elobau

sustainable solutions

Instruction manual

Version: 1.1
No.: 9010052B01D

N6/N7 Tilt sensor

N6SA, N6SC static
N7DA, N7DC dynamic

Table of contents

1. User information

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Validity This Instruction manual generally applies to the product N6/N7 listed on the title page and must be appended to the product documents of the downstream machine. Other variants are possible and are also listed in case of deviating specifications. Depending on the customer's wishes or special versions, individual components may be missing or deviate from the standard. Some drawings and figures in this Instruction manual are for illustrative purposes only. Deviations from the original part are therefore possible and desired for reasons of a better representation.

The publisher has tried to make this Instruction manual as accurate and up-to-date as possible. We are constantly working on developing our products further. We reserve the right to make changes to the scope of delivery in terms of shape, equipment and technology. No claims can be derived from the information, figures and descriptions in this documentation.

This Instruction manual is a translation of the original Instruction manual. For more information, we are at your disposal.

1.1 General

This document makes it possible to safely work and handle to the product properly N6/N7. Read through this Instruction manual carefully before commissioning and observe the relevant health and safety and accident prevention regulations. Also observe all warnings to avoid hazards for personnel, the environment or the product.

Make this Instruction manual as well as other information about the product (e. g. data sheets) available to the person who installs, maintains or repairs the product. When passing on or selling the product, this Instruction manual must be enclosed with the product because it is part of the product. Therefore, keep this Instruction manual safe for the entire service life of the product and readily accessible in a legible condition.

If you do not understand this Instruction manual or parts of it, please ask us.

1.2 Representation conventions

(i) **Information!**

Refers to effective and practical use of the product.

Text/image reference (1) Item number: Refers to an item number in a figure

↓ ↑ ↺↻ Direction arrows: Indicate movement directions and screwing directions or specific information on the coordinate system.

Lists Numbered and non-numbered lists are represented as follows:

1. Numbered list
2. Numbered list
- List, level 1
  - List, level 2
  - List, level 2

Handling instructions Handling instructions in chronological order for operating the machine are represented as follows:

Action task

1. Action step: Prompts an action.
   Interim result: To check an action step.

2. Action step: Prompts an action.
   Interim result: To check an action step.

3. Action step: Prompts an action.

✓ *Result of action*

Individual handling instructions, without a chronological order, are represented as follows:

▶ Unordered action step

1.3   Abbreviations used

The following abbreviations are used in this document:

°	Grad
°/s	Grad pro Sekunde
CAN	Controller Area Network
CE	Conformité Européenne (engl.: Conformity for Europe)
CiA	CAN in Automation (CAN application interest group)
ECU	Electronic Control Unit
EMC	Electromagnetic compatibility
EMCY	Emergency Message
EUC	Equipment under control
FIR	Finite impulse response
FMEA	Failure Mode and Effect Analysis
FMI	Failure Mode Identifier
ID	Identifier
IMU	Inertial measurement unit
IP	International Protection
Kbps	Thousand bits per second
LED	Light Emitting Diode
MAVG	Moving Average Filter
MEMS	Microelectromechanical System
n.c.	not connected
OTE	Output of Test Equipment
PDO	Process Data Object
PGN	Parameter Group Number
REACH	Regulation, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
SRS	System Requirements Specification
SPN	Suspect Parameter Number
TAA	Average ambient temperature
UDS	Unified Diagnostic Services
UKCA	United Kingdom Conformity Assessed
UV	Ultraviolet

Table 1

1.4 Functional principle

N6/N7 is a compact and robust tilt sensor that can be easily integrated into agricultural machinery, construction machinery and industrial trucks to record tilt information from machine components and make it available via an electrical interface.

For the electrical connection to a higher-level system, the tilt sensor provides a connector on the back as an electrical interface.

1.4.1 Intended use

The tilt sensor is a measuring device for determining tilts in mobile machinery and for supplying the downstream device with measured values in the form of electronic output signals. The tilt sensor must not be used for any other purpose.

Typical applications of mobile machines:

*   Mobile machinery
*   Forestry and agricultural machinery
*   Construction machinery
*   Industrial trucks
*   Automated guided vehicles (AGV)

The application is only within the limits of the technical data and the latest data sheet. The ambient conditions must be checked by the user before using the tilt sensor.

*   Only operate the tilt sensor in a completely closed and undamaged housing.
*   Only use the tilt sensor correctly and as intended.
*   If used incorrectly, any guarantee and manufacturer liability is forfeited.
*   Ensure that the safety regulations of the individual machines are complied with.
*   Ensure that the international and national regulations are complied with.

1.4.2 Foreseeable misuse (improper use)

Any improper use of the product and any activities not described in this Instruction manual are unauthorised use outside the legal liability limits of the manufacturer.

In the event of improper use, hazards can arise for persons or property.

The following operating conditions, amongst others, are classified as misuse:

*   Use in potentially explosive areas. The product is not a safety component per the EC Machinery Directive (2006/42/EC).
*   Use in aeronautical and aerospace applications, nuclear and military applications.
*   Fall from heights over 1 metre. The function of the product is no longer guaranteed.
*   Non-compliance with the technical data.

Operation contrary to the intended use will void the warranty.

1.5   Warranty and liability

All products are extensively tested for all functions before delivery. Nevertheless, material and/or manufacturing defects may occur.

(i) **Information**

This product has a warranty of 24 months beginning at the time of transfer of risk. The general terms and conditions of the manufacturer apply to the warranty and liability.

Defects in the form of material or manufacturing defects that occur during this warranty period shall be rectified free of charge either by repair or replacement. The General Terms and Conditions of Delivery of elobau GmbH & Co. KG apply.

If a warranty is provided, the warranty period is not extended.

We reserve the right to charge for costs resulting from unjustified claims, e. g. installation or operating errors.

Liability exclusion The manufacturer excludes warranty and liability claims for personal injury and property damage if they are caused by one or more of the following causes:

- Non-compliance with this manual.
- Improper use.
- Unauthorised repairs, conversions and modifications that are not described in this Instruction manual. This also includes painting the tilt sensor.
- Deliberate damage or improper handling.
- Use of spare parts or accessories that have not been approved by the manufacturer.

The warranty does not apply in the event of third-party interference or dismantling by a third party without our prior consent. To the extent permitted by law, other claims for compensation are excluded.

1.6   Manufacturer

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2. Safety instructions

2.1 General labelling of hazards and information

The severity of the hazard and its consequences are classified in this Instruction manual with the following signal words and colours.

<div style="text-align:right">

VORSICHT!
</div>

Here is a brief description of the type and source of danger.

If the safety instruction "CAUTION" appears, there is a low risk of danger. The occurrence of the mentioned hazard may result in reversible minor personal injuries.

▶ Listing of all measures which must be taken to prevent the consequences.

<div style="text-align:right">

ACHTUNG!
</div>

Here is a brief description of the type and source of danger.

If the following safety instruction "ATTENTION" appears, there is a situation which may potentially result in property damage.

▶ Listing of all measures which must be taken to prevent the consequences.

2.2 Definition of personnel groups

2.2.1 Operator/contractor

The operator of the downstream machine is responsible for training personnel to work in a safety-conscious manner at regular intervals and to ensure the personnel are appropriately qualified for the necessary work.

The operator is obligated to only allow personnel to work on the machine, system, assembly or with the software who:

• Have been trained in the procedures and operation.
• Are familiar with the regulations on health and safety and accident prevention.
• Have read and understood the content of the Instruction manual in order to prevent hazards for personnel or the product.

2.2.2 User / operating and maintenance personnel

This includes all persons who are responsible for the installation, operation, set-up times, maintenance work (including cleaning) and troubleshooting on behalf of the operator/contractor. Personnel tasked with operation and maintenance must be appropriately qualified for this work. The area of responsibility, competence and supervision of personnel must be precisely regulated by the operator. If personnel do not possess the requisite knowledge, the operator must provide training and instruction. If necessary, this can be provided by the manufacturer or supplier on behalf of the operator.

2.3 Conformity

The product N6/N7 conforms to the state of the art plus the applicable safety conditions at the time of bringing into circulation within the scope of its intended use. From a design point of view, foreseeable misuse cannot be avoided without limiting the intended functionality.

The specification of this system is based on the following documents:

- REACH 1907/2006/EU
- RoHS 2011/65/EU
- DIN EN 12895 (EMC standard)
- DIN EN ISO 13766 (EMC standard)
- DIN EN ISO 14982 (EMC standard)
- DIN EN 60068 (Environmental influences)
- ISO 11898 (CAN)
- ISO 20653 (IP protection)

2.4 Changes, modification

Any unauthorised change or modification is expressly forbidden. The activities described in this Instruction manual are excluded from this.

3. Transport and storage

During transport and storage, protect the product against heat, moisture, chemicals and impacts. Transport and storage only permitted in the original packaging. Do not exceed the permissible storage temperature of -40°C to +85°C.

4. Product-specific information

4.1 System description

The system offers the following functions:

- Provision of tilt information as the main function,
- Visual status display.

The following information received is processed by the system and leads to a corresponding action:

- Setting a tilt offset,
- Downloading logged data from the system memory.

Depending on the output signal variant of the system, the transmitted tilt signal and the transmitted "harmless error signal" can be an analogue output signal or a corresponding CAN message.

4. Product-specific information

4.2 Dimensions
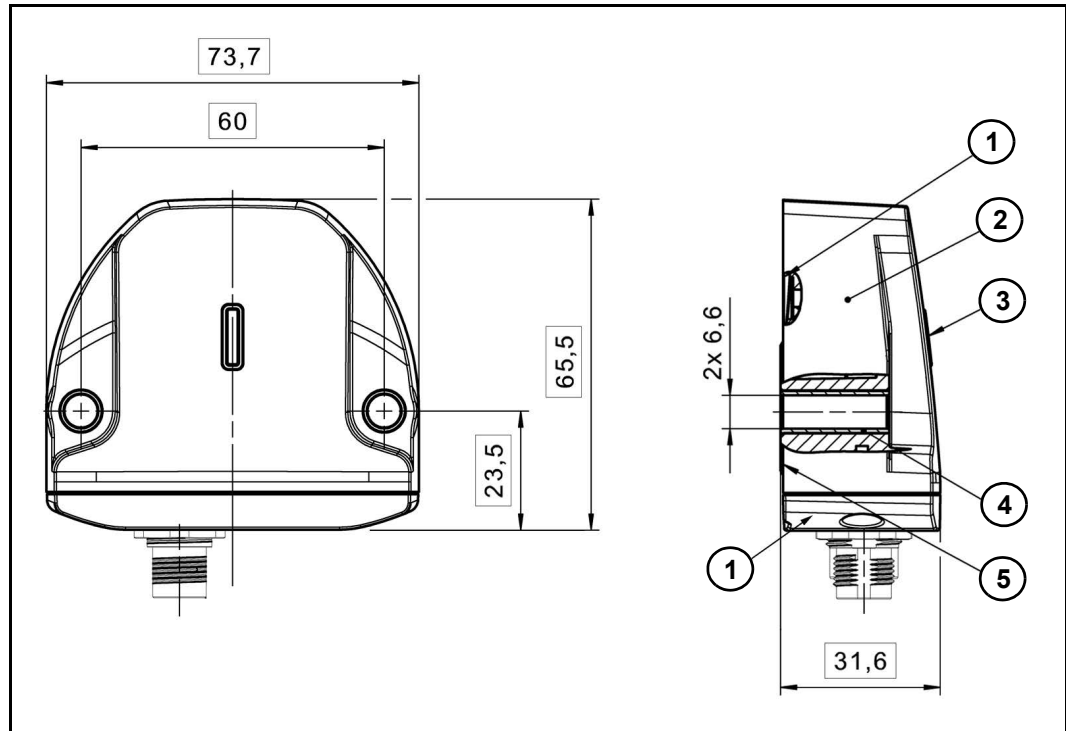
Figure 1

1. Lid
2. Housing
3. Status display
4. Pressure equalisation membrane
5. Receptacle
6. Labelling

Please refer to your data sheet for further details.

4.2.1 Pressure equalisation membrane

There is a pressure equalisation membrane on the underside of the sensor. This enables the sensor to operate at different temperatures and altitudes.

Figure 2

ACHTUNG!

System error due to mechanical damage!

If the pressure equalisation membrane is damaged, this can lead to a system failure.

▶ Protect the membrane from external influences of any kind.

▶ Do not paint over the membrane.

▶ Position the tilt sensor accordingly.

4.2.2   Material definition and materials

The materials of the tilt sensor are selected taking various aspects into account to ensure a long service life.

All materials that are applied to the outside of the system, e. g. on the housing, or are visible from the outside, e. g. behind the light guide, are selected with the following aspects in mind:

- Resistance to the effects of salt,
- Resistance to the effects of the following chemicals:
  - Petrol, diesel, biodiesel, bioethanol (E85), rapeseed methyl ester (CME), AdBlue (DEF), engine oil, transmission oil,
  - Brake fluid,
  - Lubricating grease,
  - Underbody protection,
  - Antifreeze mixture (incl. ethylene glycol), windscreen antifreeze, windscreen washer fluid, isopropyl alcohol,
  - Degreaser, contact spray (e.g. WD40),
  - Battery acid, NPK fertiliser and urea nitrogen,
- Resistance to UV radiation,
- Compliance with the REACH Regulation [1907/2006/EU],
- Fulfilment the RoHS Regulation [2011/65/EU] and lead-free.
- Scratch-resistant grain and do not release any hazardous substances.

All materials that are using internally, e. g. the control board, are selected with the following aspects in mind:

- Compliance with the REACH Regulation [1907/2006/EU].
- Fulfilment the RoHS Regulation [2011/65/EU] and lead-free.

4.2.3 Integrated LED configuration
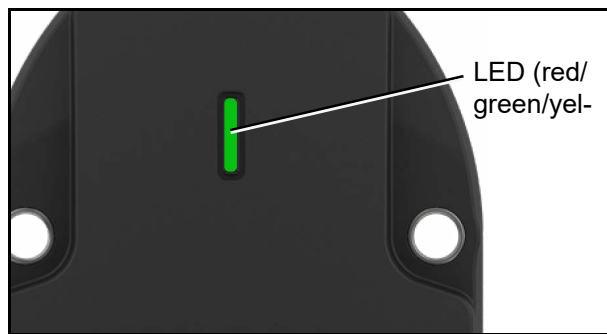
An integrated LED enables the functional status of the tilt sensor to be monitored.

