



- Contactless, wear-free MEMS sensor system
- Number of measurement axes: 2
- Frequency range: 0.05 ... 60 Hz
- Measuring range:  $\pm 2$  g
- Various signal settings: RMS, PEAK etc.
- Signal output:
  - PROFIsafe over PROFINET
  - PROFINET standard (grey channel)
- Option: Fast Fourier Transformation FFT



## KEY INFORMATION OVERVIEW

### DESIGN & FUNCTION

The sensor system is intended as a component for use in e.g. wind turbines to measure and evaluate vibrations in the nacelle. Dynamic accelerations are measured using MEMS (Micro-Electro-Mechanical System) sensors with subsequent processing in a microcontroller.

The sensor's high resistance to vibration and shock beyond the defined measurement range makes it suitable for use in harsh environments.

Electrical connection is done via three connectors. Four LEDs assist with installation and diagnostics of the NVT90/S3.

The constant acceleration component due to an angle of inclination caused by a non-horizontal installation is determined and subtracted from the measured vibration signal.

The filter characteristics can be individually programmed at the factory (low pass, high pass or band pass). They can be applied to the x, y and resultant horizontal axes.

The resulting signals can be used for

- Output to PROFIsafe over PROFINET
- Output to PROFINET standard protocol
- Calculation of momentary, RMS, peak or integral output

### 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 series NVT.

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 vibration sensor 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 [NVT14588](#) manual.

- 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
- Programming via Profinet

## GENERAL INFORMATION

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The vibration sensor measures in two axes (x and y) in a frequency range from 0.05 to 60 Hz. These two axes are parallel to the mounting surface of the NVT90. This spectrum can be divided into a maximum of six frequency ranges. The frequency ranges are factory set. All acceleration values acting within the corresponding frequency window are registered and output as a digital value via PROFI-safe over PROFINET.

The measurement axes are x and y or the vector sum  $\sqrt{(x^2+y^2)}$ .

This sensor is intended for horizontal mounting only. Tilt angles up to 15° are permitted. If the tilt angle increases by 15°, an error message is generated by the sensor and transmitted by PROFI-safe via PROFINET. The constant component resulting from a less than perfectly horizontal installation is determined and subtracted from the measured vibration signal so that no offset or zero shift of the dynamic component occurs. This is done continuously with a time constant of approximately 40 seconds. The minimum lower frequency limit of the vibrations to be measured is therefore 0.05 Hz. This function can be disabled at the factory.

### FILTER CHARACTERISTICS

After the constant component suppression, the NVT first applies a digital pre-filter to largely suppress higher-frequency interfering oscillations (standard: > ~95 Hz), as these often have comparatively high amplitudes (1st order FIR filter).

The individual frequency bands are then implemented in the downstream controller using further digital main filter types. For example: 8<sup>th</sup> to 11<sup>th</sup> order Chebichev filters or 2<sup>nd</sup> order Butterworth filters. Other filters and filter combinations are available on request.

The acceleration value (instantaneous value) can be used directly, or the average of the instantaneous value (RMS) can be used as the output value. The time over which averaging is performed can be set (e.g. 30 s). A PEAK value or an integration value can also be selected. The peak value are be decremented after a predefined time and with a specified rate.

Note: High order filters provide high frequency rejection but also high group delay. Please contact our technical staff for details and filter curves to adapt the NVT to your application. Please also refer to the manual [NVT14588](#).

## TECHNICAL DATA

### ELECTRICAL DATA

Sensor system	MEMS acceleration sensor
Operating voltage range	+ 9 to + 36 VDC
Power consumption	< 2 W
Current consumption	ca. 60 mA at 24 VDC
Measuring range	± 2 g for each axis (standard)
Frequency range	0.05 to 60 Hz
Resolution	4096 digits / g (9.81 m/s <sup>2</sup> = 1 g)
Accuracy	5 % typ.
Sampling frequencies (standard setting)	1000 Hz(MEMS) 120 to 800 Hz (output (main) filter, depending on frequency)
Number of frequency bands	maximum of 6 (setting ex works)
Maximum inclination vs. horizon	15° (at angles >15° an error message will be transferred by PROFINET)
Sign of output data	see drawing concerning axes and sign of acceleration direction on <a href="#">page 8</a>
Electrical connection	3 x connector M12 or 3 x Cable (1 x Power supply / 2 x PROFINET)

### INPUT DATA \*

2 byte status word  
5 x 2 byte filter output data

### OUTPUT DATA \*

2 byte control word

### PROFINET DATA

MAC address	88:A9:A7:BX: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

\* From the point of view of the control system

## TECHNICAL DATA

### DIAGNOSIS LEDS

LED 1 (VS, green)	Power supply
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

