SUPREME SENSORING

Dynamic inclination sensor
Model NBN-G/S3
Interface: CANopen Safety, SAE J1939

Document no.:
NBN 17266 BE
11.03.2025

- **Dynamic inclination sensor**
- **MEMS-accelerometer and MEMS-gyroscope**
- **Safety dynamic inclination output for 3 axes**
- **Standard measuring ranges:**
  - **One axis: 360 ° (± 180°)**
  - **Two axes: ± 90°**
- **Safety rotation rate output for 3 axes**
- **Safety acceleration output for 3 axes**
- **Active temperature compensation**
- **Housing: zinc die cast**
- **Protection type: IP6K5 / IPX7**
- **TÜV certified: SIL2 and PLd**

CANopen safety easy to use | SAE INTERNATIONAL J1939 | SIL2 IEC 61508 FUNCTIONAL SAFETY SENSOR | PLd ISO 13849 FUNCTIONAL SAFETY SENSOR | E1 UN ECE R10 OFFICIAL LISTED SENSOR

KEY INFORMATION OVERVIEW

DESIGN & FUNCTION

The inclinometer measures the inclination in the gravitational field by means of MEMS sensors (Micro-Electro-Mechanical-System).

By combining MEMS acceleration sensors and MEMS angular rate sensors, each with 3 measuring axes, it is possible to generate an inclination signal that is insensitive to disturbing accelerations. Disturbing accelerations can be caused by vibrations and other accelerations (e.g. curve movements or changes in speed). All measured variables are recorded and processed in a functionally safe manner in order to obtain a stable inclination signal that corresponds to a SIL2/PLd safety level. Several filters (Butterworth, Kalman) are selectable to match the NBN-G to the application and therefore to achieve the best result.

The individual measured variables for each axis of acceleration and angular rate can also be read out separately.

The NBN-G has a stable zinc die cast housing with a robust design for use in harsh environments. An integrated heater enables the customer to operate an active temperature compensation.

It is equipped with a status LED and two connectors M12-A for CANopen bus loop use.

Different mechanical alignments of the NBN-G for several mounting situations in the application can be selected through customer via CAN parameter (see page 4).

FEATURES INTERFACE

The NBN-G is equipped with a CAN interface with the following transmission protocols/profiles, which can be selected via CAN parameter:

- CANopen
- CANopen Safety
- SAE J1939

It is short-circuit protected and can be operated with a bit rate up to 1000 kBit/s.

A status LED (green / red) indicates normal operating status or errors according to CiA DR-303-3.

Via CAN parameters the NBN-G can be parameterized and configured in many ways.

A detailed description of the NBN-G and the interface with CANopen / SAE J1939 protocol can be found in the NBN17275 manual (in preparation).

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TECHNICAL DATA

ELECTRICAL DATA

Sensor system	MEMS acceleration & gyroscope sensor
Operating voltage	9 to 36 VDC (supply lines inverse-polarity protected)
Operating current without active heating	25 mA (@ 12V)
Operating current with active heating	350 mA (@ 12V)
Number of measuring axes (standard)	1 axis 360° (± 180°) 2 axes á ± 90° 3 axes on request

Angle:

Measuring range	± 90° or 360° (± 180°)
Resolution	0.01°
Absolute accuracy @ +25 °C	± 0.3° (static) . . . . . ± 0.62° (dynamic)
Absolute accuracy @ -40 °C to +85 °C	± 0.8° (static) . . . . . ± 1.6° (dynamic)
Filter options *	IIR Butterworth filter 8th order IIR Critical damped filter 8th order

Accelerometer:

Measuring range	± 3 g
Resolution	0.25 mg
Offset error @ +25 °C	± 5 mg
Offset error @ -40 to +85 °C	± 20 mg
Gain error @ +25 °C	± 0.4 %
Gain error @ -40 to +85 °C	± 0.7 %

Gyroscope:

Measuring ranges (selectable)	± 125 °/s to ± 4000 °/s (parameterisable via CANopen)
Resolution	0.004375 °/s to 0.140 °/s (= 1 LSB, depending on selected measuring range)
Offset error @ +25 °C	± 2 °/s
Offset error @ -40 to +85 °C	± 5 °/s
Gain error @ +25 °C	± 2 %
Gain error @ -40 to +85 °C	± 5 %
Bias instability @ +25 °C	typ. 3 °/h
Angle random walk @ +25 °C	typ. 0.2 °/√h