Figure 3

System operation	Mode	Colour
Not operating	Off	-
Booting / Activation	Continuously on	Yellow
Normal operation	Continuously on	Green
Communication stopped	Continuously on	Red
Error information	Flashing	Yellow

Table 2

LED status

LED	Sensor	Cause	Remedy
Red constant	N6/N7	CAN Bus Off Error	Rectify error in CAN network
		CAN has incorrect baud rate set	Check CAN baud rate
		Sensor defective	Contact elobau
Yellow constant	N7	Filter not initialised	Sensor reset
		Too much vibration when sensor starts	Lower vibrations
Yellow flashing	N7	Maximum rotation speed exceeded	Increase measuring range
		Maximum acceleration exceeded	Increase measuring range
		Sensor temperature too low/high	Check ambient temperature
		Sensor input voltage too low/high	Check voltage
off	N6/N7	Sensor temperature clearly too low/high	Check ambient temperature
		Sensor input voltage clearly too low/high	Check voltage
		Sensor defective	Contact elobau

Table 3

4.3   Electrical data

N6SA[1]	N6SC[1]	N7DC[1]	N7DA[1]	Description
x	x	x	x	EMC conformity in accordance with the current off-highway standards (chapter 2.3 "Conformity")
x	x	x	x	Ideally suited for use in harsh environmental conditions: • Temperature range: -40 - +85 °C • Protection type: IP67K / IP6K9K • Robust housing
x	x	x	x	Large supply voltage range 8 VDC - 36 VDC
x	x	x	x	Compact design for use in tight installation situations
x	x	x	x	Application-specific configuration by means of parametrisation
x	x	x	x	Modular connector principle (Deutsch connector, 1x M12 connector, 2x M12 connector - daisy chain)
x	x	x	x	1-axis and 2-axis tilt sensor
		x		Use as an acceleration or angular rate sensor
x			x	Analogue output signals 4 mA - 20 mA or 0.5 V - 4.5 V[2]
	x	x		Convenient CANopen or SAE J1939 interface
x	x	x	x	Output signals in combination with relay outputs
		x	x	Initial measurement unit (IMU) consisting of accelerometer and gyroscope • Dynamic applications • Compensation of external accelerations • Fast response time • Intelligent sensor fusion filter
	x	x		Diagnosis, updating, flashing or troubleshooting via UDS 14229
x	x	x	x	CO_2 neutral production - Made in Germany
x[1]	x	x	x[1]	**Programmable parameters:** • Zero point adjustment • Switch-on/switch-off delay • Hysteresis • Switching points • Connection type • Signal path • Measuring range • Cut-off frequency • Coordinate system
x	x	x	x	Diagnostic function

Table 4

[1] Factory configurable
[2] Signal outputs can be scaled by configuration, e. g. 0 V - 10 V or 0 mA - 20 mA signal (see "Detection of the position in relation to the reference plane" page 23).

4. Product-specific information

> **Information!**
> Consult elobau in the event of deviations from the permissible technical data. Validation performed by testing.

4.4 Signal flow

Below is a signal flow diagram from the raw data to the output signals.
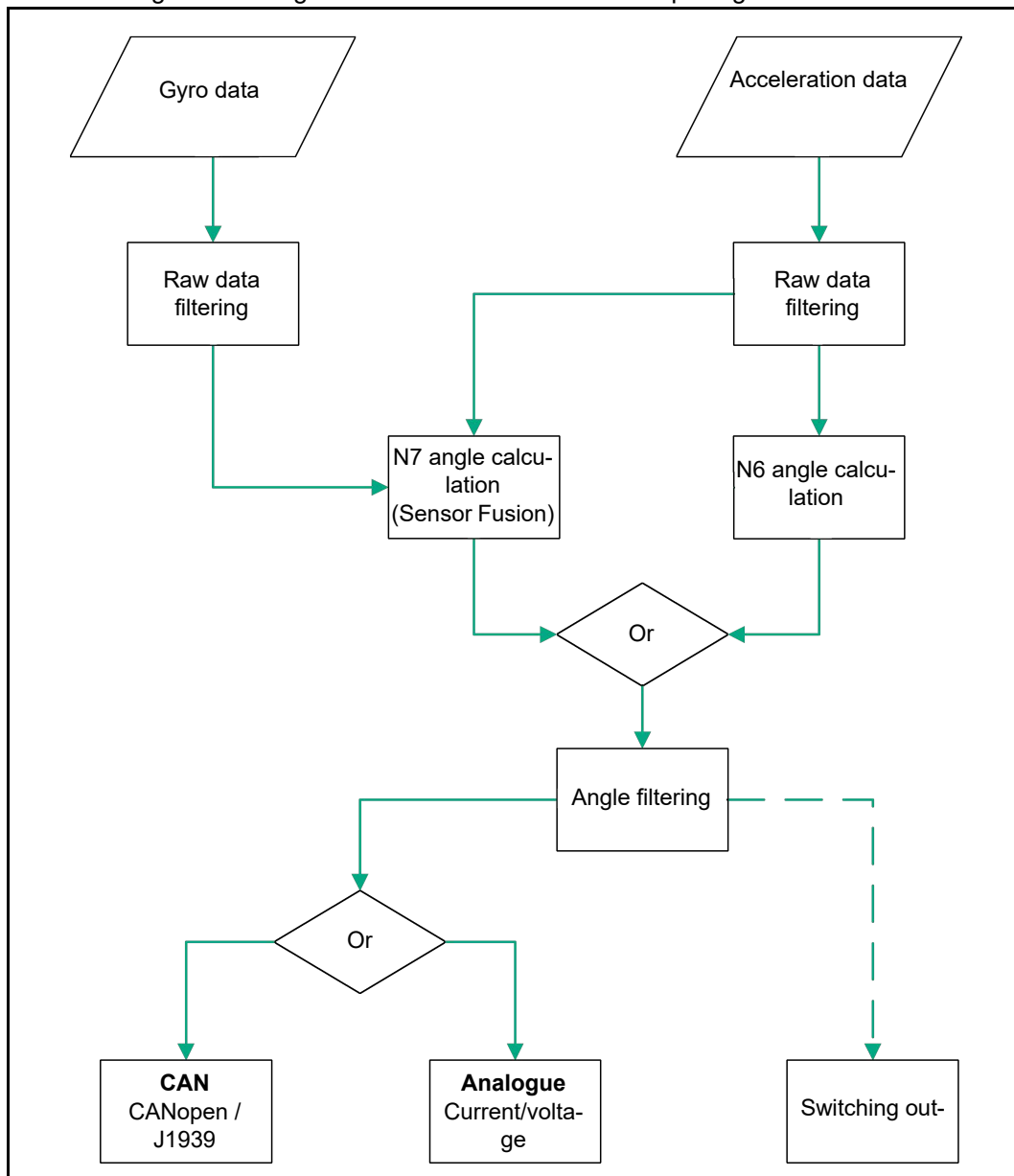
Figure 4

4.5 Output signals

The tilt sensor N6/N7 has three interfaces via which it can provide tilt information. Currents or voltages can be output via the analogue output in proportion to the angle. Alternatively, the calculated angles can also be sent via CAN, whereby the CANopen and J1939 protocols are available.

In addition, the tilt sensor offers two switching outputs for variants with a Deutsch connector, the switching thresholds of which can be set at the factory and at the customer's location (only with CAN) (see "Relay switching outputs" page 19).

4.5.1   Analogue output signals

The standard signal range is shown in the following tables. Other configurations are possible on request.

Output signal	Error signal
4 mA - 20 mA	22 mA
0.5 V - 4.5 V	5 V

Further technical details can be found in the relevant data sheet for your configuration.

Table 5

Z-axis output characteristics

Z-axis -60°	Z-axis -20°	Z-axis 0°	Z-axis +20°	Z-axis +60°
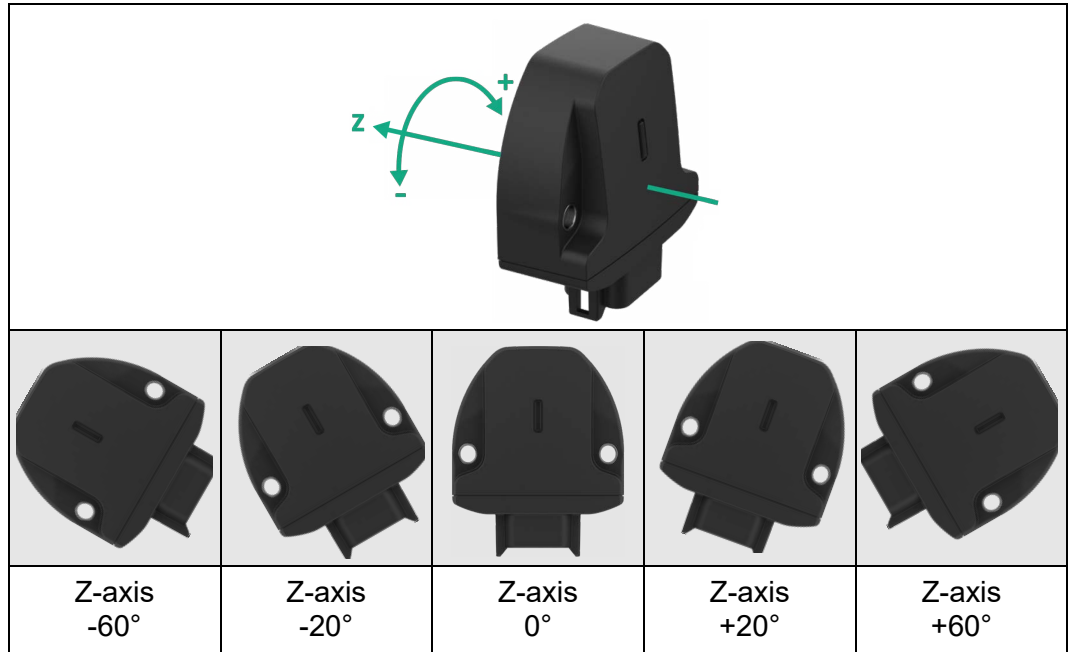
Figure 5

CAN: Z = Roll

Measuring range ±60° - vertical mounting (Z-axis)
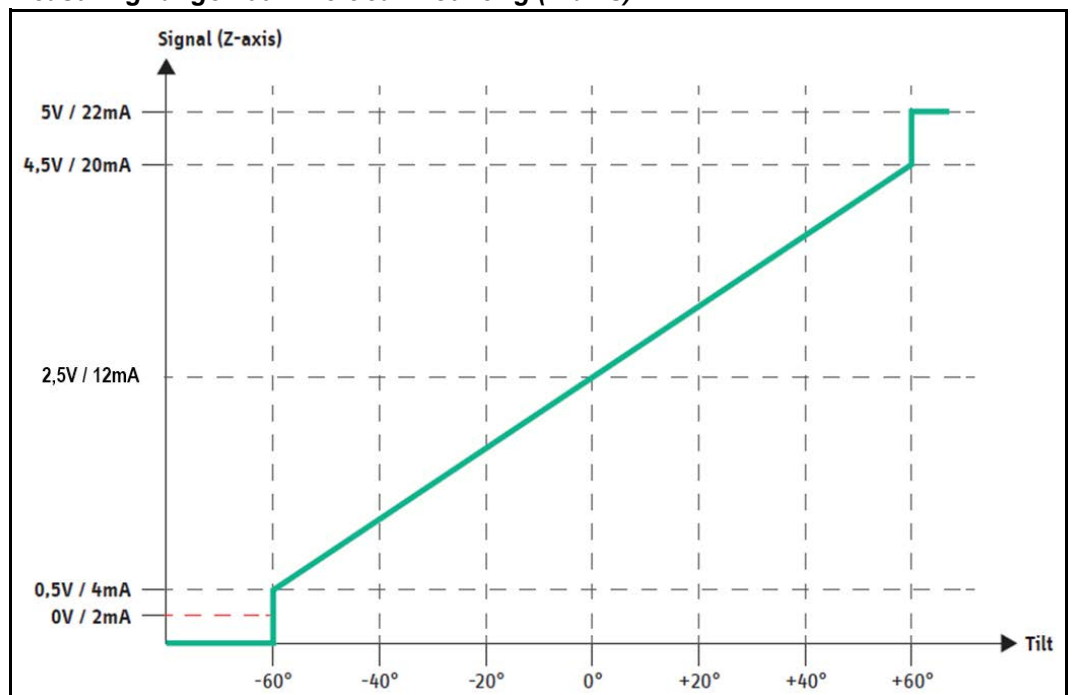
Figure 6

