Rotor hub sensor
Interface: **PROFIsafe/PROFINET**
Model **NBT-D/S3**

PROFI NET®

PROFIsafe

PLd ISO 13849 — FUNCTIONAL SAFETY SENSOR

SIL2 IEC 61508 — FUNCTIONAL SAFETY SENSOR

- **Accelerometer for angular position and gyroscope for angular velocity**

- **Selectable measurement axes: x or y or z**

- **Angular measuring range: 360°**

- **Total angular velocity up to 25 rpm with accuracy of up to 0.5% of current velocity**

- **High vibration and shock resistance thanks to robust design and predictive filtering**

- **For use e.g. in rotor hubs of wind turbines for rotor position and speed**

Design and function

This sensor can precisely detect position (360°) and speed of a continuously rotating shaft like a wind turbine and behaves like a rotary encoder with a speed signal. Digital processing and predictive filter techniques yield a high position and speed accuracy even when the sensor is tilted or disturbed by vibrations.

No fixed shaft attachment is required. This enables simple and therefore inexpensive installation in a rotating application. The accuracy of the sensor is comparable to a rotary encoder can be used as an alternative even in safety critical applications.

The sensor is based on our NBT model series. In addition to the MEMS accelerometer, a MEMS gyroscope is used to determine the rotation rate with a high refresh rate.

The sensor does not have to be positioned in the centre of the axis of rotation. The eccentricity is automatically determined by the sensor and used to correct the signal to gain a high accuracy position and speed signal for the shaft.

The robust sensor has a stable aluminium housing (stainless steel optional). Electrical connection is carried out using M12 connectors. The protection class extends up to IP67.

Data output is realised via a PROFINET interface according to IEC 61158 / 61784 or PNO specifications order No. 2.712 and 2.722, version 2.3

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.

The PROFIsafe protocol is implemented according to the PROFIsafe Profile for Safety Technology version 2.4 (PNO Order No. 3.192).

An exhaustive description of integration into a PROFINET network can be found in the NBT15982 manual.

PROFINET properties

- 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

Rotor hub sensor NBT-D/S3

Technical data

Electrical data

- Sensor system: MEMS acceleration sensor and MEMS gyroscope

- Operating voltage: 9 bis 36 VDC
- Power consumption: < 2 W
- Current consumption: ~ 60 mA at 24 VDC
- Measuring axes: z (x and y on request)
- Zero error: ± 1°
- Noise: ± 0.06° (position), typical ± 0.6 °/s (speed)
- Signal path: CCW
- Output code: Binary
- Refresh time of output signal: 10 ms
- Permitted tilt angle : up to 10°
- Eccentricity (from rotation axis): up to 1m

Position data:

- Measuring range: 360° (infinite rotation or reverse)
- Resolution: 0.01°
- Accuracy: ~ ±1° (undisturbed)
- Repeatability: ~ ±0.5° (undisturbed)
- Data format: Unsigned 16 Bit

Velocity data:

- Measuring range: 0 to 25 rotations per minute (rpm), 0 to 150 ° / s
- Resolution: 0.01 ° / s
- Accuracy (@ ~20 °C): ±0.5 % @ 15 rpm (undisturbed, highest accuracy)

  < 0.12 rpm for velocities < 7.5 rpm (total range, including disturbances*)

  < 1.5 % for velocities ≥ 7.5 rpm (total range, including disturbances*)
- Repeatability: ~ ±0,25% @ 15 rpm (undisturbed)
- Temperature drift: Slope ±0.03 % typ
- Data format: Signed 16 Bit

PROFINET Data

- MAC address: 88:A9:A7:BX:XX:XX

  The actual MAC address of the device is printed 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

Environmental data

- Operating temperature: - 40 °C ... + 70 °C
- Storage temperature: - 20 °C ... + 60 °C (due to packaging)
- Resilience
  - □ to shock: 200 m/s²; 6 ms

    DIN EN 60068-2-27
  - □ to vibration: 100 m/s²; 10 ... 2000 Hz

    DIN EN 60068-2-6
- Protection grade: IP 67
- Weight: ~ 0,3 kg (Aluminium)

  ~ 0,65 kg (Stainless steel)

*: Values were experimentally verified on a test stand in the presence of tower oscillations (1-2 m/s², 0.3 Hz) and typical structure born noise at several kHz, as well as during normal operation of a wind turbine (see handbook 15982 for details).