Operating temperature range	- 40 °C to + 70 °C
Storage temperature range	- 40° C to + 85° C
Resistance to shock	200 m/s² / 5 ms (DIN EN 60068-2-27)
Resistance to vibration	100 m/s² at 10 Hz ... 2000 Hz (DIN EN 60068-2-6)
Protection type	IP67 (DIN EN 60529)
Humidity	≤ 95 %, not condensing
Housing material	Aluminium (see drawing <a href="#">page 8</a> )
Weight	0.4 kg

### EMC STANDARDS

EN 61000-6-4:2006 + A1:2011	EMC Part 6-4: Generic standards-Emission 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, 100 A/m, test criterion B
EN 61000-4-16:2016	EMC Part 4-16: Testing and measurement techniques - Test for immunity to conducted, common mode disturbance in the frequency range 0 Hz to 150 kHz
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 laboratory 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 DATA ACC. TO ISO 13849-1:2015 AT +70 °C

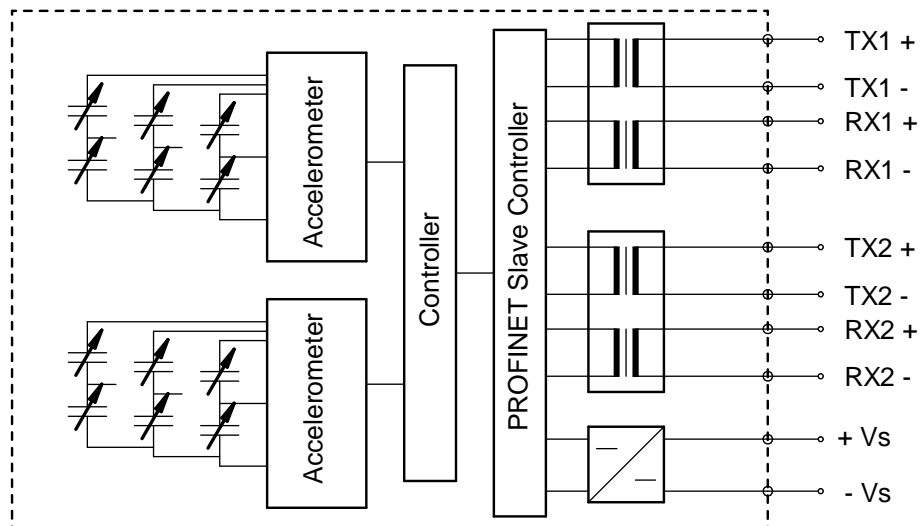
NVT with PROFIsafe interface	MTTFd	100 years (220 years calculated)
	DC <sub>avg</sub>	97.25 %
	Category	2
	Performance Level	PLd
	CCF	fulfilled
	Maximum service life	20 years

### PROGRAMMABLE PARAMETERS (REFER TO HANDBOOK NVT14588 FOR DETAILS)

Firmware download	Sets NVT in the state „firmware download mode“
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## TECHNICAL DATA

### PRINCIPAL CIRCUIT DIAGRAM



## ELECTRICAL CONNECTION - PINOUT

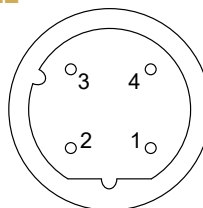
### ELECTRICAL CONNECTION

PROFINET ..... M12 connector D coded, 4 pin, female for port 1 and port 2 or cable output via cable glands  
Power supply ..... M12 connector A coded, 4 pin, male or cable output via cable gland

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

#### PIN..... Function

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



### PROFINET CABLE OUTPUT (2 X)

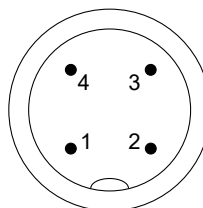
#### Colour\* ..... Function

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)

### CABLE OUTLET PROFINET (OPTIONAL)

Cable type ..... PROFINET Type-C, 4 x 0.36 mm<sup>2</sup> (AWG22)  
Cable jacket ..... PUR, color: green  
Temperature 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 OUTLET POWER SUPPLY (OPTIONAL)

Cable type ..... 2 x 0.75 mm<sup>2</sup>, shielded  
Cable jacket ..... PUR, color: gray  
Temperature 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

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

#### ORDER CODE FORMAT

**NVT**    **90** -    **A**    **5**    **0**    **0**    **- 2**    **S3**    **M**    **T**    **01**    **STANDARD VERSION**