X/Z-axis output characteristics

Z-axis = 0° X-axis = 0°	Z-axis = +20° X-axis = 0°	Z-axis = +60° X-axis = 0°
Z-axis = 0° X-axis = 0°	Z-axis = 0° X-axis = +20°	Z-axis = 0° X-axis = +60°
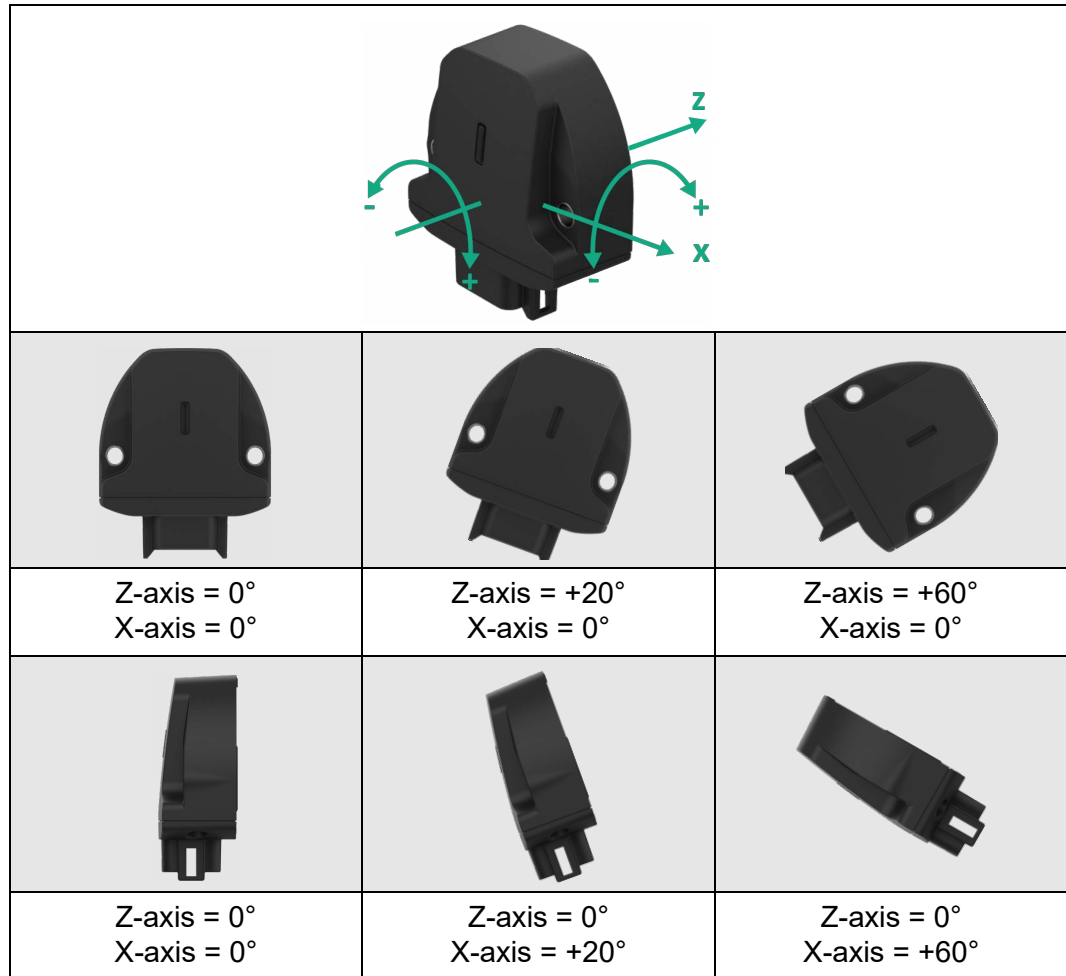
Figure 7

CAN: Z = Roll, X = Pitch

Measuring range ±60° - vertical mounting (X/Z-axis)
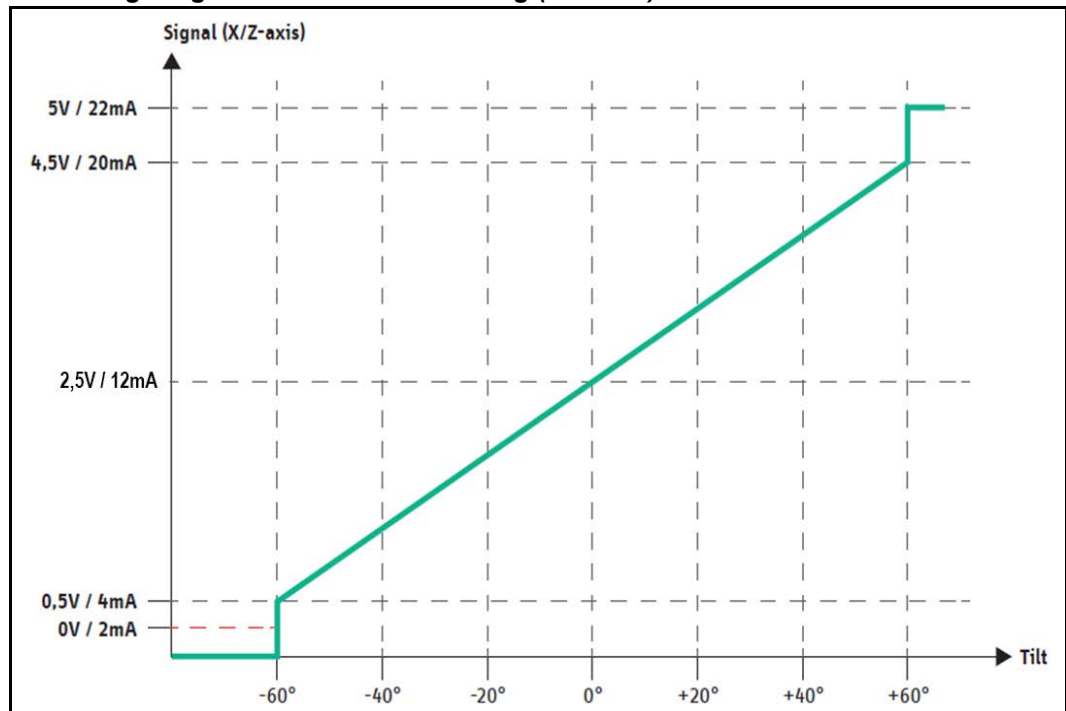
Figure 8

X/Y-axis output characteristics

Y-axis = 0° X-axis = 0°	Y-axis = -20° X-axis = 0°	Y-axis = -60° X-axis = 0°
Y-axis = 0° X-axis = 0°	Y-axis = +20° X-axis = 0°	Y-axis = +60° X-axis = 0°
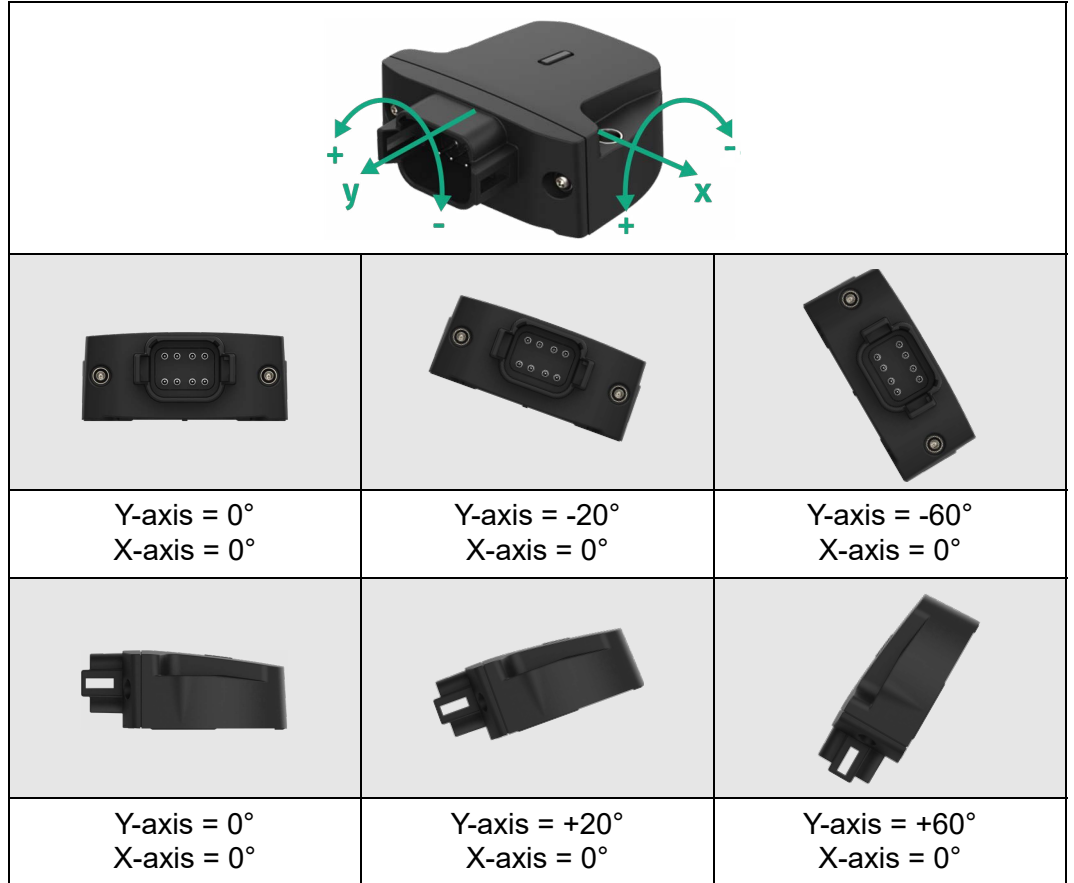
Figure 9

CAN: Y = Roll, X = Pitch

Measuring range ±60° - vertical mounting (X/Y-axis)
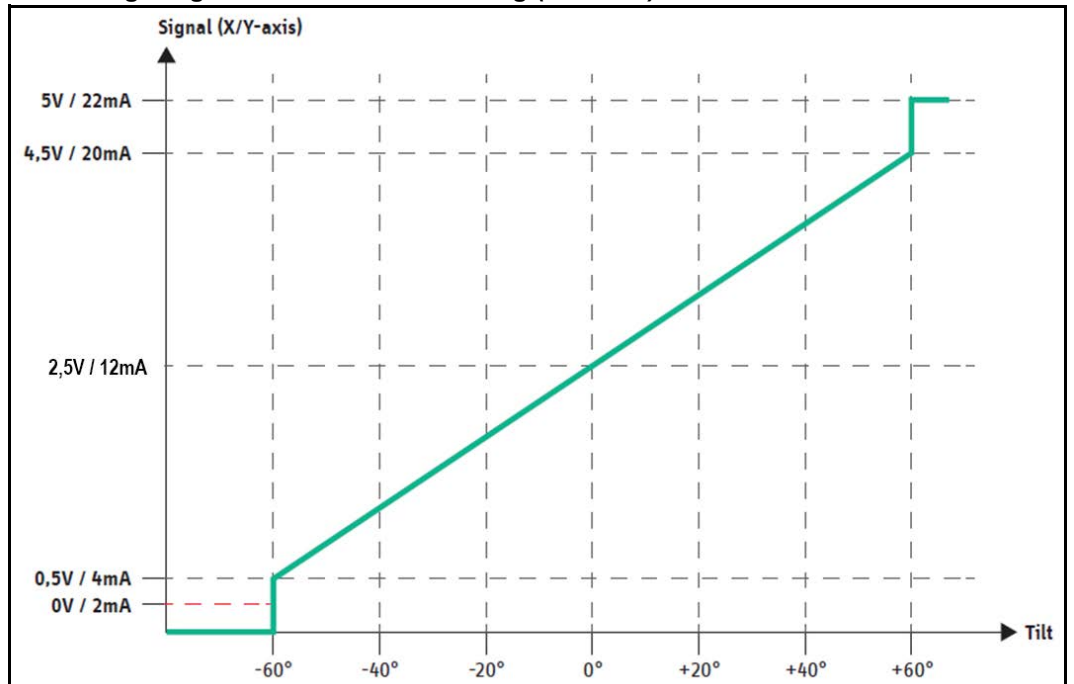
Figure 10

Derating curve   The derating curve describes the maximum permissible operating voltage of the tilt sensor depending on its ambient temperature in variants with a current output.
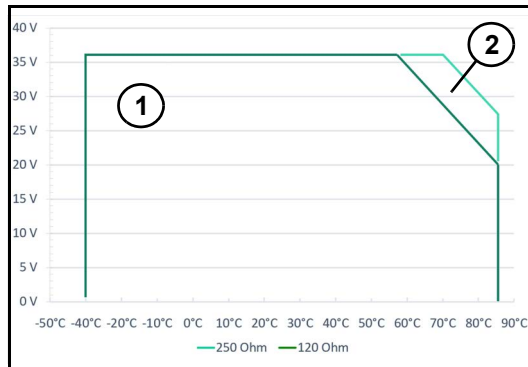
Figure 11

1. Permissible operating range with a load resistance of R_L = 120 Ω.
2. Permissible operating range with a load resistance of R_L = 250 Ω.

Example:

With a selected load resistance of RL = 250 Ω, the tilt sensor may be operated at an ambient temperature of up to 70 °C with an operating voltage of U_B =36 V. To operate at an ambient temperature of up to 85 °C, the operating voltage must be reduced up to U_B = 27.4 V.

Note   Only operate the tilt sensor N6/N7 within the permissible operating range. If operated outside the permissible operating range, a function is no longer guaranteed and can destroy the tilt sensor under certain circumstances.

4.5.2   Adaptation of analogue signals

The analogue output signals can be adapted independently of each other for each signal output, taking into account the following rules:

- The mapping always results in linear output behaviour. Non-linear mappings are not supported.
- The mapping allows you to set the tilt range of interest (e. g. +/- 30°). Ranges that are not symmetrically tilted to zero are also supported.
- The mapping enables the use of any part of the analogue signal output (e. g. 0.5 V to 4.5 V).
- The mapping enables a negative gradient (e. g. falling with increasing tilt).

The following illustration shows the standard output signal design for a signal output and two customised output signals as examples.
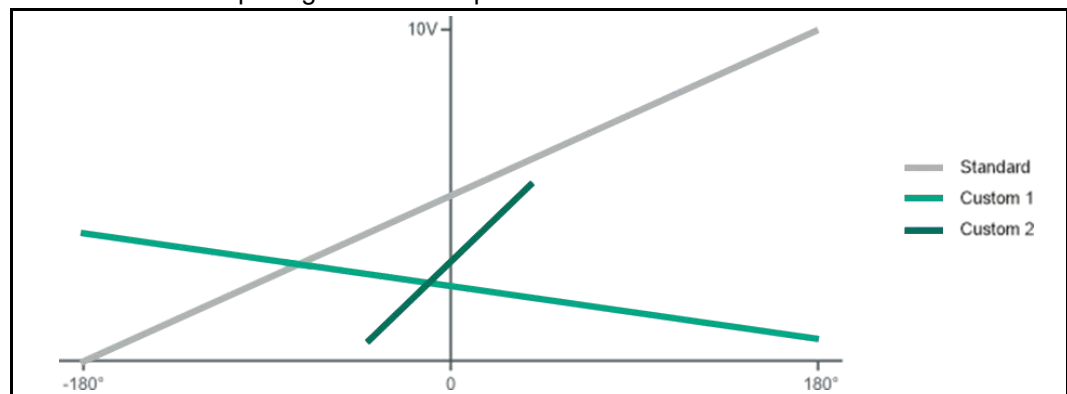
Figure 12

Examples	Angle range	Output voltage
Standard	-180° - 180°	0 V - 10 V
Custom 1[1]	-180° - 180°	4 V - 0.5 V
Custom 2[1]	-30° - 30°	0.5 V - 6 V

Table 6

[1] Configurable on request

4.5.3 CAN output

All information on CAN output can be found at chapter 6. "CANopen | J1939 interface".