CANOPEN / CANOPEN SAFETY / SAE J1939 OVERVIEW OF SPECIFICATIONS

CiA 305	CANopen - Layer Setting Sevices and Protocol (LSS)
CiA DSP 410	CANopen - Device profile for inclinometers
EN 50325-5	Industrial communication sub-system based on ISO 11898 (SRDO)
CiA 301	CANopen - Application Layer and Communication Profile
CAN-Interface	according to ISO/DIS 11898
J1939-21	Data Link Layer, revision 2016-03
J1939-71	Vehicle Application Layer, revision 2016-10
J1939-81	Network Management, revision 2017-03
J1939-DA	Digital Annex, revision 2019-04
CAN bit rate	100 to 1000 kBit/s
Terminating resistance	to be implemented separately
Max. transmission length	30 m

* The IIR filter algorithms act on the acceleration values, from which the angles are calculated.

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TECHNICAL DATA

DIAGNOSIS LED

LED 1 (green / red) . . . . . normal run state / error state, different flashing modes

MECHANICAL DATA

Housing material . . . . . zinc die cast
Dimensions . . . . . 83 mm x 73 mm x 26 mm
Weight . . . . . 0.25 kg

ENVIRONMENTAL DATA

Temperature range . . . . . - 40 °C to + 85 °C
Storage temp. range . . . . . - 40 °C to + 85 °C
Resilience to shock . . . . . 50 g, 6 ms, half sine, @ room temp., DIN EN 60068-2-27
Protection grade . . . . . IP6K5 / IPX7 / (IPX9K)

EMC STANDARDS

Selection, for complete list of standards and fulfilled values see manual NBN17275 (in preparation).

DIN EN 61326-1:2013 / DIN EN 61000-4-3 . Immunity - For electrical equipment for measurement, control and laboratory use - Radiated, radio-frequency, electromagnetic field immunity test

EN 61326-1:2013 (and 2021) /
EN IEC 61000-6-2:2019 / DIN EN 61000-4-6 Immunity to conducted disturbances, induced by radio-frequency fields - supply and data lines

EN 61326-1:2013 (and 2021) /
DIN EN 61000-4-8. . . . . Immunity - Electrical equipment formeasurement, control and laboratory use - magnetic field

SAFETY DATA

According to IEC 61508 . . . . . PFH ≤ 6.5 x 10^{-8} 1/h (softerrors included)
SFF ≥ 90 %
HFT = 0
SIL2

According to ISO 13849-1. . . . . MTTFd = 136.5 years (softerrors included)
DCavg = 92.2 %
Categorie 2
Performance Level D

Maximum operating duration. . . . . 20 years

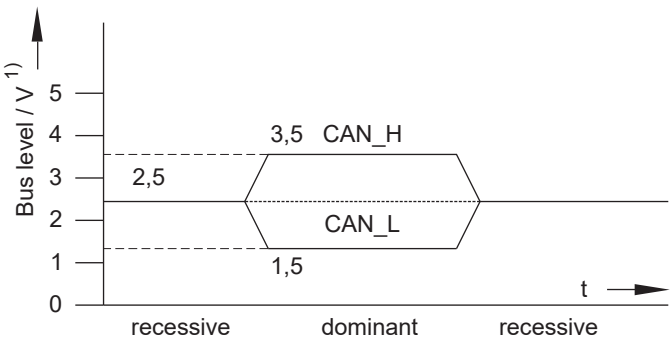
FURTHER APPLICABLE STANDARDS

E1 . . . . . approval according UN ECE Regulation No. 10, No. 10R - 06 10285

PROGRAMMABLE PARAMETERS

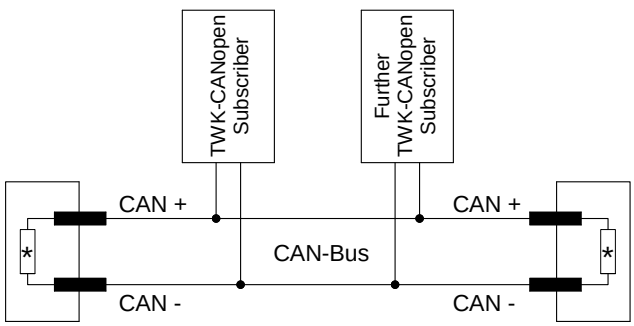
Please refer to manual NBN17275 (in preparation) for programmable parameters.

