \propto \mathbf{g} * \mathbf{sin}\ \boldsymbol{\alpha}$. In this case, the angle **α** is the inclination angle of the sensor measured against the **g** vector. These sensors measure precisely, have a long service life and are very robust. The measuring axes operate independently of each other.

The optional available gyroscope sensor is based on MEMS technology as well.

† : On request at NBN with CANopen interface

* : The special version NVA...Bxx, based on model **NBN** provides accelerations in 3 axes - not converted into an inclination. Frequency range 0 to 60 Hz, 3 axes. xx means special versions.

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## Options - general description

Only possible with CANopen: NBN

### Sensor with gyroscope correction, version 'G' (NBN with CANopen interface only)

TWK has developed a new generation of inclinometers. They measure more precisely and faster than the standard inclinometers with averaging filter, and are insensitive to interfering acceleration and lateral inclination excursion.

Due to the addition of a MEMS yaw rate sensor (gyroscope), it is possible to transmit a stable measurement value to the control system even during shock and vibration disturbances. The reaction time and measurement accuracy are also increased in comparison with conventional notification procedures (see diagram).

These sensors are highly suitable for applications with dynamic requirements in which precise inclination angles nevertheless have to be registered and transferred to a control system.

This improved performance is enabled by extending the original acceleration sensor with a yaw rate sensor, also known as a gyroscope, and skilfully combining the measurement signals to form a corrected output signal that precisely indicates the measured angle.

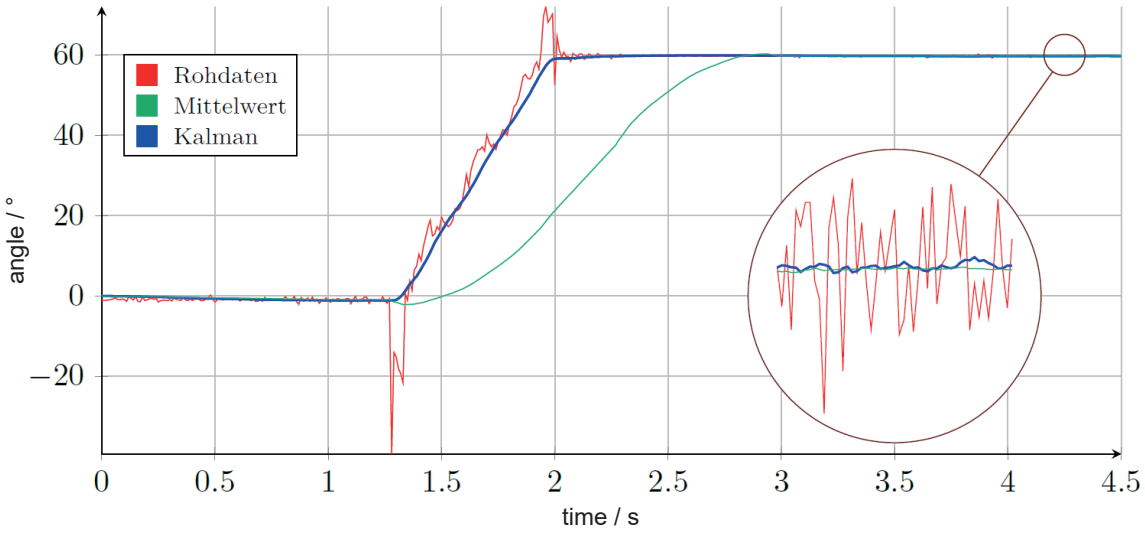
Both sensor types are based on MEMS technology.

The measured variables of the original acceleration sensor and the gyroscope are merged and processed by adding a Kalman filter. This filter technology enables the measurement value that is to be output to be calculated, corrected and predicted for a short time. This is necessary because the acceleration sensor is unable to supply a usable measured inclination value when subject to dynamic interfering acceleration; instead, the yaw rate sensor calculates and predicts a measurement value with the aid of the Kalman filter.

Unlike the acceleration sensor, the yaw rate sensor does not react to linear interfering acceleration but only to changes in the inclination angle.

All possible, realistic application simulations and measurements at TWK show that the sensor fusion system operates precisely and safely. This sensor system not only guarantees safe, hazard-avoiding operation in mobile machines, even when using motors and hydraulic pumps or during other operations that generate strong vibrations.

As soon as there is no further interfering acceleration resulting from shock and vibrations, regular acceleration sensor inclination data are again output without gyroscope correction. See order designation: version 'G'.




### 360° sensor, optional: output of the angular velocity: version 'D' (NBN with CANopen interface only)

An additional version of the NBN inclinometer (version with CANopen interface only) is the version with a 360° measuring range. In this case, the NBN can be rotated completely around its own axis in a previously defined axis, and corresponding angle values are output. The zero point or starting point is defined through the usual specification of the installation position (TOPx). In this regard, see: installation positions at the end of this document.

The values range from -180° to +180°, (e.g. NBN…180/0/0…) i.e. with a resolution of 0.01°, from -18,000 dec to +18,000 dec or from B9B0 to 4650 hex or 0° to 359,99° as an unsigned value (e.g. NBN…360/0/0…). The output of a signed angular **velocity signal** (yaw rate) is also possible in this version with the aid of the integrated gyroscopic sensor (unit: 1/100°/s, 245°/s at max.). This version can be used at hubs at wind power plants to detect position and hub speed. See order designation: version 'D'.

## General technical data

### Electrical data

- Sensor system: MEMS acceleration sensor
- No. measuring axes: 1 or 2
- Measuring range: ± 5° to ± 90° and 360° (360° on request at NBN90 with CANopen interface)
- Absolute Accuracy and temperature drift: See below "Deliverable accuracies"
- Repeatability: ± 0.05°
- Zero error: ± 0.5°
- Noise: ± 0.05°
- Signal path: Parameterisable
- EMC standards: Interference immunity: EN 61000-6-2
  Interference emission: EN 61000-6-4

### Environmental data

- Temperature range: -40 ... +85 °C
- Storage temp. range: -20 ... +60 °C (due to packaging)
- Resilience
  - ☐ To shock: 500 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 67, IP 69K (optional)
- Weight: Approx. 0.3 kg (aluminium)
  Approx. 0.65 kg (stainless steel)

## Accuracies

without gyroscope and without cross tilt compensation

- Device with 1 or 2 axes, when measuring angle ± 20° at maximum:

  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]

- Device with 1 axis, when measuring angle ± 90°:

  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°

- Reaction time: 1 s (for 100 % of final value)

## Accuracies (preliminary)

without gyroscope and with cross tilt compensation

- Absolute accuracy: ± 0,25°
- Drift: TBD
- Repeatability: ± 0,05°
- Noise: ± 0,05°
- Zero deviation: ± 0,5°
- Reaction time: < 1 s (for 100 % of final value)

## Accuracies (preliminary)

with gyroscope (in preparation) and cross tilt comp.