4.6 Relay switching outputs

The switching outputs offer a simple option of communicating the exceeding of an angle threshold of a connected evaluation unit. 4 switching thresholds per axis are available which can be assigned to the two relays.

N6SA	N6SC	N7DC	N7DA		
x	x	x	x	Switching output	2x NC contact (NO contact on request)
x	x	x	x	Switching voltage	36 V DC (max.)
x	x	x	x	Switching current	1 A (max.)
x	x	x	x	Switching power	30 W (max.)
x	x	x	x	Hysteresis*	0.1° - 10°
x	x	x	x	Switch-on delay*	Selectable (0 - 2 s in 0.5 s increments)
x	x	x	x	Switch-off delay*	Selectable (0 - 2 s in 0.5 s increments)

Table 7

* The values listed can be configured ex works.

4.6.1 Connection types of the relay outputs

Installation position vertical mounting (Z-axis)
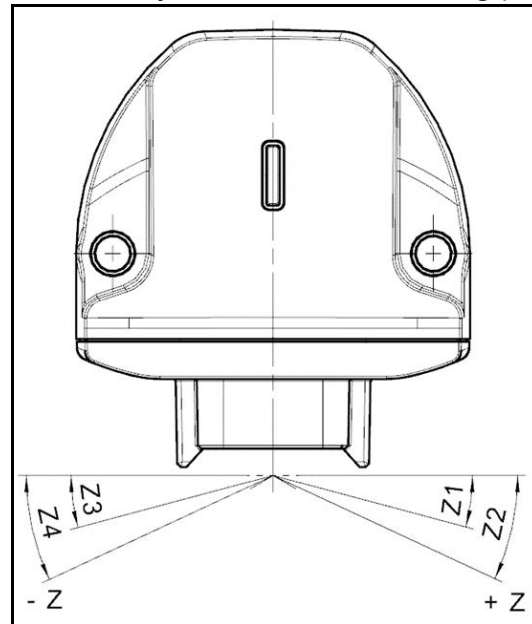
Figure 13

Possible linking types for vertical mounting (Z-axis):

Linking type	Relay linking
B8	Relay 1 = Z1/Z3 Relay 2 = Z2/Z4
B9	Relay 1 = Z1 Relay 2 = Z3

Table 8

Installation position vertical mounting (X/Z-axis)
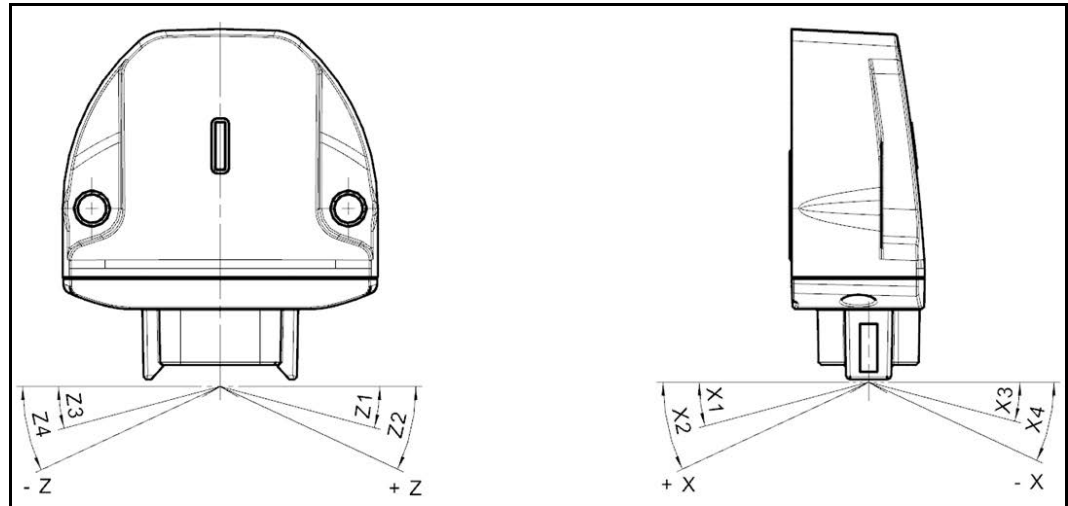
Figure 14

Possible linking types for vertical mounting (X/Z-axis):

Linking type	Relay linking
B1	Relay 1 = X1/X3 Z1/Z3 Relay 2 = -
B2	Relay 1 = X1/X3 Relay 2 = Z1/Z3
B3	Relay 1 = X1/X3 Z1/Z3 Relay 2 = X2/X4 Z2/Z4
B4	Relay 1 = X1/X3 Relay 2 = X2/X4
B6	Relay 1 = X1 Relay 2 = X3
B8	Relay 1 = Z1/Z3 Relay 2 = Z2/Z4
B9	Relay 1 = Z1 Relay 2 = Z3

Table 9

Installation position horizontal mounting (X/Y-axis)
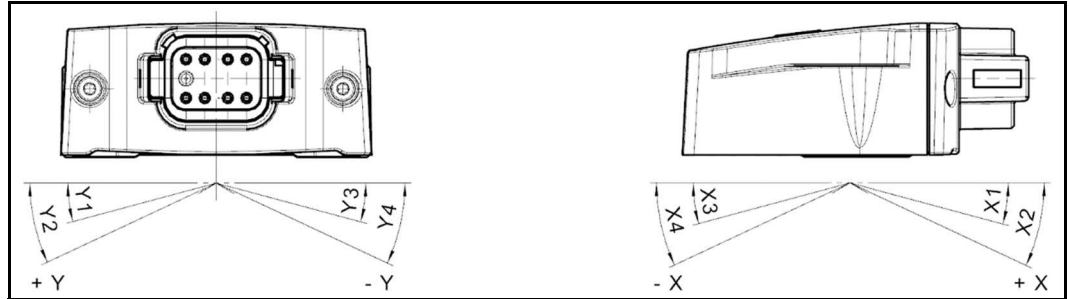
Figure 15

Possible linking types for horizontal mounting (X/Y-axis):

Linking type	Relay linking
B1	Relay 1 = X1/X3 Y1/Y3 Relay 2 = -
B2	Relay 1 = X1/X3 Relay 2 = Y1/Y3
B3	Relay 1 = X1/X3 Y1/Y3 Relay 2 = X2/X4 Y2/Y4
B4	Relay 1 = X1/X3 Relay 2 = X2/X4
B6	Relay 1 = X1 Relay 2 = X3
B8	Relay 1 = Y1/Y3 Relay 2 = Y2/Y4
B9	Relay 1 = Y1 Relay 2 = Y3

Table 10

4.6.2 Switching behaviour

The switched signalling line is always designed as a "normally closed" contact and supplies the two output signals:

- Activated (open = no signal)
- Unactivated (closed = signal)

On request, the signalling line is also available as a "normally open" contact.

Switch-off behaviour

If the power supply fails, the switched signalling line switches to "Unactivated".

Switching delay

A switching delay of 0 s to 20 s can be configured for the signal output of the switched signal line. This delay can be configured separately for

*   "delay on".
    The switchover is performed within the configured time period after the trigger condition occurs.
*   "delay off".
    The last signal for the configured time period is held after the next trigger condition has occurred.
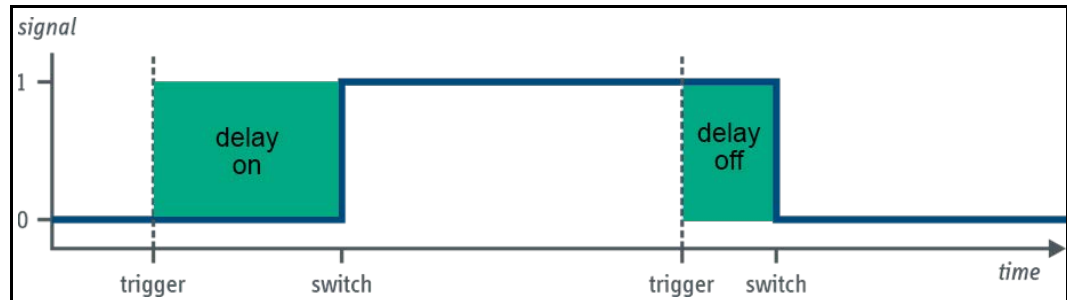
Figure 16

Calculation of the switching signal line trigger

The trigger condition for a switched signal output is calculated using a logical equation. The following rule applies:

$$Trig = (Ax1CondA \quad \wedge \, or \, \vee \quad Ax1CondB) \quad \wedge \, or \, \vee \quad (Ax2CondC \quad \wedge \, or \, \vee \quad Ax2CondD)$$

*   The trigger condition is a logical combination of up to four individual slope conditions (CondA to CondD).
*   A slope condition can be set or hidden.
*   Two of the tilt conditions refer to the first axis of the tilt plane, the other two tilt conditions refer to the second axis of the tilt plane.
*   The two trigger conditions that refer to an axis of the tilt plane can be logically ANDed or ORed.
*   The tilt conditions of one axis can be ANDed or ORed with the tilt conditions of the other axis.

Example of a trigger condition that uses a single tilt condition:

CondA

CondA = Inc(Ax1) > 45°
Trig = CondA
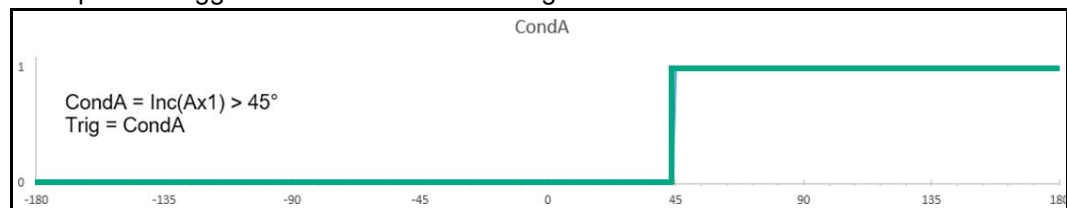
Figure 17

Example of a trigger condition that uses two ORed tilt conditions:

CondA OR CondB

CondA = Inc(Ax1) > 45°
CondB = Inc(Ax1) < -45
Trig = CondA OR CondB
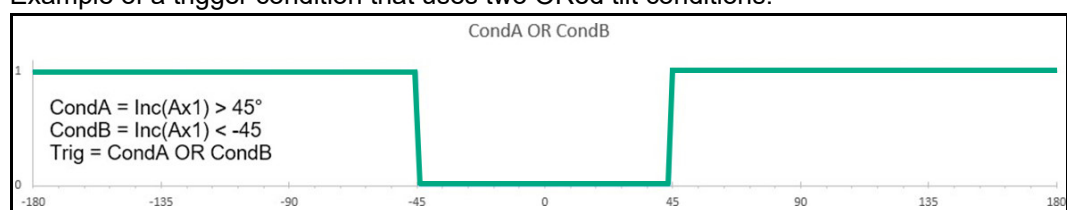
Figure 18

Below is an example of a trigger condition that uses two tilt conditions of each axis, combined with an OR. The result is a switched signal output that is triggered when the N6/N7device is tilted by more than 45° in either direction.
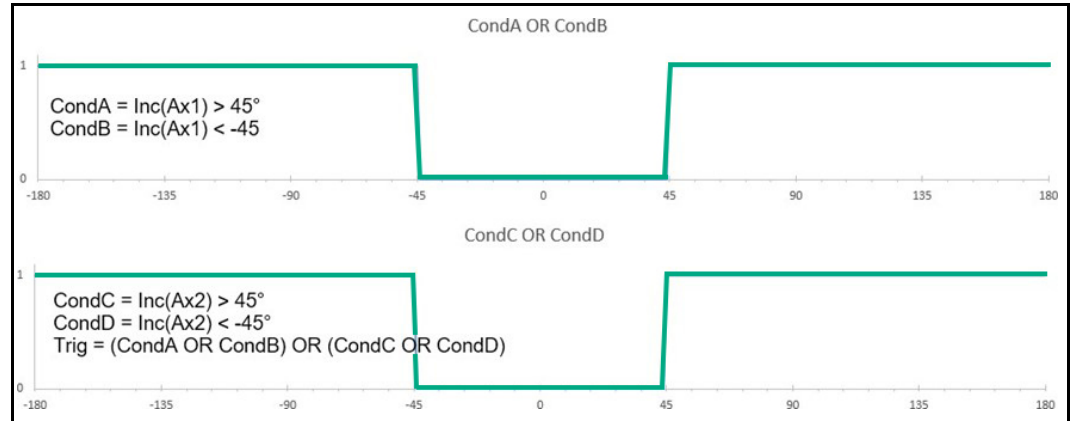
Figure 19

4.7   Behaviour of output signals

The system offers the following angle measurement ranges:

State	Range	Remark
Single axis	+/-180°	Endless fluctuation supported
Double axles	First tilt axis: +/- 180° Second tilt axis: +/- 90°	Endless changeover of the first axis supports dynamic assignment of first/second axis

Table 11

4.7.1   Detection of the position in relation to the reference plane
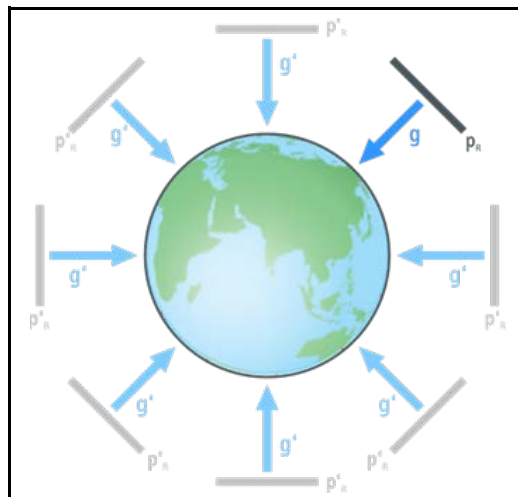
Figure 20

To obtain information about its tilt to the surroundings, the system detects the earth's gravity vector g (Figure 20). The sensor calculates the tilt angle from the standard reference plane orthogonal to the earth's gravity vector and the alignment of the sensor.

4.8   Filter

Tilt sensors are based on an indirect measurement of the tilt due to the earth's gravitational field. Parasitic accelerations, e. g. due to vibrations and lateral acceleration, influence the function of the sensor due to the principle of operation.

4. Product-specific information

The tilt sensor offers the option of making the angle value less sensitive to external, disruptive vibrations. By adjusting the integrated filters, the sensor can be specifically adapted to an application (see "Setting options Filtering for raw data and angle signals" page 34).