CAN OUTPUT LEVEL ACCORDING TO ISO/DIS 11898



1) with common mode voltage= 0V

CANBUS ACTIVATION ACCORDING TO ISO / DIS 11898



*Terminating resistor (120 Ω)

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PRODUCT CHARATERISTICS

INSTALLATION POSITION AND MEASUREMENT AXES

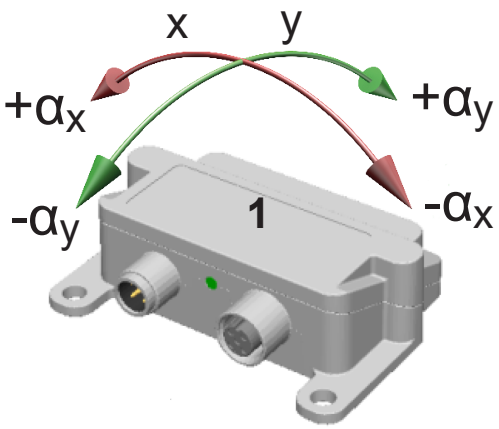
The installation position TOP 1...6 of the inclination sensor determines, which face points upward when the zero transition 360° → 0° occurs ex factory (resp. the middle of the measuring range). The zero position can be slightly modified by customer due to the preset/ offset function. For the three possible axes x, y, z the following surfaces / installation positions are assigned (1 to 6). See examples on this page for dynamic inclination output α_X, α_Y and α_Z. Definitions of acceleration output a_X, a_Y, a_Z and angular speed output ω_X, ω_Y, ω_Z are described in manual NBN17275 (in preparation).
The TOP position can be modified due to the mounting situation through customer by using the parameter CS_ROT (coordinate system rotation).

Standard installation positions ex works are TOP1 and TOP2.

1: Upper side	2: Back	3: Bottom
4: Front (connector side)	5: Left	6: Right

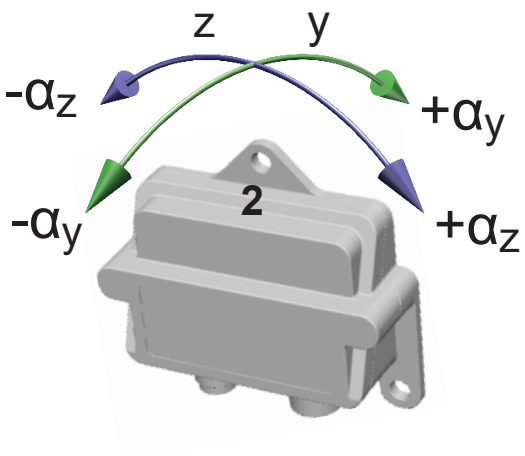
INSTALLATION POSITION TOP 1

NBN45 - Z x/y/0 G S3 - 1 - S2 N01



INSTALLATION POSITION TOP 2

NBN45 - Z 0/y/z G S3 - 2 - S2 N01



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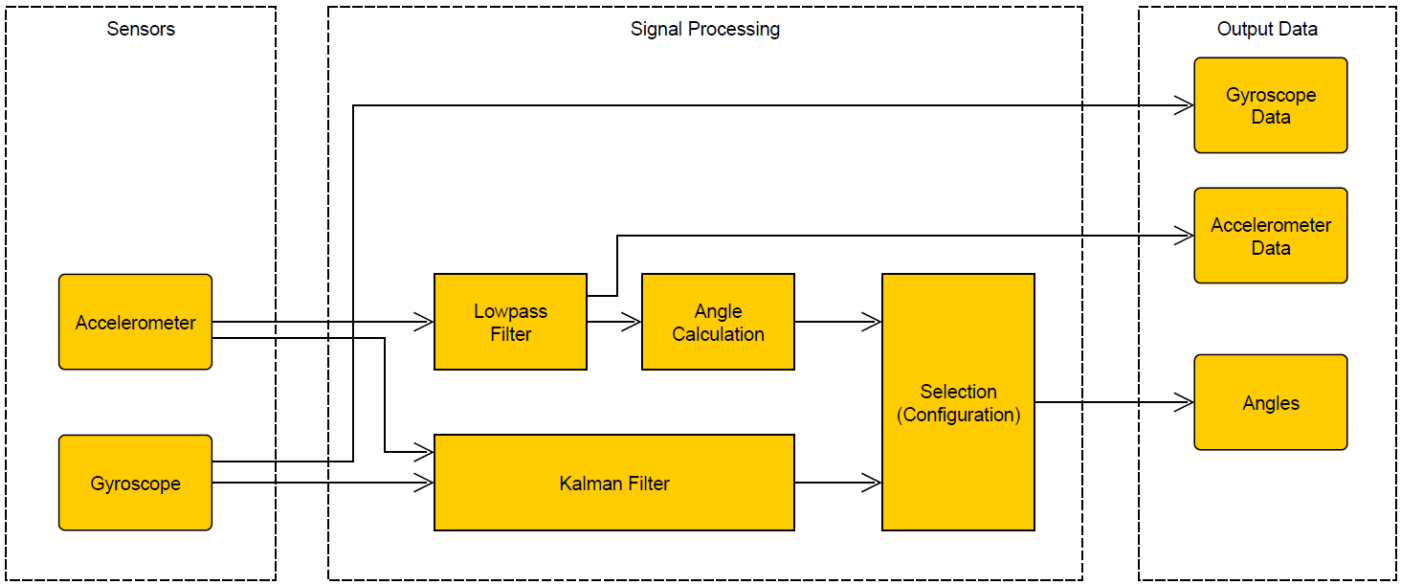
TECHNICAL DATA