- Absolute accuracy: ± 0,2°
- Drift: TBD
- Repeatability: ± 0,05°
- Noise: ± 0,02°
- Zero deviation: ± 0,25°
- Reaction time: < 0,1 s (for 100 % of final value)

## Important informations

At older inclinometer versions without cross tilt correction the measured axis is no longer detected in case of an inclination in a second axis (cross-axis inclination) is greater than 30°. Meaning the sensor will go in an over flow stage. This feature is required since measuring accuracy decreases with increasing cross-axis inclination.

**Behaviour of the 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.

## CANopen data

### Function

A CAN controller at the output enables integration into the CANopen network. The protocol is designed according to "CANopen Application Layer and Communication Profile, CiA Draft Standard 301, version 4.1" as well as according to "Device Profile for Inclinometers, CiA Draft Standard Proposal 410, version 1.2“ and "CANopen Layer Setting Services and Protocol (LSS), CiA DSP 305, version 1.1.1". The sensor is also available with a redundant system and CANopen safety profile (see datasheet NXN 12054).

| | |
|---|---|
| ■ Operating voltage: | 11 to 36 VDC |
| ■ Resolution: | 0.01° |
| ■ Power consumption: | < 1 W |
| ■ Signal path: | Ascending values with CCW (parameterisable) |
| ■ Measuring range: | ± 5° to ± 90° |
| ■ Output code: | Binary |
| ■ Transmission rate: | 1 MBaud |
| ■ CAN interface: | According to ISO/DIS 11898 |
| ■ Address/baud rate setting: | Via SDO/LSS |
| ■ Terminating resistor: | To be implemented separately |
| ■ Max. transmission length: | 200 m. No galvanic separation between supply voltage and bus lines (also see CiA DS301). |

The design guideline "CiA Draft Recommendation 303 CANopen additional specification Part 1: Cabling and connector pin assignment" must be observed on installation.

### CANopen features

| | |
|---|---|
| ■ NMT master: | No |
| ■ NMT slave: | Yes |
| ■ Maximum boot-up: | No |
| ■ Minimum boot-up: | Yes |
| ■ COB ID distribution: | Default, SDO |
| ■ Node ID distribution: | Via Index 2000 or LSS |
| ■ No. of PDOs: | 2 Tx |
| ■ PDO modes: | Sync, async, cyclic, acyclic |
| ■ Variable PDO mapping: | No |
| ■ Emergency message: | Yes |
| ■ Heartbeat: | Yes |
| ■ No. of SDOs: | 1 Rx / 1 Tx |
| ■ Device profile: | CiA DSP 410 Version 1.2 |
| ■ Baudrate, factory setting: | 20 kBaud |
| ■ Node ID, factory setting: | 1 |

A detailed description of the profile you will find in the NBN 12527 specification.

* At digital output version NBN the resolution is set to maximum. Reducing the measuring range means only that at smaller angels the overflow will be reached and output to signalize the applications controller that the maximum angel is exceeded. See characteristic curve on page 6.

## CANopen data

### Data format CANopen

| Data Byte 0 | | | | | | | | Data Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| LSB | | | | | | | | | | | | | | | MSB |
| angle (or acceleration) x-axis | | | | | | | | | | | | | | | |

| Data Byte 2 | | | | | | | | Data Byte 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| LSB | | | | | | | | | | | | | | | MSB |
| angle (or acceleration) y-axis | | | | | | | | | | | | | | | |

| Data Byte 4 | | | | | | | | Data Byte 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| LSB | | | | | | | | | | | | | | | MSB |
| angle (or acceleration) z-axis | | | | | | | | | | | | | | | |

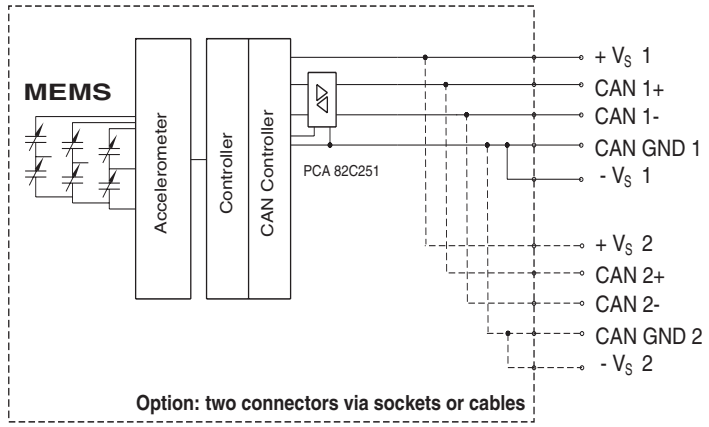
| Data Byte 6 | | | | | | | | Data Byte 7 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| LSB | | | | | | | | | | | | | | | MSB |
| velocity of rotation - version 'D' | | | | | | | | | | | | | | | |

Model NBN: Inclination values.

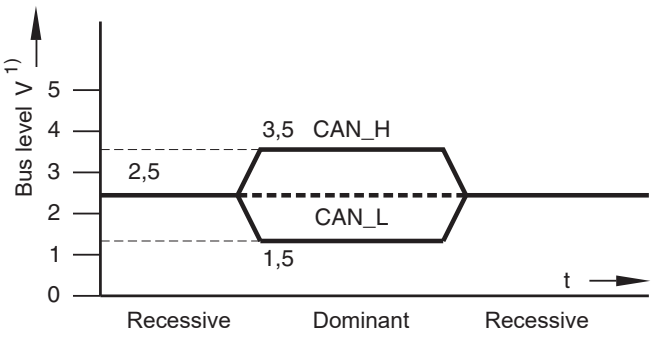
Model NVA...Bxx (based on NBN): Acceleration values

When a velocity signal is available - version 'D' - bytes 6 and 7 provide this velocity signal. It's a signed 16 Bit signal.