Technical data

Electromagnetic compatibility (EMC)

EN 61000-6-4:2006 + A1:2011	EMC Part 6-4: Generic standards-Emision standard for industrial environments
EN 61000-6-2:2005	EMC Part 6-2: Generic standards-Immunity for industrial environments
EN 61000-4-2:2009	EMC Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3:2006 A1:2008 + A2:2010	EMC Part 4-3: Testing and measurement techniques - Radiated, radio frequency. electromagnetic field immunity test
EN 61000-4-4:2004	EMC Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5:2006	EMC Part 4-5: Testing and measurement techniques - Surge immunity test
EN 61000-4-6:2009	EMC Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8:2010	EMC Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test Power frequency magnetic field immunity test: 30 A/m, test criterion A (±0.5°) 100 A/m, test criterion B
EN 61000-4-29:2000	EMC Part 4-8: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
IEC 61326-3-2:2018	Electrical equipment for measurement, control and labortory use - EMC requirements Part 3-2: Immunity for safety-related systems and for equipment intended to perform safety related functions (functional safety) - industrial applications with specified electromagnetic environment

Safety relevant data

- According to DIN EN 61508:
  $PFH = 5.27 *10^{-8}$
  $SFF = 97.3\ \%$
  $HFT = 0$
  SIL2
- According to DIN EN ISO 13849-1:
  $MTTF_d = 100$ years (calculated 180 years)
  $DC_{avg} = 96.7\ \%$
  Category 2
  Performance Level D
- Maximum service life
  25 years

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
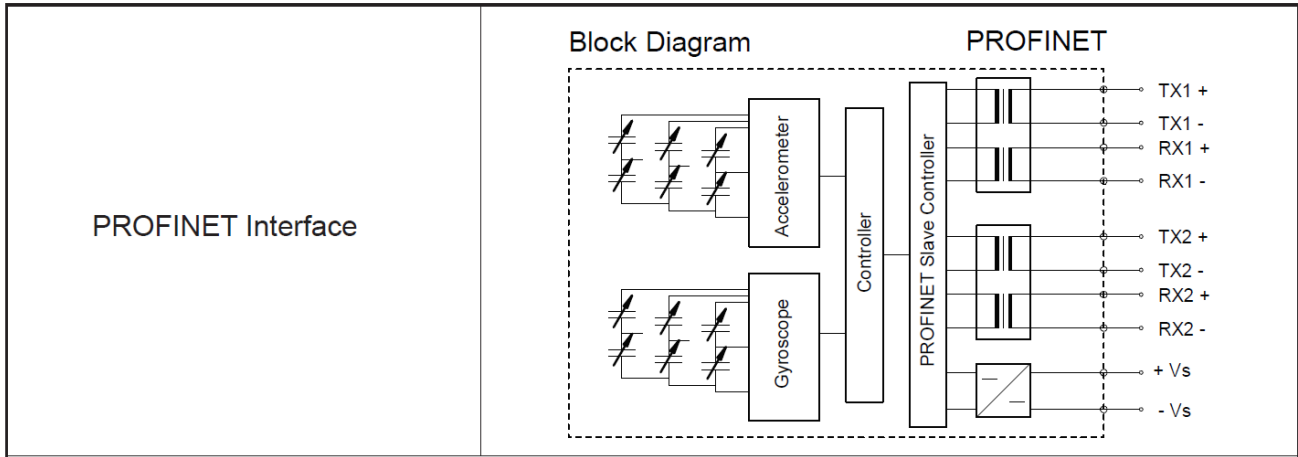
Cable output PROFINET (optional)