NVT	Vibration / acceleration sensor with PROFIsafe over PROFINET interface		
<b>90</b>	Design form	90	Design form 90
<b>A</b>	Housing material	A	Aluminium (see <a href="#">page 8</a> )
<b>5</b>	Number of frequency filters	1 to 6	Filter settings according to customer request (see <a href="#">NVT14588</a> )
<b>0</b>	Number of switching outputs	0	Not currently available for this model (relays)
<b>0</b>	Number of analogue outputs	0	Not currently available for this model (0/4 to 20 mA)
<b>2</b>	Measuring range	2	2 g = ca. 20 m/s <sup>2</sup> – higher values on request
<b>S3</b>	Profile	S0 S3	PROFIsafe - not certified PROFIsafe - PLd certified according to this datasheet
<b>M</b>	Electrical connection	M Mx Ky	3 x connector M12 (2 x PROFINET, 1 x power supply) Reduced number of M12 connectors**: x = 1 or x = 2 3 x cable output, y: cable length in m (e.g. 2,5)
<b>T</b>	Output	T	PROFINET - 100Base-TX
<b>01</b>	Electrical and mechanical variants*	01	Standard

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

\*\* Number of connections: 1 = Hybride, 2 = 1 x power supply, 1 x PROFINET

## ACCESSORIES (SELECTION)

### 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	Zinc die-cast 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	Zinc die-cast 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>STK4WP116</b> , <a href="#">STK15518</a>	M12-D 4-pole, male	Angled, IDC	Zinc die-cast nickel-plated	4 – 8 mm AWG 23 to 22	On housing IP67
<b>STK4WS117</b> , <a href="#">STK16392</a>	M12-A 4-pole, female	Angled, PLC	Zinc die-cast nickel-plated	4 – 8 mm AWG 26 to 18	On housing IP67

Only use shielded cable for EN 61000-6-2 interference immunity for power supply and PROFINET.

### CONNECTING CABLE - PROFINET

- KABEL-x-114** . . . . . Industrial Ethernet data cable with M12 connectors, D-coded, moulded on at both ends.  
x = length in meters, standard lengths: 1, 2, 3, 5, 10, 15 and 20 m, see datasheet [KBL14673](#)
- KABEL-x-118** . . . . . Industrial Ethernet data cable with M12 connector to RJ 45, IP 20.  
x = length in meters, standard lengths: 2, 3, 5, 10, 15 and 25 m, see datasheet [KBL14655](#)
- KABEL-x-217** . . . . . Industrial Ethernet data cable, high flexible with connector STK4GP81 and open ends  
x = length in metres on request
- KABEL-x-218** . . . . . Industrial Ethernet data cable, high flexible with connector STK4GP81 and RJ45  
x = length in metres on request

### CONNECTING CABLE - POWER SUPPLY

- KABEL-x-191** . . . . . Power supply cable with moulded M12 connectors A coded straight, 2. side open.  
x = length in meters, standard lengths: 2, 5, 10, 15, 20 and 25 m, see datasheet [KBL13411](#)
- KABEL-x-216** . . . . . Cable for power supply with connector STK4GS60 and open ends  
x = length in metres on request