### Principle circuit diagram NBN (without gyroscope)

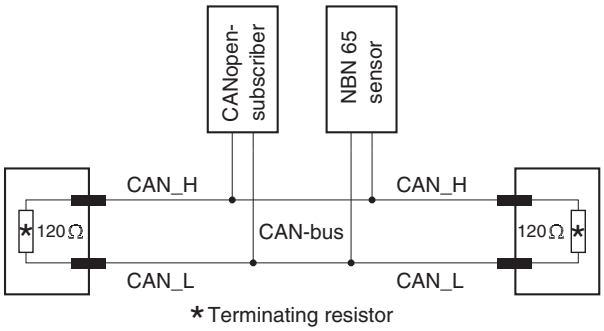



### Output level according to ISO / DIS 11898




1) With common mode voltage = 0V

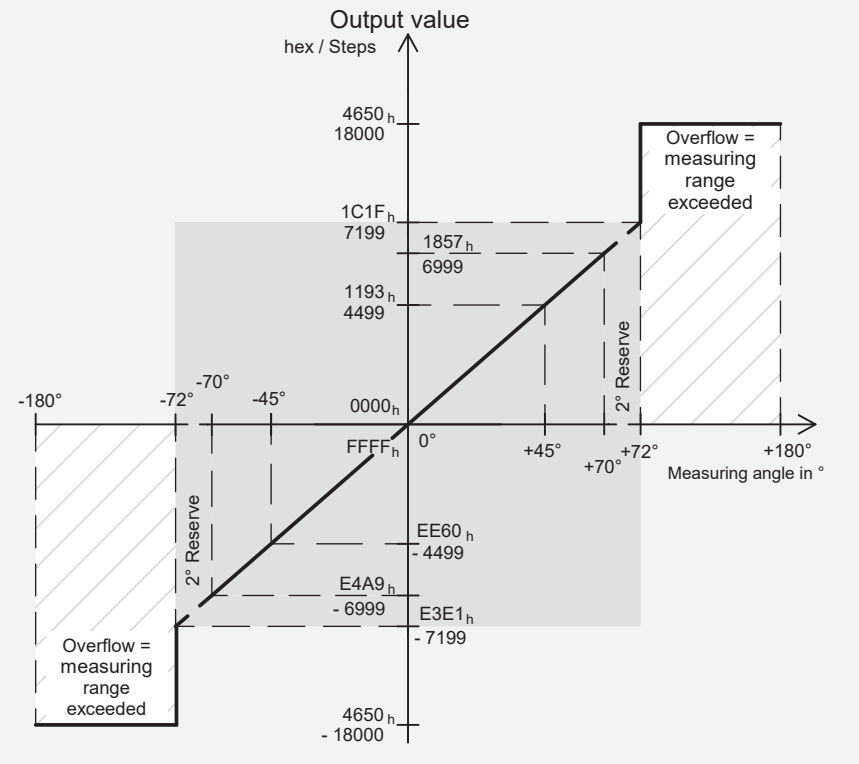
### Bus activation according to ISO / DIS 11898



## CANopen data

### Characteristic curve

- Example: ± 70° ≙ 2 x 7000 increments with resolution 0.01°.
- Data format: Signed 16-bit.




When exceeding the selected range (eg ± 70 °), plus about 2° the CANopen output values is set to 4650hex (= 18,000 steps = 180 °) in order to signal the controller that the inclinometer is tilted out of the selected scale.

Special version NVA65...Bxx, based on model NBN65, provides 4096 digits/g resolution as a signed 16 Bit output value for positive and negative accelerations due to forward and backward acceleration direction.

The version NBN....360 is defined with an unsigned 16 Bits signal output: ... 0, 1, 2, ..., 8C9E, 8C9F, 0, 1, ... , with 8C9F = 35999.

When a velocity signal is provided (yaw rate) it is defined as a signed 16 Bits signal.

### Programming parameters

| Parameter | Function |
|---|---|
| Resolution | 0,1° / 0.01° |
| Zeroing / preset value | Adjustment within ± 5° |
| Signal path | CW / CCW |
| Scaling | On / Off |

### Documentation, EDS file, etc.

- The following documents plus the EDS file, a bitmap and example programmes can be found in the Internet under www.twk.de in the documentation section, model NBN (letter "N")
  - Data sheet No. NBX 11918
  - Specification No. NBN 12527
- The following are available on request:
  - EDS file
  - Bit map image file
  - Electrical connection assignment, if required
- Supply source for the listed CANopen specifications:

  CAN in Automation (CiA),
  Kontumazgarten 3,
  D-90429 Nuremberg
  (Email: headquarters@can-cia.org, www.can-cia.org)

# Inclinometers NBN

## Order code format NBN

Please enter installation position "TOP 1...6" into the order number. See page 16 and 18 for a description.

| NBN | 65 | - A | x / y / z | G | C3 | - 1 | - S | 1 | N | 01 |
|---|---|---|---|---|---|---|---|---|---|---|

**Electrical and mechanical variants ***
- 01 Standard
- 50 Connection via plug M12, 5 pins instead 8 pins

**Output interface:**
- N CANopen

**Electrical connections:**
- 1 Single connection
- 2 Double connection

**Electrical connections [3]:**
- S Device connector M12
- K Cable 1 m

**Installation position:**
- 1 TOP 1, 2, 3, 4, 5, 6 (See pages 16-18)

**Profiles:**
- C3 CANopen according to CiA, DS 301 Version 4.1, DS 410 Version 1.2

- G G = with gyroscope for suppressing disturbance vibrations (only fill in if requested)
- D D = with gyroscope for measuring of angular speed (only fill in if requested) [5]

**Measuring range [2]:**

± z° z-axis
± y° y-axis
± x° x-axis

Please assign the measuring angles which you require to the "x, y, z" axes
Two axes at maximum selectable (Selectable from ± 5° to ± 90° in 5° steps and 360°)
For the undesired axis please choose '0' (Explanation on page 16 -18)

**Housing material [3]:**
- A Aluminium AlMgSi1
- S Stainless steel 1.4305 (not at design form 90)
- V Stainless steel 1.4404 (not at design form 90)

**Design form:**
- 65 65 mm
- 90 90 mm (on request)

**Model [4]:**
- NBN with **CANopen interface**

### Profiles

- CANopen profile C3: measuring system with CANopen profile according to CiA, DS 301 version 4.1, DS 410 version 1.2.
- CANopen safety profile with or without SIL2 certificate: see separate datasheet NBN12054

### Electrical connection

- one connector M12, 8-pole (variant 50: 5-pole) or one cable
- male/female M12 connector combination or two cables in order to loop the CANopen bus and the voltage supply through.

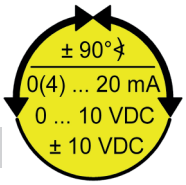
* The basic versions according to the data sheet bear the number 01. Deviations are identified with a variant number and are documented in the factory. NBN: variant 50 is firmly assigned: electrical connection via M12, 5-pin (instead of 8-pin).

2) 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. Accuracy differences may possibly arise in terms of the compatibility of the measuring ranges or the measuring angles. If in doubt, please talk to one of our employees. In the 360° version, only specify 360° at one position: at x for rotation in the xy axis plane (assembly plane). At y for rotation in the yz axis plane. At z for rotation in the zx axis plane. The installation position specifies the zero point (signed 16-bit format. Zero transition: ...FFFE, FFFF, 0, 1...). E.g. NBN90-A-360/0/0C3-5-S2N01.

3) Aluminium housing with connector M12, stainless steel housing preferably with cable 1 m and D-sub connector without cap (for test purposes).