- Cable type: PROFINET Type-C, 4 x 0.36 mm2 (AWG22)
- Cable jacket: PUR, colour: green
- Temperature range: - 40 °C bis + 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 (optional)

- Cable type: $2 \times 0.75\ mm^2$, shielded
- Cable jacket: PUR, colour: green
- Temperature range: - 40 °C bis + 70 °C fixed installation, - 5 °C bis + 70 °C freely movable
- Outer diameter: 6 mm
- Min. Bend radius: 6 x d fixed installation, 15 x d freely movable

Electrical connection

Block diagram

Block Diagram — PROFINET

PROFINET Interface

TX1 +
TX1 -
RX1 +
RX1 -
TX2 +
TX2 -
RX2 +
RX2 -
+ Vs
- Vs

PROFINET M12 connection assignment connector / cable output
(Port1 and Port 2)

PIN	1	2	3	4
Signal	TX+	RX+	TX-	RX-
Colour*	yellow	white	orange	blue

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

Supply M12 connection assignment connector / cable output

PIN	1	2	3	4
Signal	+ UB (+ 24 VDC)	—	- UB (0 VDC)	—
Colour	white	—	brown	—

Remark
Only use shielded cable for power supply and PROFINET

Diagnosis-LEDs

UB (VS)	Link 1 (L1)	Link 2 (L2)	Status (NS)	Description
green	green	green	green/red	
on				Operating voltage available
	on			Network connection established
		on		Network connection established
			green	Data exchange, device in operation and functional.
			green flashing	Network connection available, but no connection to PROFINET controller
			red, slow flashing	Firmware download mode
			red, flashing	Error message occurred, see manual NBT 15982, chapter 7
			red, fast flashing	Device error
			red	Connection to PROFINET controller disrupted

SUPREME SENSORING
TWK

Order number

NBT	90 - A 360 / 0 / 0 D S3 - 4 - S 3 T 01 → **Standardversion**
NBT	**Inclination- or rotor hub sensor with PROFINET interface**
90	Design form 90
A	Housing material: A = Aluminium
360	Measuring axis X (TOP1) (please enter 360 at the desired axis)
0	Measuring axis Y (TOP1) (please enter 360 at the desired axis)
0	Measuring axis Z (TOP4) (please enter 360 at the desired axis)
D	With gyroscope for measuring angular velocity
S3	Profile: S3 certified according to this data sheet
4	Installation position (see page 7): TOP1 or TOP4
S	Electrical connections: S: Connector M12 K: Cable
3	Electrical connections: 1: Single Connector (1 x hybrid connector) 2: Two connectors (1 x PROFINET, 1 x power supply) 3: Three connectors (2 x PROFINET, 1 x power supply) X: Cable length in m (for cable output)
T	Output profile: T: PROFINET
01	Electrical and mechanical variants * 01 Standard

* Standard versions according to this data sheet are labeled 01. Variations are identified with a variant number and are documented at TWK. the factory

Accessories, documentation, GSD file

Accessories (to be ordered separately)

- Straight mating connector

STK4GP81	for PROFINET In/Out (die-cast zinc, nickel-plated), see data sheet STK14570
STK4GP110	for PROFINET In/Out (stainless steel 1.4404), see data sheet STK14569
STK4GS60	for supply voltage (die-cast zinc, nickel-plated), see data sheet STK14572
STK4GS104	for supply voltage (stainless steel 1.4404), see data sheet STK14571

- Angle mating connector

STK4WP82	for PROFINET In/Out see data sheet STK14676
STK4WS61	for supply voltage see data sheet STK14675

- Connection cable - PROFINETt

KABEL-xxx-114	Industrial Ethernet data cable with M12 connectors, D-coded, moulded at both ends. Standard length: 1, 2, 3, 5, 10, 20 m (xxx = length in metres), other length on request, see data sheet KBL14673
KABEL-xxx-118	Industrial Ethernet data cable with M12 connector to RJ 45, IP 20 (xxx = length in metres, up to 25 m), see data sheet KBL14655

- Connection cable - power supply

KABEL-5-191	With moulded M12 connector, A coded, straight, second side open, length up to 15m, see data sheet KBL13411

Documentation and GSD file

The following documents, the GSD file and a bitmap can be found at www.twk.de.
Please browse to *Documentation* and look for Model NBT-D/S3.