## DOCUMENTATION

### DOCUMENTATION

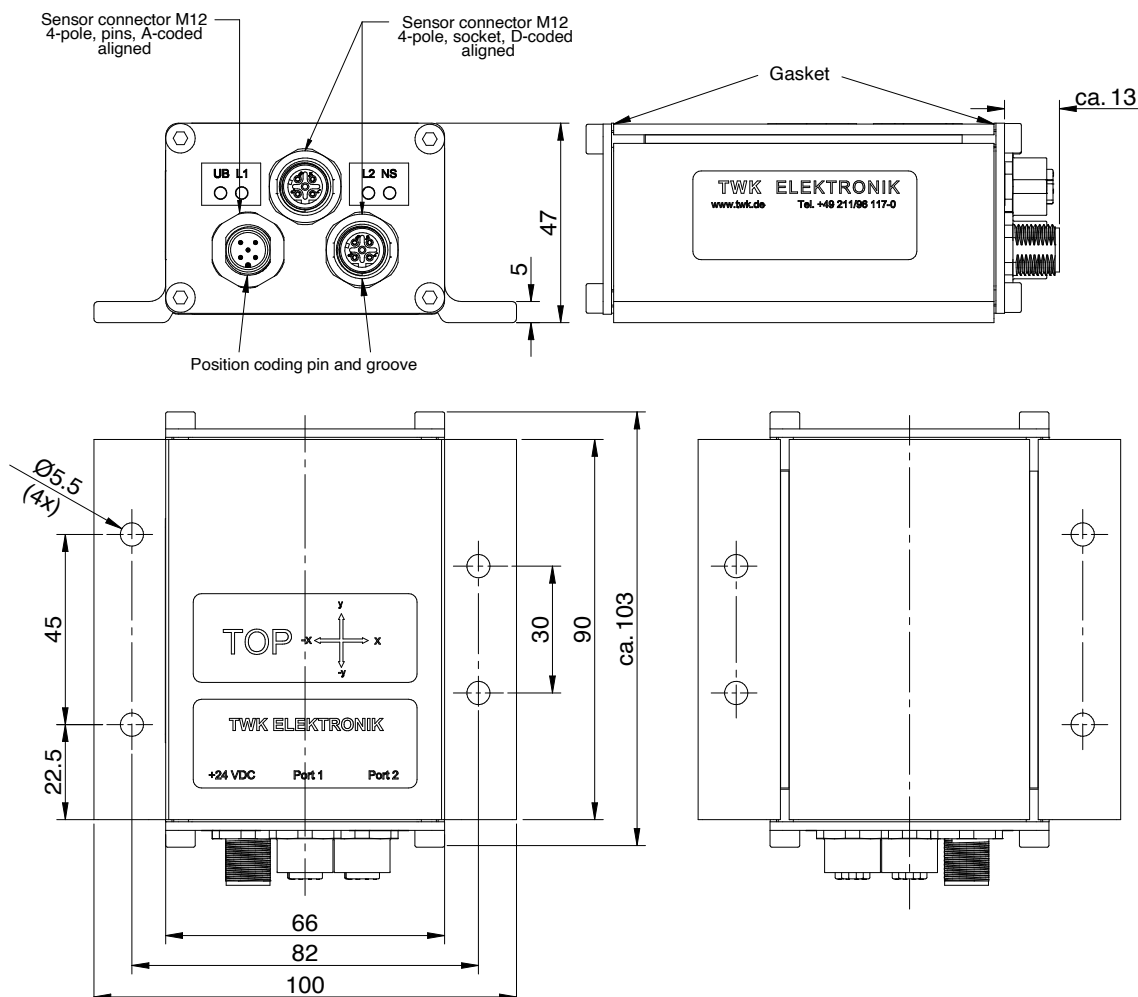
The following documents can be found in the Internet under [www.twk.de/en](http://www.twk.de/en) in the documentation area, model NVT.

- Data sheet . . . . . [NVT14587](#)  
Manual . . . . . [NVT14588](#)  
Certificate PROFINET . . . . . [NVT15256](#)  
Certificate PROFIsafe . . . . . [NVT15638](#)  
Certificate PLd . . . . . [NVT15215](#)  
Installation instructions . . . . . [AN16169](#)  
GSD file . . . . . [GSD file NVT/S3](#)  
CE Declaration of Conformity . . . . . [ZE12467](#)  
UKCA Declaration of Conformity . . . . . [ZE16569](#)  
Safety Library . . . . . [Safety Library \(VDMA/Sistema\)](#)  
Reach compliant . . . . . [QS15286](#)  
RoHS compliant . . . . . [QS13284](#)

## INSTALLATION DRAWINGS

### MODEL NVT90-A500-2 S3 M T01

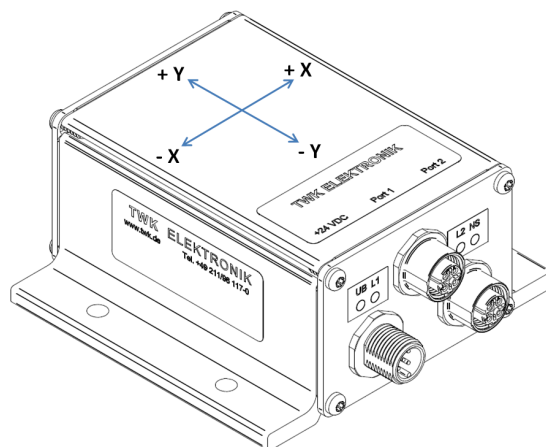
Dimensions in mm



### DEFINITION OF AXES

When NVT90 is accelerated in direction of the arrow (TOP label), the acceleration is output with this sign: -X, +X, -Y, +Y.  
Signed 16 Bit: ....., FFFD, FFFE, FFFF, 0, 1, 2, .....

Mounting orientation: horizontal



### MATERIALS USED

Aluminium housing .....	Aluminium 3.3206
Aluminium front plates .....	Aluminium 3.3316
Connectors .....	Brass, nickel plated or Die-cast zinc, nickel plated
Sealing rings .....	PTFE / NBR