4) The special version NVA...Bxx, based on model **NBN**, provides acceleration output - not converted in an inclination value. Frequency range: 0 to 60 Hz in 3 axes. xx means special versions. This datasheet and CANopen specifications NBN12527 are valid. In all othes cases of series NVA the regular documentation NVA12634 (Datasheet) and NVA12657 (CANopen specifications) are valid.

5) This version is particularly interesting in combination with the 360° version in order to also output the rotational speed in addition to the 360° position. In the PDO, this speed is output at bytes 6 and 7.




## Technical data, analogue

### Function

The contactless MEMS sensor system is extended using a 12-bit D/A converter so that the measuring variable is available as an analogue signal from 0 (4) to 20 mA, 0 to 10 VDC or ± 10 VDC.

The customer can adjust the signal path (CW or CCW) and the measuring range from ± 5° to ± 90° in 5° steps (i.e. 2,5° on each side. Example: from ± 5° is the next step ± 7,5°). The preset "centre of measuring range" value can be set (see explanations on pages 5 and 7).

Electrical connection is carried out via one male connector M12, 8 pins, A-coded or cables.

On ordering, the measuring ranges must be selected according to the application (from ± 5° to ± 90° in 5° steps (2,5° on each side), e.g. ± 5°, ± 7.5°, ± 10° etc.). If the sensor is inclined past this measuring range, an overflow is output.
Due to the 12-bit D/A converter, the resolution of the output signal is dependent on the selected measuring range.
Examples: At ± 90°, it is 0.05°. At ± 20°, it is 0.01°, etc. (better than 0.01° is not possible).

### Electrical data

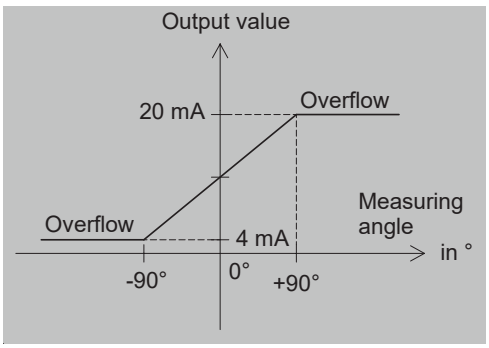
| | |
|---|---|
| ■ Operating voltage: | 20 to 30 VDC (output: A,B,C) |
| ■ Power consumption: | < 1 W |
| ■ Current: | approx. 40 mA |
| ■ Resolution: | 0.05° with ± 90° measuring range (12-bit D/A converter)<br>(higher resolutions with smaller measuring ranges) |
| ■ Measuring range: | ± 5° to ± 90° (parameterisable) |
| ■ D/A converter: | 12-bit |
| ■ Signal path: | Adjustable (CW or CCW) |
| ■ Preset value: | Centre of measuring range, optionally other values |

### Electrical output data

| | |
|---|---|
| ■ **Current output A:** | 0 to 20 mA |
| **B:** | 4 to 20 mA |
| Accuracy: | ± 50 µA |
| Load resistance (burden): | 0 ... 500 Ω |
| ■ **Voltage output C:** | 0 to 10 VDC |
| Accuracy: | At 0 V + 100 mV<br>At 10 V ± 25 mV |
| Output current: | Max. 5 mA (short-circuit-proof) Corresp. to load resistance ≥ 2 kΩ |

### Characteristic curve (measuring range ± 90°)

Current output B:



## Technical data, analogue

### Setting option via multifunctional pins MFP

The **signal path**, **preset value** and **measuring range** parameters and the **default values** can be set by the user according to the conditions in the operating location. Three multifunctional inputs are provided for this purpose. The input circuit for the MFPs is E1(see page 9).

The basic factory setting in accordance with the order number (i.e. signal path, original zero point and measuring range) can be restored on activation of the default values.

The signal path determines the inclination direction in which the output signal increases positively (see page 14-15).

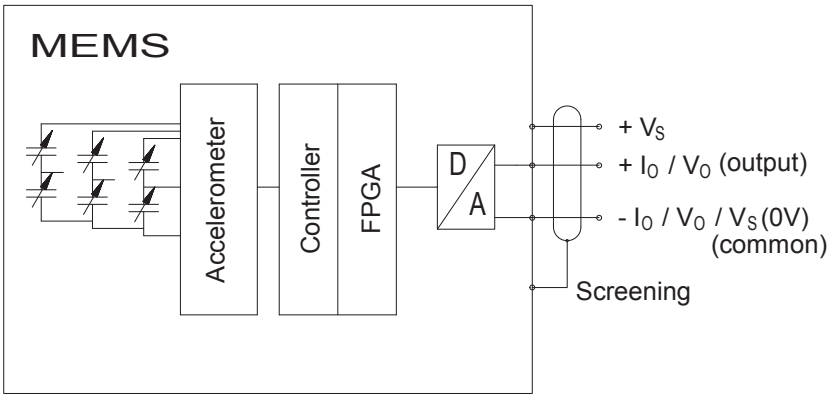
The measuring range can be incremented by activating the corresponding MFP(s) in 5° steps (2,5° on each side) up to a maximum of ± 90° (e.g. ± 10° to ± 12.5°), with reference to the measuring axes selected on ordering. On further activation, the measuring range jumps back to the minimum value of ± 5°, etc.

The preset value is set to the centre of the measuring range. Other values can be implemented in the factory.

**Table for multifunctional inputs (MFP). The functions for the 2nd axis are omitted in the 1-axis sensor**

| **Function** | **MFP 0** | **MFP 1** | **MFP 2** | Logical 1 ≙ 11...+UB, logical 0 ≙ < 5 V or open |
|---|---|---|---|---|
| Signal path (CW / CCW), 1st axis (e.g. x) | 1 | 0 | 0 | Set pin MFP 0 to logical 1 for the duration of 4 s. |
| Set preset value, 1st axis | 0 | 1 | 0 | Set pin MFP 1 to logical 1 for the duration of 4 s. |
| Increment measuring range by 5° in each case, 1st axis | 0 | 0 | 1 | Set pin MFP 2 to logical 1 for the duration of 4 s. |
| Signal path (CW / CCW), 2nd axis (e.g. y) | 1 | 1 | 0 | Simultaneously set pins MFP 0 and MFP 1 to logical 1 for the duration of 4 s. |
| Set preset value, 2nd axis | 1 | 0 | 1 | Simultaneously set pins MFP 0 and MFP 2 to logical 1 for the duration of 4 s. |
| Increment measuring range by 5° in each case, 2nd axis | 0 | 1 | 1 | Simultaneously set pins MFP 1 and MFP 2 to logical 1 for the duration of 4 s. |
| Set default values for all axes | 1 | 1 | 1 | Simultaneously set pins MFP 0, MFP 1 and MFP 2 to logical 1 for the duration of 4 s. |
| Normal operation | 0 | 0 | 0 | MFP 0, MFP 1 and MFP 2 to logical 0 or open |