- ☐ Data sheet No. NBT15981
- ☐ Manual No. NBT15982

Installation position and measurement axis

The installation position **TOP 1...6** of the rotor hub sensor determines, which face points upward when the zero transition 360° → 0° occurs.

For the three possible rotation axes are the following surfaces / installation positions fixed assigned. Other combination are only available on request:
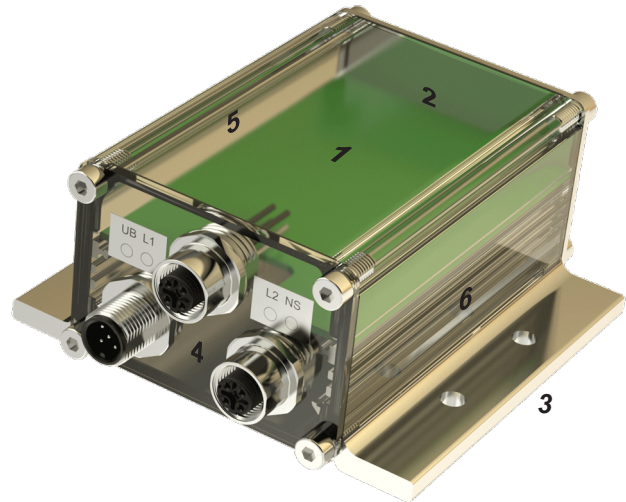
NBT 360 / 0 / 0 → TOP4

**NBT 0 / 360 / 0 → TOP1**

NBT 0 / 0 / 360 → TOP1

The signal path (increasing angle values) is per default set to CW. It can be changed to CCW by the user.

The definition of the rotation axis can be found below. The sensor does not have to be installed on of the rotation axis. Further information on possible eccentricity can be found in the manual 15892.

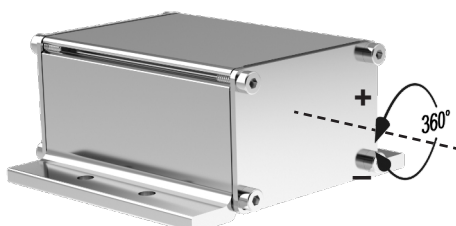| 1: Top	2: Back	3: Bottom
4: Front (Connectors)	5: Left	6: Right