A distinction is made between two basic filters:

4.8.1   Low-pass filter (N6)
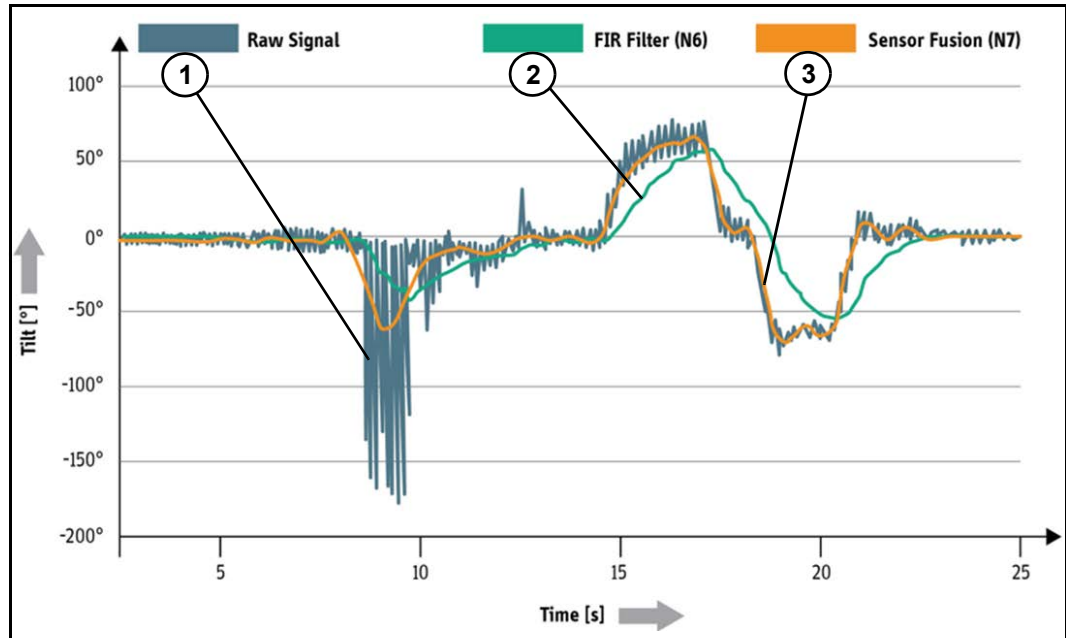
Figure 21

In Figure 21 it can be seen that the sensor fusion filter (orange line) reacts more precisely and faster to the raw signal (grey line) than the FIR filter (green line). This is made possible by a combination of the filters described below.

The N6 tilt sensor offers various options for smoothing the angle signal and making it more robust against vibrations. There are two different types of filter that can be selected at two points in the signal flow (Figure 4): a mid-pass filter or a low-pass filter. The first point is the filtering of the raw data (acceleration data). The filtering of the calculated angles forms the second point. The filters can be set independently of each other at both points.

The averaging filter allows you to set the length of the averaging process. In raw data filtering, the number 400 means averaging over one second. Equivalently, the number 200 is set for angle filtering in order to filter one second.

A FIR filter with a Blackman-Harris window is implemented as a low-pass filter, which is optimally suited for smoothing the angular signal. This filter offers the option to set the filter length and the cut-off frequency. The filter length behaves in the same way as the average value filter.

More information about the filter settings can be found in chapter 6.2 "Setting options Filtering for raw data and angle signals".

4.8.2   Sensor fusion filter (N7)

Tilt sensors are subject to rapid movements, diffuse accelerations, jerky impacts or various vibrations in any dimension, particularly in mobile machinery applications. Tilt sensors with only low-pass filters do not reliably suppress such interference. (See also Figure 21).

In addition to the earth's gravitational field, the sensor fusion filter also utilises the rotation rate information from a gyroscope as an additional measured variable. By combining both measured variables, parasitic accelerations can be successfully suppressed without the tilt information being subject to a noticeable time delay (Kalman filter).

Typical application scenarios:

- Dynamic applications in mobile machinery
- Measurements with the smallest possible time delay in the output signal
- Measurements when cornering
- Measurements during acceleration/braking processes

5.   Installation and putting into service

5.1   Installation

ACHTUNG!

Danger due to incorrect installation!

The tilt sensor may be damaged by excessive impacts and vibrations. The housing must not be subjected to torsional forces or other mechanical loads.

▶ Ensure that the tilt sensor is only installed by specially trained, authorised personnel.
▶ Avoid hitting the housing. If possible, protect housing using additional measures (enclosure).

Installing the tilt sensor

1. Remove the tilt sensor from the packaging.
2. Check the tilt sensor for damage.
3. Install the tilt sensor on a level surface (free from mechanical strains or stresses).
   Do not exceed the maximum tightening torque of the fastening screws.

✓ *Tilt sensor is attached and can be connected.*

Mounting variant 1	Mounting variant 2 - piggyback
2x M6, max. 10 Nm tightening torque	Spacer — Ø 6 mm, 11 mm, Ø 12 mm

Figure 22   *Figure 23*

ACHTUNG!

Danger due to incorrect installation!

When mounting two identical tilt sensors as a piggyback variant, damage can occur due to the application of force.

▶ Only mount tilt sensors as a piggyback if spacers are used between the two tilt sensors!

5.2 Mounting position

The tilt sensors N6/N7 can be placed on the machine flexibly to suit the application. However, the aspects under chapter 7.2 "Performance-Influencing factors", page 52 must be taken into consideration.

The sensors can be ordered for horizontal and vertical installation positions. The difference is where the zero point of the angle measurement is seen. Further information about this can be found in chapter 4.5.1 "Analogue output signals", page 15.

If the tilt sensor cannot be mounted in the desired zero position, this can be remedied via the offset setting (chapter 5.5.2 "Offset setting", page 31), or via the zero point adjustment (chapter 5.5.1 "Zero point adjustment (teach process)", page 30).

5.3 Raw data

The tilt sensor N7* can also output the raw data of the MEMS sensors in addition to the tilt angle and status information. This raw data is the acceleration and rotation rate which is output via its own CAN messages (see chapter 9.1 "Parameter configuration J1939", page 55 and chapter 9.2 "Parameter configuration CANopen" page 60).

The measuring ranges of the acceleration and rotation rate sensors can be adjusted in order to optimally adapt the tilt sensor to the respective application. These can be configured via UDS or CANopen.

Information

Changing the measuring range of the raw data also influences the angle calculation! Therefore, this function is only recommended for experts or if the angle output is not used.

5.3.1 Acceleration | Measurement axes (N7DC*)
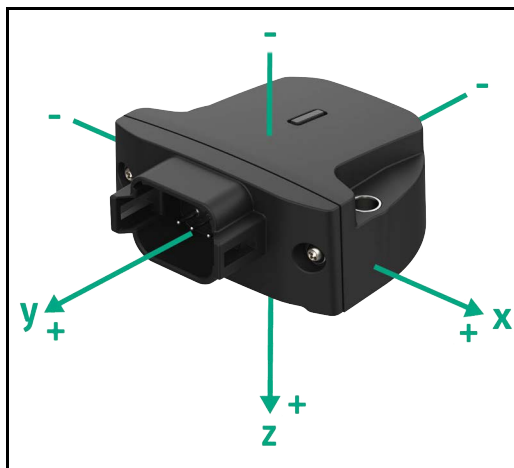
The acceleration values are output with the standard alignment as shown in the following illustration.

Adjustable measuring ranges:
- ± 2 g
- ± 4 g
- ± 8 g (default)
- ± 16 g (max)

Figure 24

5.3.2   Rotation rate | Measurement axes (N7DC*)
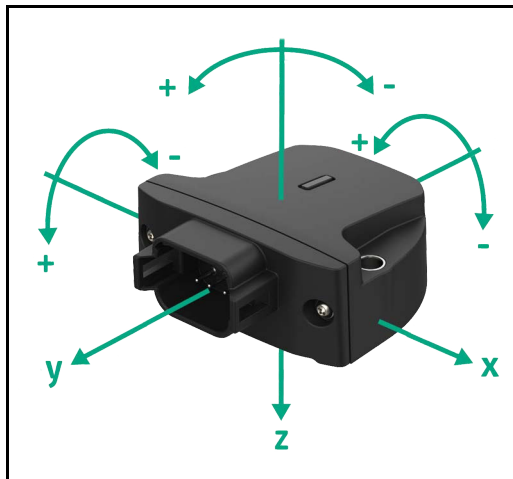
Figure 25

The rotation rate values are output with the standard alignment as shown in the following illustration.

Adjustable measuring ranges:
- ± 15.125 °/s
- ± 31.25 °/s
- ± 62.5 °/s
- ± 125 °/s
- ± 250 °/s (default)
- ± 500 °/s
- ± 1000 °/s
- ± 2000 °/s

5.4   Electrical connection

For electrical connection to a supersystem, the tilt sensor provides a connector on the rear as an electrical interface.

The following illustration shows the various connector options.

M12 connector 1x 5-pole	M12 connector 2x 5-pole	Deutsch connector 8-pole. (DT06-8S)

Figure 26

ACHTUNG!

Danger due to errors during electrical connection!

Electronic components can be destroyed, thereby resulting in malfunctioning of the machine, and hence, injuries to personnel or property damage.

▶ Please find and comply with the electrical data in the respective data sheet.
▶ Signal path of the output signal is depicted on the data sheet or is made available by elobau on request.
▶ Please pay attention to temperature drift.

Connecting the tilt sensor

1. Check voltage-free condition of all supply lines.
2. Connect the tilt sensor per the pin assignment - see connector pin assignment below.

✓ *Tilt sensor is connected and ready for setup.*

5.4.1 Pin-assignment 1x M12 connector (analogue)

In the variant with analogue signal output, the system can be equipped with a M12 connector with 5 pins (Figure 26).

Pin	Connection	Description	
1	U_B	Operating voltage	3 2 5 4 1 M12 5-pin (Male)
2	Out1	Output 1	
3	GND	Ground	
4	Out2	Output 2	
5	n.a.		

Table 12

Pin assignment based on the mounting type selected

Vertical mounting	1-axis / Z-axis	Out1 = Z-axis
Vertical mounting	2-axis / XZ-axis	Out1 = X-axis Out 2 = Z-axis
Horizontal mounting	2-axis / XY-axis	Out1 = X-axis Out2 = Y-axis

Table 13

5.4.2 PIN assignment 1x M12 connector (CAN)

In the variant with CAN signal output, the system can be equipped with a M12 connector with 5 pins (Figure 26).

Pin	Connection	Description	
1	n.c.	not connected	3 2 5 4 1 M12 5-pin (Male)
2	U_B	Operating voltage	
3	GND	Ground	
4	CAN_H	CAN signal line	
5	CAN_L	CAN signal line	

Table 14

5.4.3   PIN assignment 2x M12 connector (CAN)

In the variant with CAN signal output, the system can be equipped with two M12 connector, each with 5 pins (Figure 26). This assignment is backwards compatible with existing elobau tilt sensors.

Pin	Connection	Description	
1	n.c.	not connected	
2	U_B	Operating voltage	
3	GND	Ground	
4	CAN_H	CAN signal line	
5	CAN_L	CAN signal line	

Table 15

5.4.4   PIN assignment Deutsch connector (DT06-8S) 8-pole (analogue)

In the variant with analogue signal output, the system can be equipped with a Deutsch connector with 8 pins (Figure 26). This assignment is backwards compatible with existing elobau tilt sensors.

Depending on the variant, not all pins are assigned.

Pin	Connection	Description	
1	U_B	Operating voltage	
2	GND	Ground	
3	Out1	Output 1	
4	Out2	Output 2	
5	Relay1	Switching output 1	
6	Relay1	Switching output 1	
7	Relay2	Switching output 2	
8	Relay2	Switching output 2	

Table 16

Pin assignment based on the mounting type selected

Vertical mounting	1-axis / Z-axis	Out1 = Z-axis
Vertical mounting	2-axis / XZ-axis	Out1 = X-axis Out 2 = Z-axis
Horizontal mounting	2-axis / XY-axis	Out1 = X-axis Out2 = Y-axis

Table 17

5.4.5   PIN assignment Deutsch connector (CAN)

In the variant with CAN signal output, the system can be equipped with a Deutsch connector with 8 pins (Figure 26). This assignment is backwards compatible with existing elobau tilt sensors.

Depending on the variant, not all pins are assigned.

Pin	Connection	Description	
1	U_B	Operating voltage	
2	GND	Ground	
3	CAN_L	CAN signal line	
4	CAN_H		
5	Relay1	Switching output 1	
6	Relay1	Switching output 1	
7	Relay2	Switching output 2	
8	Relay2	Switching output 2	

Table 18

5.5 Offset correction

A correction of the zero point may be required depending on the positioning of the tilt sensor in the machine (offset correction).

There are two basic types of offset correction.

- The zero point adjustment is carried out after installing the sensor to the machine. The current position is set as the zero point.
- The offset setting is set ex works or via CAN and moves the zero point to a defined angle value.

5.5.1 Zero point adjustment (teach process)

Information

To ensure high accuracy of the sensor during operation, a zero point adjustment is always recommended before initial commissioning. Zero point adjustment is only possible if both axes have an angle of less than 60 degrees.

Variant with analogue signal output (Teach by Wire) - N6SA*

Zero point adjustment is only possible immediately after the power supply is applied.

Adjust zero point with analogue signal output

1. Move the tilt sensor to the final position.
2. Connect the tilt sensor to the power supply.
3. Connect signal output 1 or 2 for the duration of at least 3 s up to max. 10 s with ground.
   The sensor confirms the setting of the zero point by restarting.

✓ **The current position was successfully taken into account as the zero point.**

Variant with J1939 signal output - N6SC* | N7DC*

Appropriate UDS protocols are required for zero point adjustment via CAN. See the procedure below.

Adjusting the zero point via UDS

1. Extended Diagnostic Session (0x3)
2. Seed & Key
3. Start routine S31 0x0103
4. Hard reset (S11 0x1)

   The angle output returns the value "0".

✓ *Zero point adjusted via UDS.*

Adjusting the zero point via CANopen

1. Set object 0x6012 to 0 (longitudinal)
2. Set object 0x6022 to 0 (lateral)
3. Saving in object 0x5999
4. Save sub index 0x3 via "save" (0x65766173).