### Principle circuit diagram NBA65

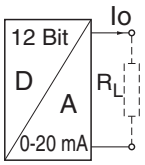


## Technical data, analogue

### Output circuits

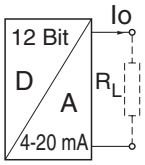
**Output A**

Io = 0 - 20 mA
$R_L$ = 0 - 0.5 k



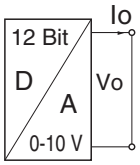

**Output B**

Io = 4 - 20 mA
$R_L$ = 0 - 0.5 k



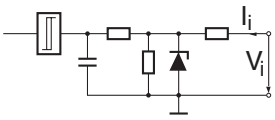

**Output C**

Vo = 0 ... 10 V
$Io_{max.}$ = 5 mA
$R_{min}$ = 2 k




### Input circuit E1 for multifunctional pins (MFP)

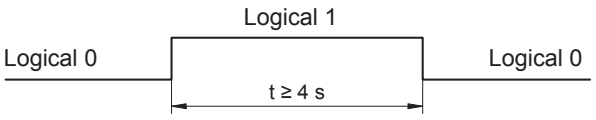
**Input E1** active "high"




Log 0 < 5 V or not connected
Log 1 = 11 ... Vs
E1 specification

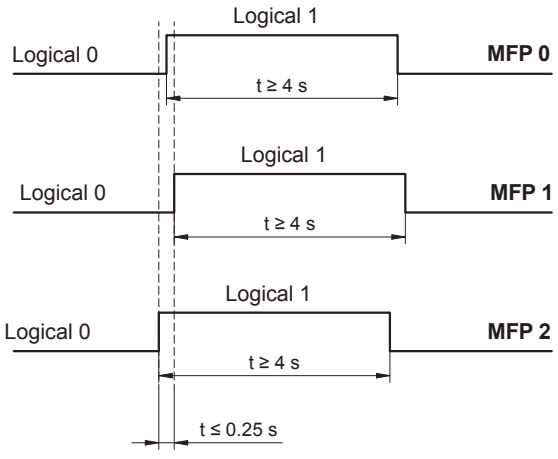
### Timing charts for the MFP settings

**1. Set MFP 0 or MFP 1 or MFP 2 once**




**2. Set two or all three MFPs simultaneously**

Time difference between MFP 0 and MFP 1 (and MFP 2) ≤ 0.25 s.



# Inclinometer NBA

## Order code format NBA 65

Please enter installation position "TOP 1...6" into the order number. See page 16 to 18 for a description.

| NBA | 65 | - A | x / y / z | W | S | 1 | - 2 | - B | 01 |
|---|---|---|---|---|---|---|---|---|---|

**Electrical and mechanical variants ***
- 01 Standard

**Output signals:**
- A 0 - 20 mA
- B 4 - 20 mA
- C 0 - 10 V

**Installation position:**
- 2 TOP 1, 2, 3, 4, 5, 6 (See pages 16-18)

**Version:**
- 1 1 measuring system

**Electrical connections ***:**
- S Device connector M12
- K Cable 1 m

**Signal path:**
- W CW
- C CCW

For all measuring ranges. (See explanation on page 16)

**Measuring ranges **:**

± z° z-axis
± y° y-axis
± x° x-axis

Please assign the measuring angles which you require to the "x, y, z" axes
Two axes at maximum selectable (Selectable from ± 5° to ± 90° in 5° steps)
For the undesired axis please choose '0' (Explanation on page 16-18)

**Housing material ***:**
- A Aluminium AlMgSi1
- S Stainless steel 1.4305
- V Stainless steel 1.4404

**Design form:**
- 65 65 mm

**Modell:**
- NBA with **analogue interface**

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

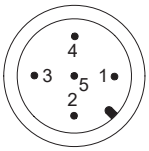
** The measuring ranges for the various measurement axes can be selected in 5° steps (2,5° on each side), whereby it must be noted that only 2 axes can be used at any one time. Accuracy differences may possibly arise in terms of the compatibility of the measuring ranges or the measuring angles. If in doubt, please talk to one of our employees.

*** Aluminium housing with connector M12, stainless steel housing preferably with cable 1 m and D-sub connector without cap (for test purposes).

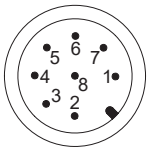
## Electrical connections

Via: - 1 connector M12 (male)
- 2 connectors M12 (male + female), 8-pin in each case
- 2 connectors M12 (male + female), 5-pin in each case (Variant 50 in CANopen sensor NBN65 order code format)
- 1 or 2 cables

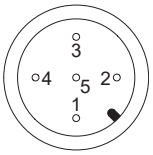
**Electrical connection at the mating connector**
(View on clamp- or soldering side)




**Male connector:**
5 pin (pin)




**Male connector:**
8 pin (pin)




**Female connector:**
5 pin (socket)


**Female connector:**
8 pin (socket)

The pin assignment can be found in the connection assignment which is enclosed with each device.

## Accessories

- Mating connector (EMC) **STK5GP90** (M12, 5 pin male connector (pin), A-coded)
- Mating connector (EMC) **STK5GS56** (M12, 5 pin female connector (socket), A-coded)
- Mating connector (EMC) **STK8GP99** (M12, 8 pin male connector (pin), A-coded)
- Mating connector (EMC) **STK8GS54** (M12, 8 pin female connector (socket), A-coded)

(Mating connectors have to be ordered separately)