Rotation direction CW
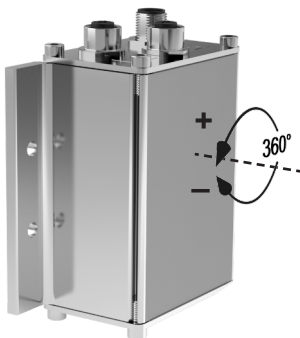
→ **NBT90-A 360 / 0 / 0 D S3 - 4 - S3 T01**
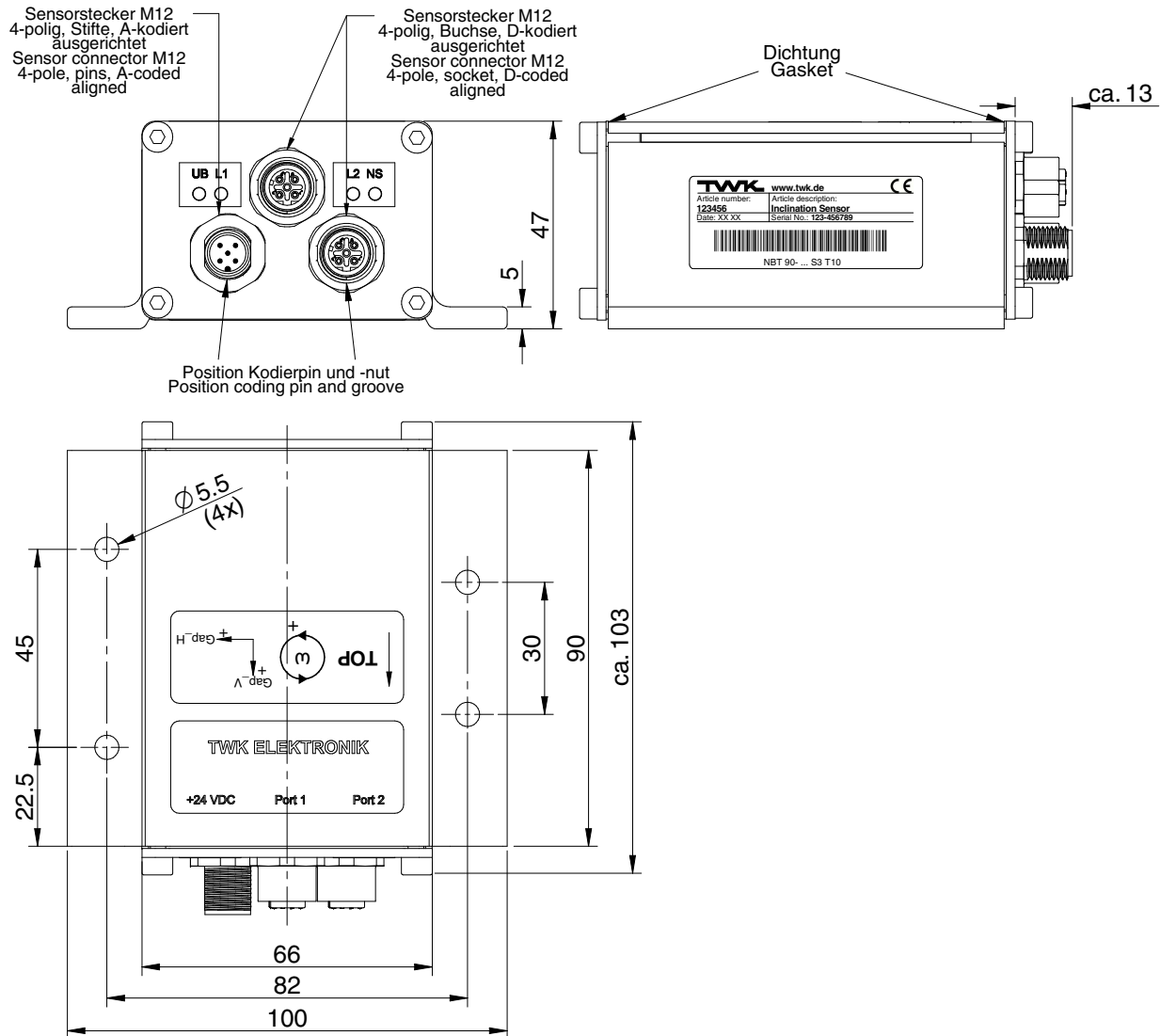

→ **NBT90-A 0 / 360 / 0 D S3 - 1 - S3 T01**
(on request)

→ **NBT90-A 0 / 0 / 360 D S3 - 1 - S3 T01**
(on request)

Installation drawing

Design form 90, order number: NBT90-Axx/xx/xxDS3-x-S3T01

Dimensions in mm

Materials used:

Aluminium housing:	AlMgSi0,5 (EN AW 6060)
Aluminium front plates:	AlMg2Mn0,8 (EN AW-5050)
Connector/cable gland:	Die-cast zinc, nickel-plated
Sealing rings:	NBR