✓ *Adjust the zero point via CANopen.*

5.5.2 Offset setting

On the system side, an offset value of -60° to +60° can be set individually for each axis via the parameterisation and added to the determined tilt information. Depending on the application and alignment of the sensor in the higher-level system, this can be advantageous.

Adjusting the offset via UDS

1. Extended Diagnostic Session (0x3)
2. Seed & Key
3. Write offset angle for roll in DID 0xF204.
4. Write offset angle for pitch in DID 0xF205.
5. Hard reset (S11 0x1)

   The angle output is moved in the roll or pitch by the configured values.

   Note: The unit of the register is 0.001°, i.e. 45000 must be entered for 45°.

✓ *Adjust the offset via UDS.*

5.5.3 Adjusting the offset via CANopen

Several objects are available to the user in CANopen. The following section explains which objects can be used to calculate an additional offset to the angle signal.

Longitudinal	Lateral	Description
0x6010	0x6020	Slope_Angle
0x6011	0x6021	Slope_Operating_Parameter
0x6012	0x6022	Slope_Preset_Value
0x6013	0x6023	Slope_Offset
0x6014	0x6024	Slope_Differential_Offset

Table 19

Slope_Operating_Parameter

Function	Bit	0	1
Inversion	0	disabled	enabled
Scaling	1	disabled	enabled
reserved	2...4	-	-
Manufacturer-specific	5...7	-	-

Table 20

If scaling has been activated, the angle is calculated in the objects 0x6010 and 0x6020 according to the following equation:

Slope_Angle = current measured value + Slope_Differential_Offset + Slope_Offset

If the "scaling" parameter is deactivated, only the measured angle is output.

Slope_Preset_Value

The set angle is adjusted directly to the set value and the value in Slope_Offset is recalculated taking Slope_Differential_Offset into account.

Slope_Offset

The user can enter an optional offset.

Slope_Offset = Slope_Preset_Value – current measured value – Slope_Differential_Offset

Slope_Differential_Offset

The output angle is moved regardless of the "Slope_Preset_Value".

5.6 Sensor behaviour when measuring range exceeded

The following settings are recommended for the various sensor variants:

DID	Parameter	Description	Default	Min.	Max.	Unit	CO_IDX	CO_SUB_IDX
0xF208	meas_overflow_fault_reaction	How the system reacts on a measurement overflow	4	0	5	0: No reaction 1: Signal SafeState (No Healing) 2: Signal SafeState (Healing) 3: System SafeState 4: Reinit Algorithm 5: Reset Sensor	0x2003	0x4

Table 21

Note N6   In order to readjust the behaviour of the N5 with the N6 when exceeding 1:1, the error response can be changed to "no reaction". The current angle is also calculated during the excess. This procedure, however, is not recommended.

Note N7   For the N7, only the following settings (1), (3), (4), (5) are recommended. Exceeding the measuring range results in a drift of the angle sensor over several seconds to minutes. The height of the angle deviation is dependent on the height of the excess and duration of the measuring range.

Note relay   If an error was detected and also set, the relay is switched into the error state at the same time.

No reaction (0)

The sensor does not react to the excess and continues to output an angle signal.

Signal SafeState (No Healing) (1)

J1939   DM1 message is set if the measuring range is exceeded. The "figure of merit" in the CAN messages SSI, SSI2, ACCS, ARI and ePSSI1 is set to "degraded". The sensor must be restarted in order to mark the error as inactive.

CANopen   An EMCY message is sent.

Signal SafeState (Healing) (2)

J1939   DM1 message is set if the measuring range is exceeded and resets automatically as soon as the measuring range is no longer exceeded. The "figure of merit" in the CAN messages SSI, SSI2, ACCS, ARI and ePSSI1 is set to "degraded" as long as the error is active.

CANopen   The EMCY message is set and reset as soon as there is no longer an error.

System-SafeState (3)

The sensor stops the functional CAN communication in the event of a measured value overflow. This means that the sensor can still be reached via diagnostics. A power-on cycle is required in order to restore sensor communication.

Reinit-Algorithm (4)

If the measured value is exceeded, the angle signal output is marked as invalid and the sensor fusion is set again in initialisation mode. The sensor must remain in a situation in which there are only low movement changes or vibrations for up to 2 seconds until the sensor goes back into operating mode.

J1939   The DM1 message is set and reset. The "figure of merit" in the messages SSI, SSI2, ACCS, ARI and ePSSI1 is also set accordingly.

CANopen   The EMCY message is set and deactivated when the sensor goes back into operating mode.

Reset sensor (5)

The sensor automatically restarts if the measuring range is exceeded (as with power ON).

5.7   Putting into service

Putting the tilt sensor into operation

1. Ensure that the electrical specifications are adhered to.
   The values must never be exceeded.

2. Do not plug or unplug electrical connection whilst energised.
3. Install the entire machine in an EMC-appropriate manner.
   The installation environment and cabling can influence the electromagnetic compatibility of the tilt sensor. So, install the tilt sensor and supply lines separately and at a sufficient distance from lines with a high interference level (frequency converters, contactors, etc.).

4. Connect all assigned outputs.
   Non-assigned outputs must no be connected.

5. Connect the operating voltage and check the functioning of the tilt sensor.

✓ *The tilt sensor is ready for operation.*

6. CANopen | J1939 interface

The tilt sensor has standardised interfaces:

• CANopen
• J1939

The description of the respective interfaces is provided in the appendix in chapter 9.1 "Parameter configuration J1939" and chapter 9.2 "Parameter configuration CANopen".

Functional description

The tilt sensor provides tilt information via the CAN bus. In addition, two relays can be actuated independently of various defined switching points per axle, optionally with configurable switching delays and hysteresis.

CAN data

CAN	ISO 11898, CAN specification 2.0A/2.0B	
Protocol	CANopen	J1939
Baud rate	20 kbit/s - 1000 kbit/s 250 kbit/s (default)	
Transmission cycle	10 ms...2000 ms 10 ms (default)	
J1939 Source		92 – 237 226 (default)
CANopen NodeID	0 – 127 32 (default)	

Table 22

6.1 Bus terminating resistor

Information

A terminating resistor must be present on the end of the network. The elobau

tilt sensor does not have an internal terminating resistor.

6.2 Setting options Filtering for raw data and angle signals

The filter unit contains an average value filter or a vibration filter (FIR filter), which can be applied to the raw data and to the angle signals.

Raw data and angle filtering

Figure 27

	CANopen						
UDS 0x...	Index 0x...	Sub-index	Description	Default	Min.	Max.	Unit
Raw data filtering							
F215	2001	0x3	Filter profile	0	0	1	0: Low-pass filter with Blackman-Harris window 1: Moving average filter
F214	2001	0x2	Filter length	32	12	1024	2.5 ms
F213	2001	0x1	Cut-off frequency [mHz]	0	0	25000	0.001 Hz
Angle filtering							
F212	2000	0x7	Filter profile	0	0	1	0: Low-pass filter with Blackman-Harris window 1: Moving average filter
F211	2000	0x6	Filter length	32	6	512	5 ms
F210	2000	0x5	Cut-off frequency [mHz]	0	0	25000	0.001 Hz

Table 23

Angle data (0xF210 - 0xF212)

The calculated tilt information is then filtered using these objects.

Raw data (0xF213 - 0xF215)

These objects are used to apply the FIR filter to the raw data (acceleration and - if available - rotation rate data). The filtered values are used to calculate the tilt information.

6.2.1 Average value filter

The noise of the MEMS sensor or also interference such as vibrations can be reduced with the aid of the moving average filter MAVG. The objects (0xF211 or 0xF214) determine the filter order. Filter order 32 is defined by default.

Further object addressing can be found in chapter 9.1 "Parameter configuration J1939", page 55 and in chapter 9.2 "Parameter configuration CANopen", page 60.

6.2.2 Vibration filter

A digital low pass filter (FIR filter) is implemented in the N6 and N7 tilt sensors, in which the filter order and the limit frequency can be set.

With the objects 0xF210 or F213 (cut-off frequency), the cut-off frequency can be set between 1 Hz and 25 Hz in steps of 0.001 Hz. If the value 0 is saved, the FIR filter is deactivated (See also table 23 on page 35).

The objects (0xF211 or 0xF214) determine the filter order. Filter order 32 is defined by default.

More information about the filter and its applications can be found in chapter 4.8 "Filter", page 23.

6.2.3 Application examples

	CANopen					
UDS 0x...	Index 0x...	Sub-index	Description	Light vibration	Medium vibration	Strong vibration
Low-pass filter raw data						
F215	2001	0x3	Filter profile	0	1	1
F214	2001	0x2	Filter length	0	50	400
F213	2001	0x1	Cut-off frequency [mHz]	0	0	0
Low-pass filter angle						
F212	2000	0x7	Filter profile	0	0	0
F212	2000	0x6	Filter length	32	20	20
F210	2000	0x5	Cut-off frequency [mHz]	5000	1000	1000

Table 24

The following diagrams represent a noise signal with filter examples listed in Table 24.
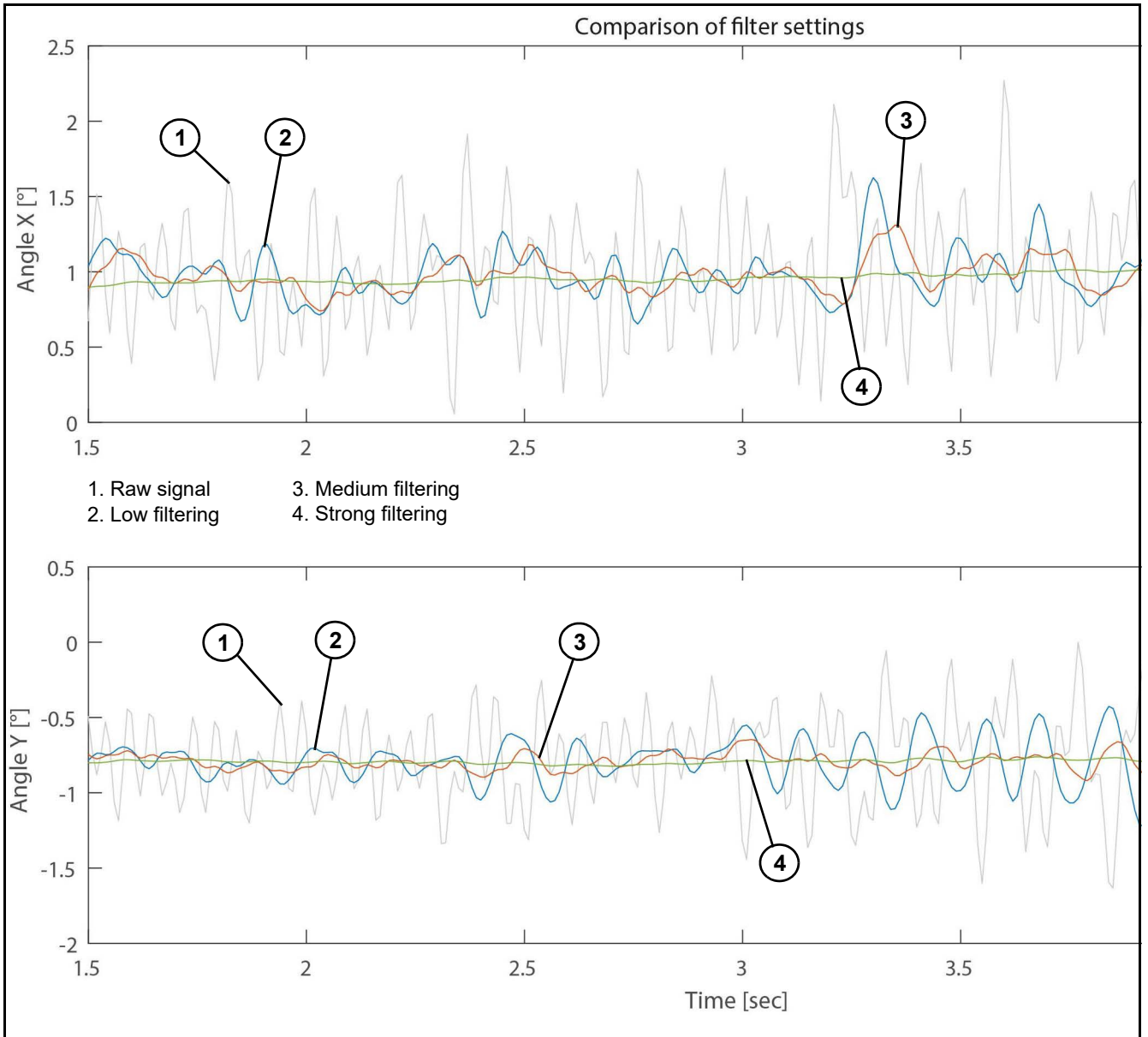
Figure 28: Noise signal with different filter settings