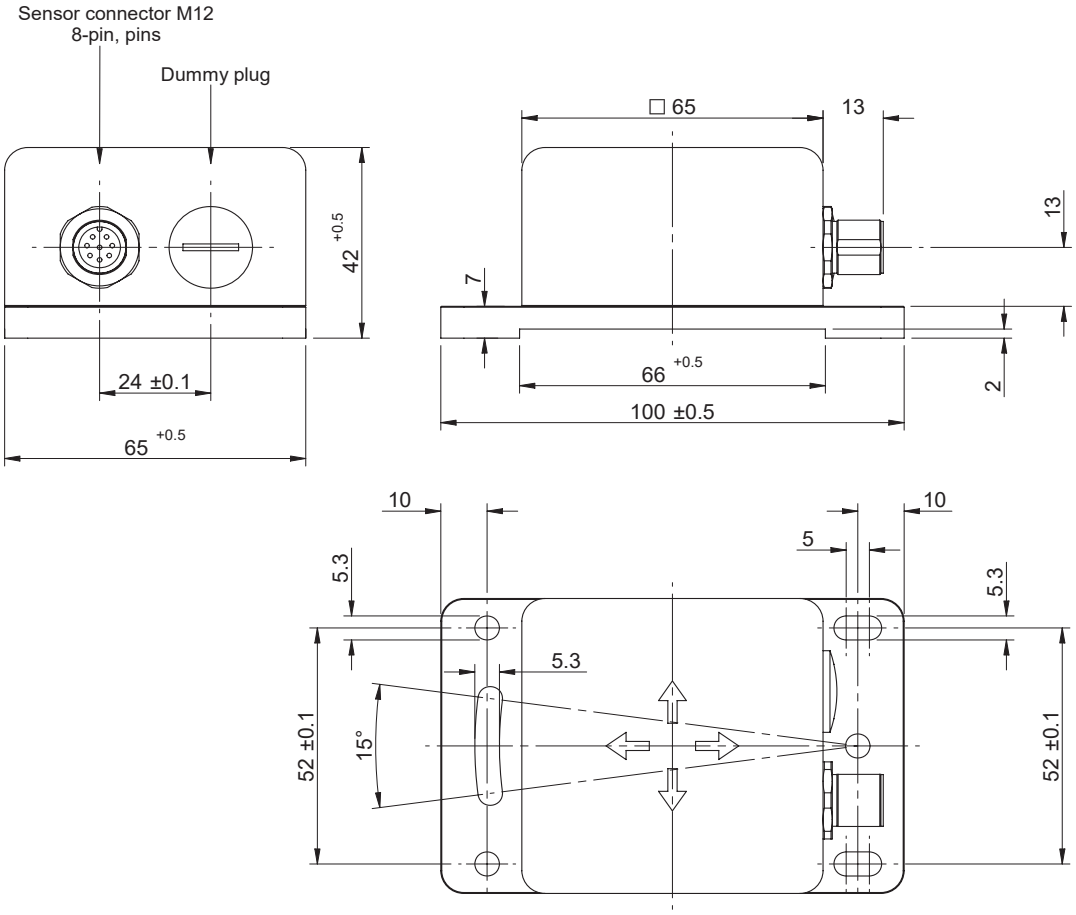
## Installation drawing

NBx65 with connectors

Via round and slotted mounting holes for M5 bolts. The inclination sensor can be mechanically adjusted up to approx. ± 7.5° via the slots. Fasteners are not enclosed in the scope of delivery.

No dummy plug in case of two connectors.

**Dimensions in mm**




### Materials used

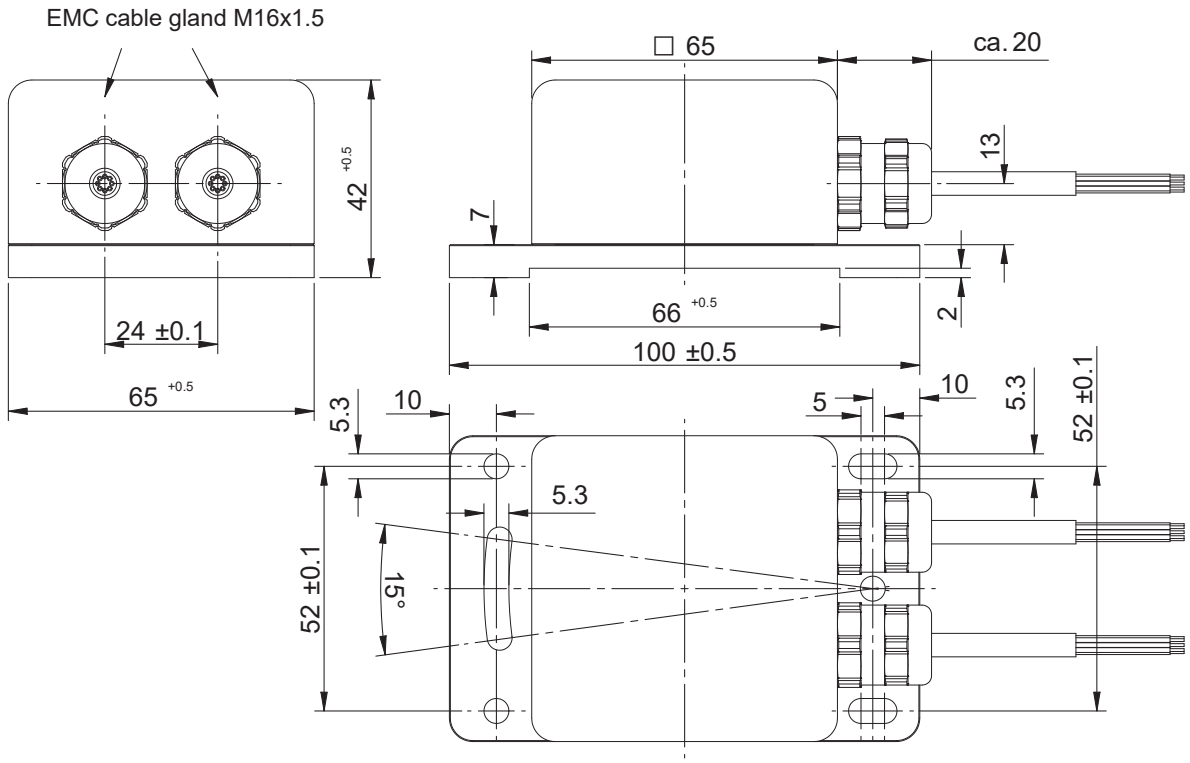
| | |
|---|---|
| Aluminium housing: | AlMgSi1 |
| Stainless steel housing: | 1.4305 |
| or: | 1.4404 |
| Connector/cable gland: | Ms, nickel plated |
| or: | stainless steel |
| Sealing rings: | NBR |