PRINCIPAL DIAGRAM OF SIGNAL FLOW



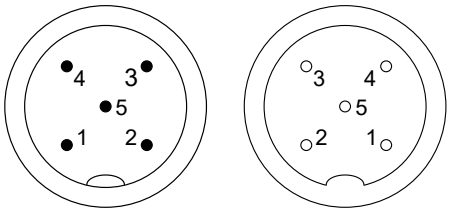
ELECTRICAL CONNECTION

ELECTRICAL CONNECTION

2 x M12 connector A-coded, 5-pole, male and female for bus in / bus out and power supply.
The connection assignment TYxxxxx is part of the scope of supply and is included with each device.

CONNECTOR FOR SUPPLY AND CANOPEN (BUS IN AND BUS OUT)

PIN. . . . . Function
1 . . . . . shield (PE, housing)
2 . . . . . + V_S (power supply)
3 . . . . . - V_S, GND (common ground)
4 . . . . . CAN_High
5 . . . . . CAN_Low



REMARK

Only use shielded cable for power supply and CANopen.

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ORDER CODE FORMAT

NBN	45 -	Z	90 /	90 /	0	G	S3	- 1 -	S	2	N	01	STANDARD VERSION

NBN	Inclination sensor with CANopen Safety / SAE J1939 interface		
45	Design form	45	Design form 45 mm
Z	Housing material	Z	Zinc die cast
90	Measuring range x	0 90 180	x-axis (± 90° at two axes or ± 180° at one axis available, else fill in 0)
90	Measuring range y	0 90 180	y-axis (± 90° at two axes or ± 180° at one axis available, else fill in 0)
0	Measuring range z	0 90 180	z-axis (± 90° at two axes or ± 180° at one axis available, else fill in 0)
G	Type of inclination sensor	G	Dynamic inclination sensor with gyroscope
S3	Profile	S3	SIL2 / PLd certified according to this data sheet
1	Installation position	1, 2, 3, 4, 5, 6	TOP position: see page 4 and below: available types
S	Electrical connection (kind)	S	Connector M12-A, 5-pole
2	Electrical connection (number)	2	2 x connector, male / female
N	Output	N	CANopen Safety / SAE J1939
01	Electrical and mechanical variants*	01	Standard

AVAILABLE TYPES

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

NBN45 - Z 90 / 90 / 0 G S3 - 1 - S2 N 01
NBN45 - Z 180 / 0 / 0 G S3 - 1 - S2 N 01

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

ACCESSORIES (TO BE ORDERED SEPARATELY)

MATING CONNECTORS

Order number, Datasheet	Type	Design & wire fixing	Housing-material	Cable ø & wire size	Shielding & IP grade
STK5GS56, –	M12-A 5-pole, female	Straight screws	Zinc die cast, nickel-plated	6 – 8 mm ≤ 0.75 mm²	On housing IP67
STK5GP90, –	M12-A 5-pole, male	Straight screws	Zinc die cast, nickel-plated	6 – 8 mm ≤ 0.75 mm²	On housing IP67
STK5WS58, –	M12-A 5-pole, female	Angled, screws	Zinc die cast, nickel-plated	6 – 8 mm ≤ 0.75 mm²	On housing IP67
STK5WP102, –	M12-A 5-pole, male	Angled, screws	Zinc die cast, nickel-plated	6 – 8 mm ≤ 0.75 mm²	On housing IP67

DOCUMENTATION

DOCUMENTATION

The following documents can be found in the Internet under www.twk.de/en in the documentation area, model NBN-G/S3

Data sheet NBN17266
Manual . . . . . NBN17275 (in preparation)
CE Declaration of Conformity ZE12467
UKCA Declaration of Conformity ZE16569
Reach-compliant QS15286
RoHS-compliant QS13284
Installation instructions AN16169

INSTALLATION DRAWING

MODEL NBN45 - Z *X* / *Y* / *Z* G S3 - *TOPX* - S2 N 01