The following figure shows the step response for different filter settings (see table 23 on page 35)
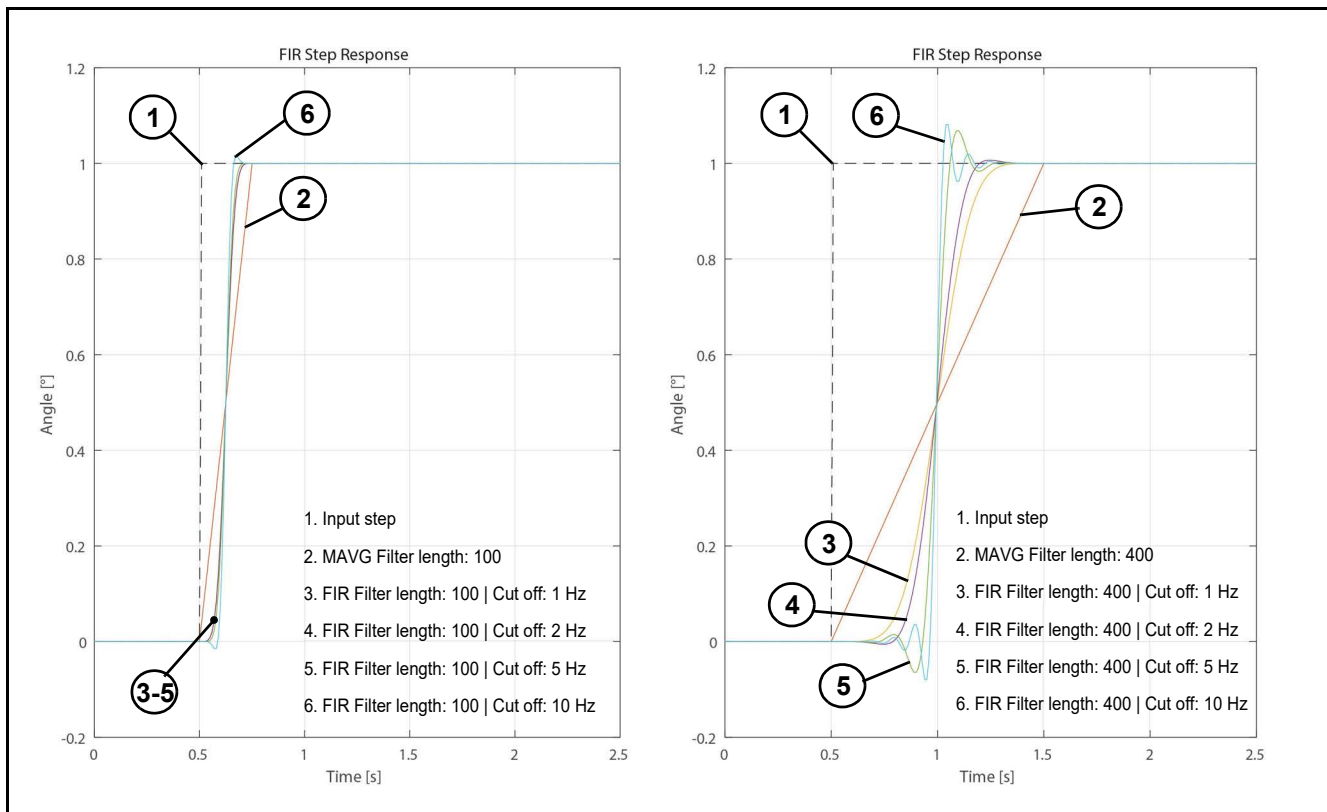
Figure 29: Step response for different filter settings

It can be seen that with increasing filter length (from 100 to 400) the delay time also increases. If both graphics are compared, it can be seen that cut-off frequency has less influences with a short filter length than with a longer one.

Figure 30 shows the frequency response of the FIR filter, as an example with a cut-off frequency of 5 Hz and different filter lengths. It can be seen that the filter slope increases with increasing filter length. However, a higher filter length also results in a greater delay (group delay) of the signal:

1. fcutoff = 5 Hz / FIR filter (FIR) = 250
2. fcutoff = 5 Hz / FIR filter (FIR) = 128
3. fcutoff = 5 Hz / FIR filter (FIR) = 64
4. fcutoff = 5 Hz / FIR filter (FIR) = 32
5. fcutoff = 5 Hz / FIR filter (FIR) = 16
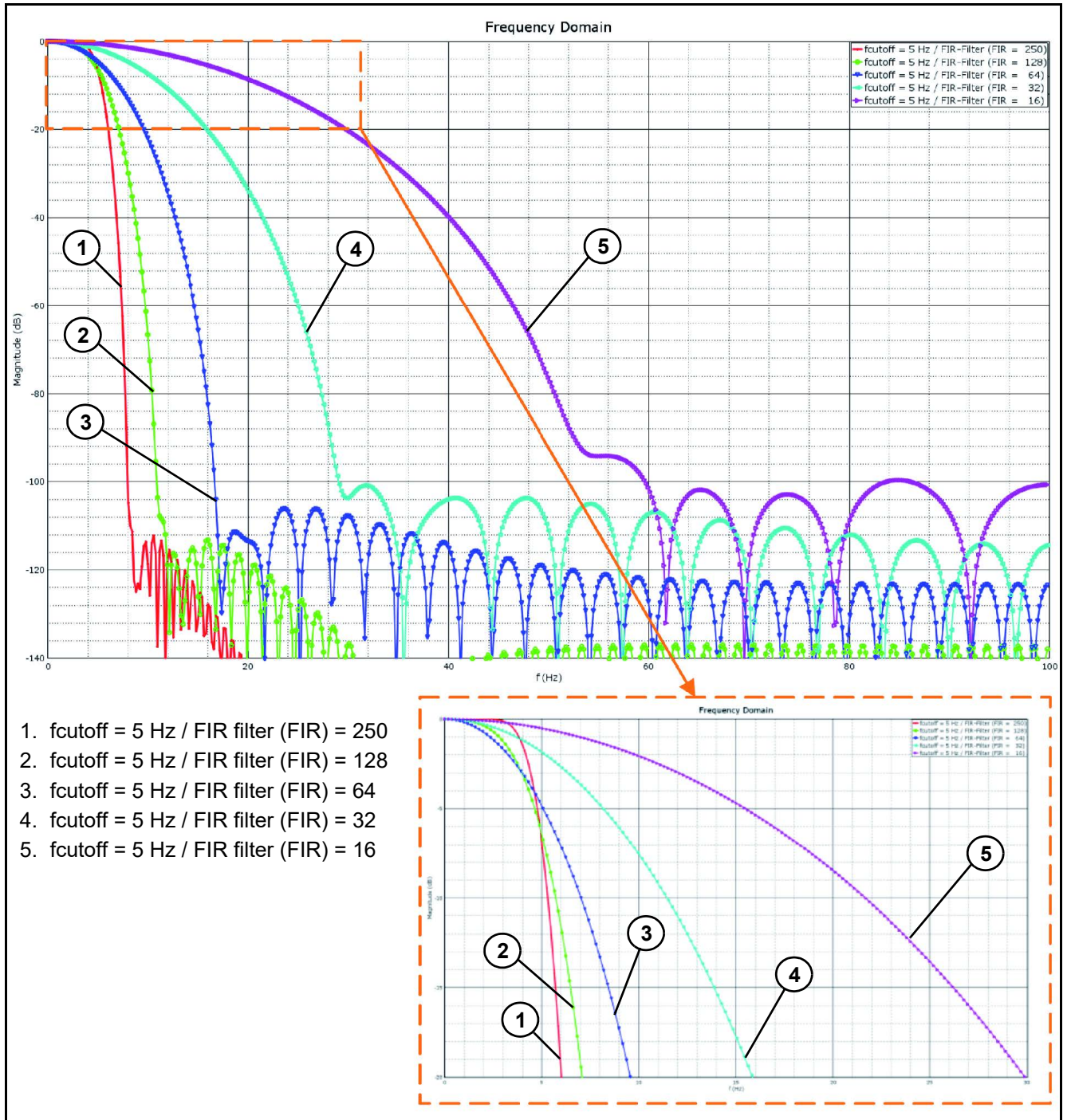
Figure 30: Representation of the FIR filter in the frequency domain

The following filter settings are defined as standard ex works:

Parameter	Default value	Description
Low-pass filter cut-off frequency	20 Hz	
Zero point offset (see chapter 5.5.1 "Zero point adjustment (teach process)")	0	Off

Table 25

6.3   Relay switching points

The tilt sensor N6/N7 is available with up to 2 relay outputs. Up to 4 switching points can be assigned to the two outputs with the aid of different connection types. A switch-on and switch-off delay time can be defined for each of these switching points as well as a hysteresis. These settings can be made in the objects 0xF250 to 0xF282 (see chapter 9.3 "Switching output", page 70).

6.4   Messages

There are different types of CAN messages for communication with the tilt sensor. The messages and signals are described in the following chapters.

6.4.1   CANopen interface

Information

Each node-ID may only be assigned once in the network.

COB-IDs / Node-ID (standard): 32 (20h)

| Communication object	COB-ID
NMT	0h
EMCY	80h + Node-ID
TPDO #0	0x180 + Node-ID
SDO (Client → Server)	600h + Node-ID
SDO (Server → Client)	580h + Node-ID
Heartbeat	700h + Node-ID

Table 26

TPDO #0

The transmit process data object (TPDO #0) asynchronously transmits the current position of the tilt sensor.

If the "Event Timer" is activated (object: 0x1800.5 >0), the data are sent cyclically with the specified value of the "Event Timer" after transmitting of the status "Operational".

The data of the individual axes are sent as displayed in the following table.

The Z-axis is only used to determine the correct installation position of the tilt sensor. A constant + 1° (standard installation position) or -1° (sensor is rotated by >±90°) is sent.

Byte	0	1	2	3	4	5
Content	Angle X (low Byte)	Angle X (high Byte)	Angle Y (low Byte)	Angle Y (high Byte)	Angle Z (low Byte)	Angle Z (high Byte)

Table 27

The Event Timer is preconfigured with a value of 10 ms. The sequence of the TPDO#0 can be adjusted upon request.

TPDO #1

In TPDO #1, the raw data of the acceleration sensor is transmitted in [g]. The data is sent under the message ID 0x280 + Node ID. The message can be activated in the object directory under the message ID 0x1801.5.

Byte	0	1	2	3	4	5
Content	Accelerati on Y (low Byte)	Accelerati on Y (high Byte)	Accelerati on X (low Byte)	Accelerati on X (high Byte)	Accelerati on Z (low Byte)	Accelerati on Z (high Byte)

Table 28

TPDO #2

In TPDO #2, the raw data of the gyroscope is transmitted in [°/s]. The data is sent under the message ID 0x380 + Node ID. The message can be activated in the object directory under the message ID 0x1802.5.

Byte	0	1	2	3	4	5
Content	Rotation Rate Y (low Byte)	Rotation Rate Y (high Byte)	Rotation Rate X (low Byte)	Rotation Rate X (high Byte)	Rotation Rate Z (low Byte)	Rotation Rate Z (high Byte)

Table 29

Information

All messages are only 6 bytes long and not 8 bytes.

Heartbeat message

The "Heartbeat-Time" is pre-set to 300 ms. This time can be changed using object 0x1017.

COB-ID	Byte	0	1	2	3	4	5	6	7
0x700+ Node-ID	Content	0: BOOTUP 4: STOPPED 5: OPERATIONAL 127: PRE-OP.							

Table 30

Emergency messages

The EMCY message comprises 8 bytes. The message comprises the "Emergency Error Code", the "Error Register" (object: 0x1001) and the manufacturer-specific Error Code.

COB-ID	Byte	0	1	2	3	4	5	6	7
0x80+ Node-ID	Content	Emergency Error Code		Error Register (object 0x1001)	Manufacturer specific error code (object 0x4001)		Manufacturer specific error code		

Table 31

The content of "Manufacturer specific error code" (Byte 5,6,7) is an SPN from Table 54 Diagnostic Trouble Codes page 51. Byte 4 specifies how often the error is occurring.

6.4.2 CANopen Error Codes

EMCY Error Code	Title	Description
0x1000	APP_MANUFACTURER_SPECIFIC_ER-ROR	DTC Error List ist mapped into this error
0x5010	APP_ACCEL_X_VALUE_OUT_OF_RANGE	Overflow of accelerometer x value
0x5020	APP_ACCEL_Y_VALUE_OUT_OF_RANGE	Overflow of accelerometer y value
0x5030	APP_ACCEL_Z_VALUE_OUT_OF_RANGE	Overflow of accelerometer z value
0x5040	APP_GYRO_X_VALUE_OUT_OF_RANGE	Overflow of gyroscope x value
0x5050	APP_GYRO_Y_VALUE_OUT_OF_RANGE	Overflow of gyroscope y value
0x5060	APP_GYRO_Z_VALUE_OUT_OF_RANGE	Overflow of gyroscope z value
0x6100	APP_INTERNAL_SOFTWARE	internal software error
0x8140	APP_RECOVERED_FROM_BUS_OFF	µC Power Supply undervoltage
0xFF01	APP_SENSOR_IS_DEFECT	Defect of sensor component

Table 32: Table CANopen Error Codes

6.4.3 J1939 Standard Message Overview

Name	Direction	Remarks
ACL	TX	J1939 Address Claim Message
RQST	RX	Request Message. Used to request e.g. the ACL message.

Table 33: Table J1939 CAN messages

6.4.4 UDS Message overview

Name	Direction	Remarks
ISO15765	TX	This message is used for UDS communication with the tilt sensor. PGN: 0xDA00, Priority: 0x6, e.g. tilt sensor SA 0x70, DA: 0xF9: message ID = 0x18DAF970
ISO15765	RX	This message is used for UDS communication with the tilt sensor. PGN: 0xDA00, Priority: 0x6, e.g. Tester SA 0xF9, DA: 0x70: message ID = 0x18DA70F9

Table 34: Table UDS related CAN messages

6.4.5 J1939 Message overview

Name	Direction	Remarks	Proprietary
SSI		Slope Sensor Information	no
SSI2		Slope Sensor Information 2	no
ACCS	TX	Acceleration Status	no
ARI		Angular Rate Information	no
ePSSI1		elobau Proprietary Slope Sensor Information 1	yes
ePSSI5		elobau Proprietary Slope Sensor Information 5	yes

Table 35: Table Proprietary CAN messages

6.4.6 Detailed message definition

SSI

Used to transmit information about the calculated tilt sensor information. Provides the tilt and roll angle in a range of -64° and 64.51°. The resolution of the angle is set to 16-bit.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic (default),	The message will be sent periodically with the defined cycle time.
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Priority	3	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF
Parameter Group Number (PGN)	0xF013	Slope Sensor Information

Table 36: Table SSI Parameters

Message layout

Signal	Description	Unit	Size
Pitch Angle	-	deg	16 bits
Roll Angle	-	deg	16 bits
Pitch Rate	-	deg/s	16 bits
Figure Of Merit - Pitch Angle	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Figure Of Merit - Roll Angle	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Figure Of Merit - Pitch Rate	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Pitch And Roll Compensated	0 = Sensor Fusion enabled 1 = Sensor Fusion disabled	-	2 bits
Pitch and Roll Latency Measurement	Latency of the measured tilt angle signal. Just returns the latency introduced by the sampling frequency of 100 Hz. Doesn't account for delay introduced by low pass filters.	ms	8 bits

Table 37: Table SSI Message Layout

SSI2

Used to transmit information about the calculated tilt sensor information. Provides the tilt angle in a range of -/+ 90° and the roll angle in a range of -/+ 180°. The resolution of the angle is set to 24-bit.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic (default)	The message will be sent periodically with the defined cycle time.
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Priority	3	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF
Parameter Group Number (PGN)	0xF029	Slope Sensor Information 2

Table 38: Table SSI2 Parameters

Message layout

Signal	Description	Unit	Size
Pitch Angle Extended Range	-	deg	24 bits
Roll Angle Extended Range	-	deg	24 bits
Pitch Angle Extended Range Compensation	0 = Sensor Fusion enabled 1 = Sensor Fusion disabled	-	2 bits
Figure Of Merit - Pitch Angle Extended Range	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Roll Angle Extended Range Compensation	0 = Sensor Fusion enabled 1 = Sensor Fusion disabled	-	2 bits
Figure Of Merit - Roll Angle Extended Range	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Latency Measurement	Latency of the measured tilt angle signal. Just returns the latency introduced by the sampling frequency of 100 Hz. Doesn't account for delay introduced by low pass filters.	ms	8 bits

Table 39: Table SSI2 Message Layout

elobau Proprietary Slope Sensor Information 1

The elobau Proprietary Slope Sensor Information message provides:

*   Angle of tilt,
*   Roll angle in an extended format,
*   Status of the relay outputs,
*   Sensor status,
*   Relay status.