## Installation drawing

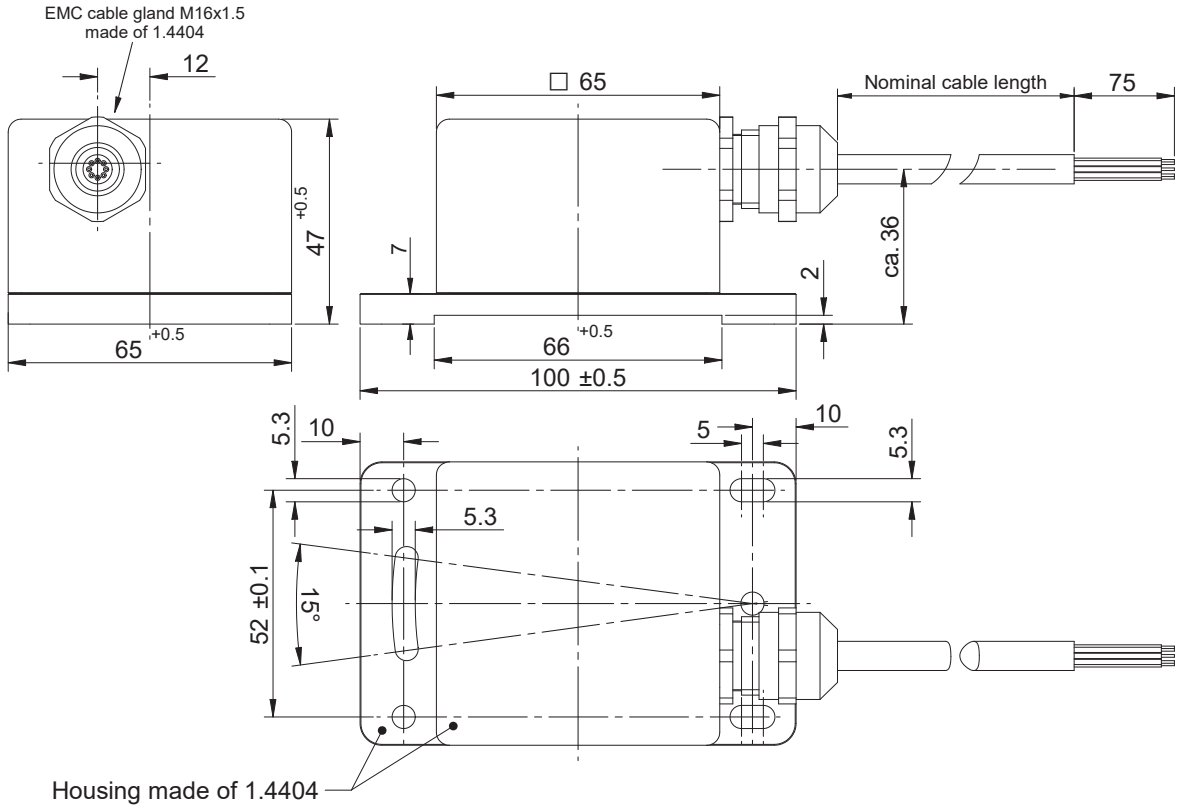
NBx65 with cable

### Version IP67 with 2 x cable

Dimensions in mm




### Version IP69K with 1 x cable (Housing height is bigger than at IP67)

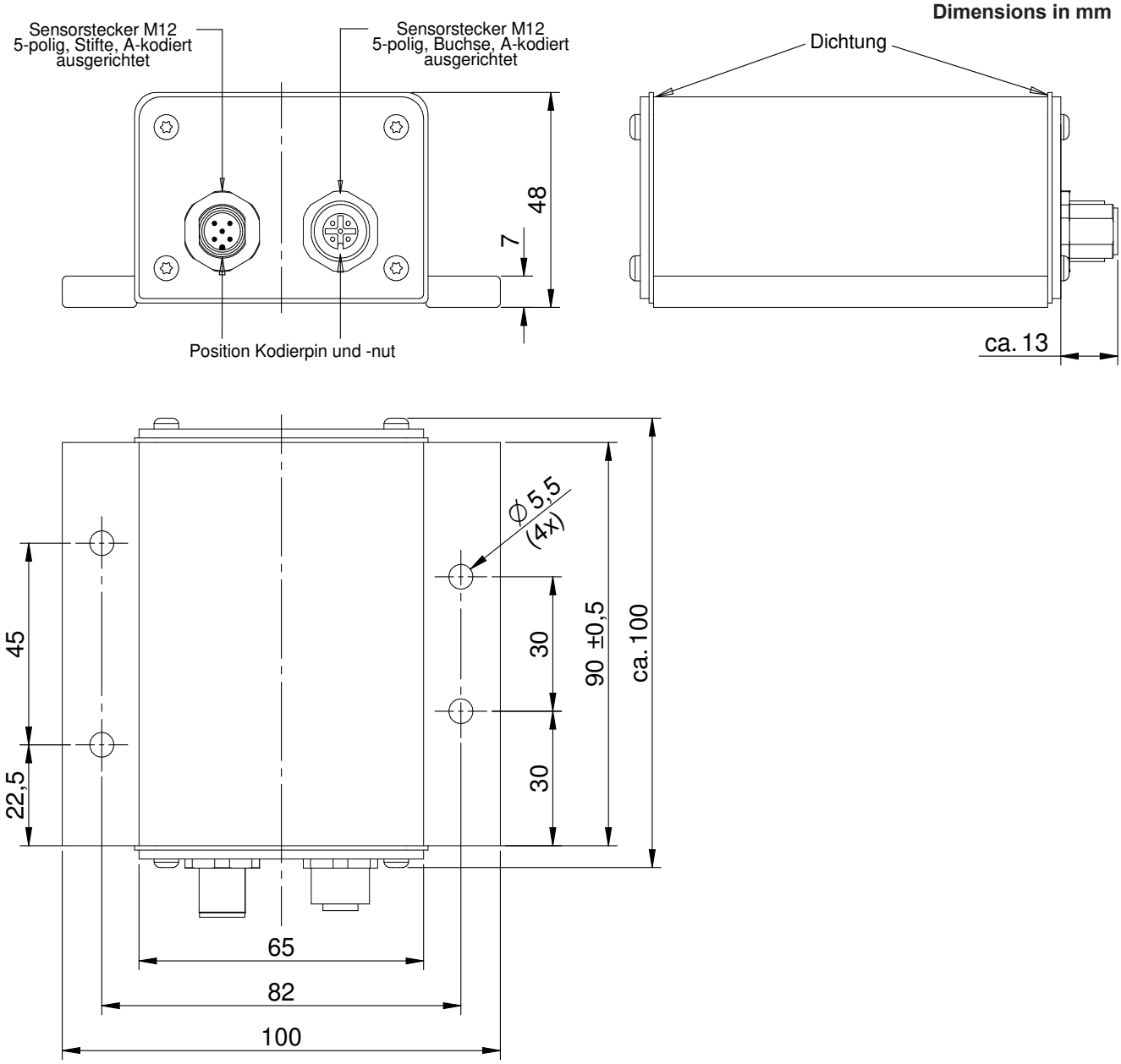


# Inclinometers NBN

## Installation drawing

NBN90: version is on request

**Dimensions in mm**




**Page 15: Materials used**

| | |
|---|---|
| Aluminium housing: | AlMgSi1 |
| Connector: | Ms vernickelt |
| Sealing rings: | NBR |


**Page 14: Materials used**

| | |
|---|---|
| Aluminium housing: | AlMgSi1 |
| Stainless steel housing: | 1.4305 |
| or: | 1.4404 |
| Connector/cable gland: | Ms, nickel plated |
| or: | stainless steel |
| Sealing rings: | NBR |

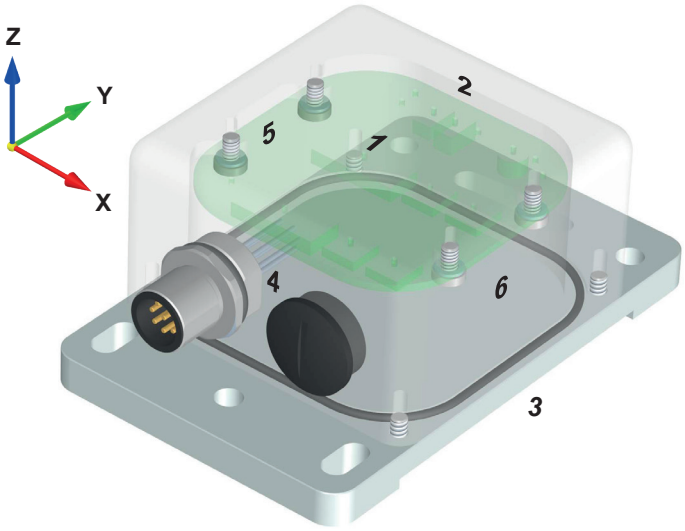
## Installation positions and measurement axis assignment

**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 NBN65 (see figure on the right). The installation position is clearly marked on each device ('TOP'). This surface/edge must point upwards.

Only 2 of 3 axes are selectable. The installation position determines these axes.

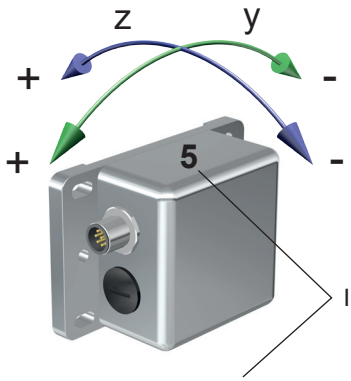
Signal path: with the CW setting, the prefixes in the figures below specify the direction of rotation in which the output values increase positively during inclination measurement. This is accordingly reversed with the setting CCW.




| | | |
|---|---|---|
| 1: Upper side | 2: Rear side | 3: Lower side |
| 4: Connector side | 5: Left side | 6: Right side |

E.g. NBN 65 - A xx / yy / zz C3 - **1** - S 1 N 50: TOP1

In this example, circumstances necessitate the installation of the inclinometer in installation position "5".
The y-axis with a range of ± 35° to be measured and the z-axis with a range of ± 12° to be measured are required for measurement.



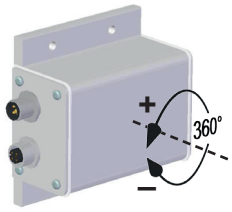

Installation position 5 (with reference to the upper side)

NBN65 - A 0/**35**/**12** C3 - **5** - S 1 N 01

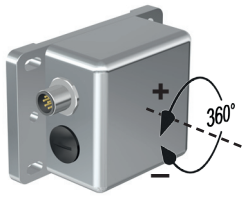
z-axis = 12° (± 12°)
y-axis = 35° (± 35°)
x-axis = 0° (As the x-axis is not available in this installation position, it is specified as 0)

## Installation positions and measurement axis assignment for 360° measuring range only NBN

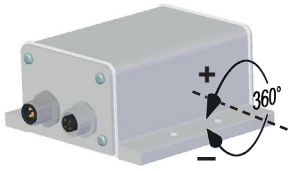
**NBN90**

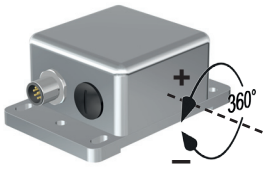



**NBN65**

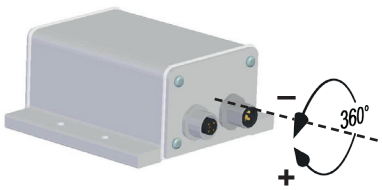


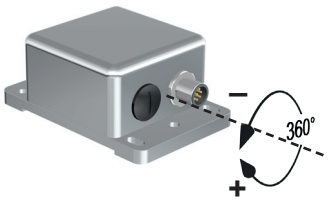

**360° rotation in xy- axis plane with zero point at installation position 5 (TOP5) → NBNxx-A-360/0/0 .. C3-5-S2N01**
The velocity signal (version 'D') refers to the same plane.




**360° rotation in yz- axis plane with zero point at installation position 1 (TOP1) → NBNxx-A-0/360/0 .. C3-1-S2N01**
The velocity signal (version 'D') refers to the same plane.



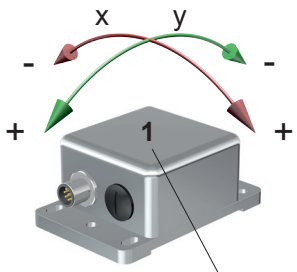

**360° rotation in zx- axis plane with zero point at installation position 1 (TOP1) → NBNxx-A-0/0/360 .. C3-1-S2N01**
The velocity signal (version 'D') refers to the same plane.

## Further examples for installation positions

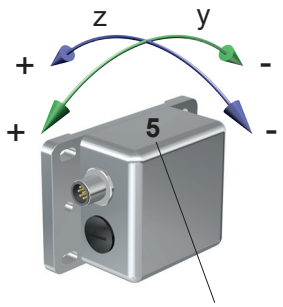
Further examples which refer to the assumed example measuring angles.

x = ± 90° y = ± 25° z = ± 15°

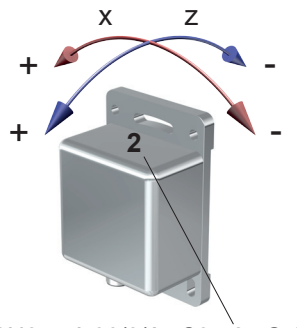
It is to be noted that the installation position always represents the device surface which is viewed from above. In the various illustrations, this is indicated with the bold number and must be specified on ordering under all circumstances.



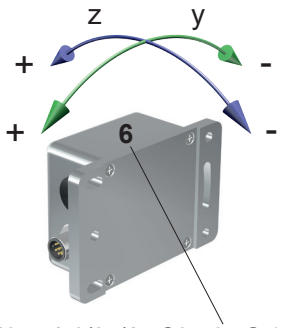

NBN65 - A **90**/**25**/0 C3 - **1** - S 1 N01



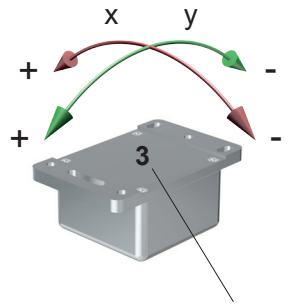

NBN65 - A 0/**25**/**15** C3 - **5** - S 1 N01



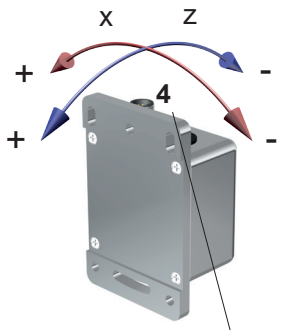

NBN65 - A **90**/0/**15** C3 - **2** - S 1 N01




NBN65 - A 0/**25**/**15** C3 - **6** - S 1 N01




NBN65 - A **90**/**25**/0 C3 - **3** - S 1 N01




NBN65 - A **90**/0/**15** C3 - **4** - S 1 N01