In addition, a message counter and a checksum are added at the end of the message.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic	The message will be sent for each new demand.
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Default Priority	6	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF
Parameter Group Number (PGN)	0xFF2A	elobau Proprietary Slope Sensor Information 1.

Table 40: Table elobau Proprietary Slope Sensor Information 1

Message layout

Signal	Description	Unit	Size
Pitch Angle Extended Range	-	deg	24 bits
Roll Angle Extended Range	-	deg	24 bits
Relay 1 - Switch Status	0 = relay closed, 1 = relay open, 2 = error, 3 = N/A	-	2 bits
Relay 2 - Switch Status	0 = relay closed, 1 = relay open, 2 = error, 3 = N/A	-	2 bits
Overhead signal	0 = No vehicle rollover detected 1 = Vehicle rollover detected	-	2 bits
Combined Figure of Merit	0 = functional, 1 = degraded, 2 = error, 3 = N/A	-	2 bits
Message Counter	Rotating counter between 0...7	-	4 bits
Message Checksum	Checksum according to SPN 4207	-	4 bits

Table 41: Table elobau Proprietary Slope Sensor Information 1

The ePSSI1 message contains an additional message counter to recognise lost messages and other error states of the control unit. In addition to the message counter, an additional checksum is formed in the data bytes. The checksum contains the message counter, so the checksum changes even though the message signals are unchanged. The message counter ranges from 0 to 7.

ACCS

Used to transmit information about the measured acceleration data. The measured signal is compensated by the factory calibration and sensor fusion (if activated). Only available with N7.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic	The message will be sent for each new demand.
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Default Priority	6	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF.
Parameter Group Number (PGN)	0xFF2B	elobau Proprietary Slope Sensor Information 2.

Table 42: Table elobau Proprietary Slope Sensor Information 2

Message layout

Signal	SPN	Size
Acceleration X	5347	16 bits
Acceleration Y	5348	16 bits
Acceleration Z	5349	16 bits
Figure of Merit - X	5350	2 bits
Figure of Merit - Y	5351	2 bits
Figure of Merit - Z	5352	2 bits

Table 43: Table elobau Proprietary Slope Sensor Information 2

ARI

Used to transmit information about the measured rotation rate of the gyroscope. The measured signal is compensated by the factory calibration and sensor fusion (if activated). Only available with N7.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic	The message will be sent for each new demand
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Default Priority	6	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF
Parameter Group Number (PGN)	0xFF2C	elobau Proprietary Slope Sensor Information 3.

Table 44: Table elobau Proprietary Slope Sensor Information 3

Message layout

Signal	SPN	Size
Rotation Rate X	4983	16 bits
Rotation Rate Y	4984	16 bits
Rotation Rate Z	4985	16 bits
Figure of Merit - X	4986	2 bits
Figure of Merit - Y	4987	2 bits
Figure of Merit - Z	4988	2 bits

Table 45: Table elobau Proprietary Slope Sensor Information 3

elobau Proprietary Slope Sensor Information 5

Indicates the orientation in quaternion notation.

Message parameter

Parameter	Definition	Remarks
Cycle Time [ms]	10 ms (default)	This parameter is configurable
Send Type	Cyclic	The message will be sent for each new demand.
Requestable	False	Cyclic messages are not requestable.
Data Length (DLC)	8	Data length of the message type.
Default Priority	6	Priority of the message type.
Message type	Proprietary B	User defined PGN in range 0xFF00 – 0xFFFF
Parameter Group Number (PGN)	0xFF2E	elobau Proprietary Slope Sensor Information 5.

Table 46: Table elobau Proprietary Slope Sensor Information 5

Message layout

Signal	SPN	Size
Quaternion scalar		16 bits
Quaternion i		16 bits
Quaternion j		16 bits
Quaternion k		16 bits

Table 47: Table elobau Proprietary Slope Sensor Information 5

6.4.7 Definition of J1939 request PGN

PGN definition

This message type identified by the PGN makes it possible to request information globally or from a specific destination. Requests that relate to a specific target are referred to as tar-

get-specific requests. The information in the table below shows the PGN definition for the "Request PGN" parameter group.

Name	Description
Parameter Group Name	Request
Definition	Used to request a Parameter Group from a network device or devices.
Transmission repetition rate	Per user requirements , generally recommended that requests occur no more than 2 or 3 times per second.
Data length	3 bytes (The CAN frame for this PG shall set the DLC to 3.)
Extended Data Page	0
Data page	0
PDU Format	234
PDU specific field	Destination Address (global or specific).
Default priority	6
Parameter Group Number	59904 (0x00EA00)
Byte: 1,2,3	Parameter Group Number being requested.

Table 48: Table Request PGN definition

Requestable PGNs of the tilt sensor

PGN	Description
0xEE00	Address claimed
0xFEDA	Soft
0xFDC5	ECU ID
0xFECA	DM1
0xFECB	DM2
0xFECC	DM3
0xFED3	DM11

Table 49: Table Requestable PGNs

Response codes

The tilt sensor responds to a target-specific request with the following acknowledgement control bytes.

Acknowledgment-Control byte	Description
0	Positive Acknowledgment (ACK), if the request was successful.
1	Negative Acknowledgment (NACK), if the requested PGN does not exist/ is not implemented.
2	Access Denied, not used.
3	Cannot Respond, BAM protocol is busy.

Table 50: Table Acknowledgement control bytes

Requestable PGN definition

J1939 Soft PGN

Byte	Description
0	4 (Number of software identification designators represented in the software identification parameter group)
1...15	Customer SOFT-ID 0
16	Field delimiter (*)
17...31	Customer SOFT-ID 1
32	Field delimiter (*)
33...47	Software Version Number (example „001.000.000.000")
48	Field delimiter (*)
49...63	Part Number of the Configuration
64	Field delimiter (*)

Table 51: Table Soft PGN definition

J1939 ECUID PGN

Byte	Description
0...14	ECU Serial Number
16	Field delimiter (*)
17...30	ECU Manufacturer Name
31	Field delimiter (*)
32	Hardware Version
33	Field delimiter (*)

Table 52: Table ECU ID PGN definition

6. CANopen | J1939 interface

J1939 DM1 / DM2

Bit	Length	Description	Value
0	2	Protection Lamp Status	00: Lamp off 01: Lamp on
2	2	Amber Warning Lamp	00: Lamp off 01: Lamp on
4	2	Red Stop Lamp	00: Lamp off 01: Lamp on
6	2	Malfunction Indicator Lamp	00: Lamp off 01: Lamp on
8	2	Flash Protection Lamp	00: Slow Flash (1 Hz, 50% duty cycle) 01: Fast Flash (2 Hz or faster, 50% duty cycle) 10: reserved 11: Unavailable / 00 Not Flash
10	2	Flash Amber Warning Lamp	00: Slow Flash (1 Hz, 50% duty cycle) 01: Fast Flash (2 Hz or faster, 50% duty cycle) 10: reserved 11: Unavailable / 00 Not Flash
12	2	Flash Red Stop Lamp	00: Slow Flash (1 Hz, 50% duty cycle) 01: Fast Flash (2 Hz or faster, 50% duty cycle) 10: reserved 11: Unavailable / 00 Not Flash
14	2	Flash Malfunction Indicator Lamp	00: Slow Flash (1 Hz, 50% duty cycle) 01: Fast Flash (2 Hz or faster, 50% duty cycle) 10: reserved 11: Unavailable / 00 Not Flash
16	32	DTC1	Error Code - optional
48	32	DTC2	Error Code - optional
80	32	DTC3	Error Code - optional
112	32	DTC4	Error Code - optional

Table 53 J1939 DM1 / DM2

6.5   Diagnostic Trouble Codes (DTCs)

Customer ID	Description	SPN	FMI	Resulting system state	special instruction
spn_generic_sw_error	General SW error	522000	12	system_safe_state	replace frimware/ sensor
spn_can_busoff_detected	CAN bus off detected	522001	2	-	temporary condition, check the can bus wiring + configuration
spn_cpu_temperature_error_limit	CPU Temperature monitoring	522131	3, 4	system_stop_state	temporary condition, the operating range was exceeded
spn_mems_temperature_error_limit	MEMS Temperature monitoring	522133	3, 4	system_stop_state	temporary condition, the operating range was exceeded
spn_power_supply	Power supply monitoring	522140	3, 4	system_stop_state	temporary condition, the operating range was exceeded
spn_the_device_config_is_corrupt	The device configuration is corrupt	522301	12	system_safe_state	replace firmware/ sensor
spn_the_calibration_config_could_not_be_loaded	The calibration config could not be loaded.	522302	13	system_safe_state	replace firmware/ sensor
spn_hw_version_not_supported	hw version not supported	522303	12	system_safe_state	replace firmware/ sensor
spn_acceleration_on_xaxis	Accleration on X-Axis over/underflow	522510	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_acceleration_on_yaxis	Accleration on Y-Axis over/underflow	522511	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_acceleration_on_zaxis	Accleration on Z-Axis over/underflow	522512	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_input_rotation_rate_x	Rotation rate on X-Axis overflow/ underflow	522513	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_input_rotation_rate_y	Rotation rate on Y-Axis overflow/underflow	522514	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_input_rotation_rate_z	Rotation rate on Z-Axis overflow/underflow	522515	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_angle_calculation_is_implausible	Output of sensor fusion is implausible	522601	2	signal_safe_state	temporary condition, the operating range were exceeded
spn_internal_temporary_fault	Detected a temporary fault	522800	2, 4, 12	-	internal hw fault caused reset in last cycle. Replace on many sporadic errors
spn_internal_permanent_fault	Detected a permanent fault	522801	12	system_safe_state	replace sensor

Table 54 Diagnostic Trouble Codes

7.   Operation

The system is ready for operation within a maximum period of 500 ms. This means that:

- Measured values are available,
- Analogue signal outputs (depending on the variant) are valid,
- Switched signal outputs (depending on the variant) are valid,
- Cyclical CAN communication (depending on the variant) has started with valid data.

7.1   Calibration

(i) Information!
The tilt sensor is subject to stringent quality control. It is extensively tested before despatch and calibrated and adjusted for the desired end application.

7.2   Performance-Influencing factors

The N6/N7 uses acceleration sensors to calculate changes in direction. Some factors can influence operation.

Vibrations   In certain applications with strong vibrations or long cornering, the integrated sensors can cause interference. These disturbances are detected by N6/N7 as angle changes and can have a negative effect on the operation of the tilt sensor, depending on the application.

To ensure regular operation, we recommend a check after installation to identify measures to minimise strong vibrations or shocks.

If there is a fault due to vibrations, the following measures can lead to an improvement:

▶ Make sure that the mounting recommendations described in this document are always complied with.

▶ Application-specific adaptation of the set filters, e. g. the fusion algorithm.

▶ Consider vibration dampers to minimise vibrations (e. g. rubber pads).

▶ Increase the dimensions of the mounting surface (e. g. increase the material thickness).

▶ Reduce the vibrations emanating from the source.

▶ Move the sensor to an area with less vibration.

▶ Avoid assembly in areas with large temperature fluctuations.

7.3   Error messages, troubleshooting

Problem	Cause	Remedy
No output signal	Missing operating voltage	Check operating voltage
	Cable break in supply voltage or signal output	Check lines and cable connections
	Connector contact problems	Check that plug-in connections are correctly seated and fastened
	Fuse on the vehicle side	Check fuses
Output signal not correct / implausible	Sensor loose	Check fastening
	Alignment/mounting correct?	Check installation position[1]
	Termination resistor (on vehicle side) for signal output correct?	Check for correct terminating resistor
	Offset for signal output (teaching) used correctly?	Repeat zero point adjustment (teach process)[2]
	Applications with strong vibrations	See chapter 7.2 "Performance-Influencing factors", page 52.

Table 55

[1] See chapter 5.2 "Mounting position", page 26.
[2] See chapter 5.5.1 "Zero point adjustment (teach process)", page 30.

8.   Maintenance and servicing

The tilt sensor is maintenance-free.

<mark>**VORSICHT!**</mark>

Danger due to opening the tilt sensor.

Opening the N6/N7 results in voiding of warranty and exclusion of liability. Furthermore, machinery malfunctions can lead to personal injury or damage to property.

▶ Do not open the tilt sensor.
▶ Do not modify the electronics or mechanical components.

Under extreme usage conditions, please check the tilt sensor as part of regular inspections:

▶ Carry out a visual inspection and functional test.

▶ Check the connection cables for damage.


8.1   Decommissioning

▶ De-energise the tilt sensor.

✓ *Tilt sensor is out of operation.*

8.2   Dismantling

Remove the tilt sensor

1. Ensure a voltage-free state.
2. Undo the electrical lines on the tilt sensor.
3. Unscrew and remove screws.

✓ ***The tilt sensor is removed.***

8.3   Disposal
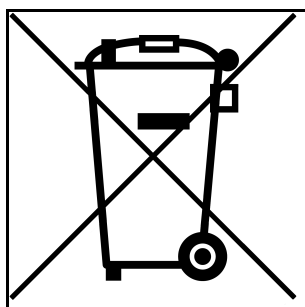
The symbol means that a product must be collected separately from other waste when it reaches the end of its service life in accordance with directive 2012/19/EU. For more information, please contact elobau or your dealer on site.
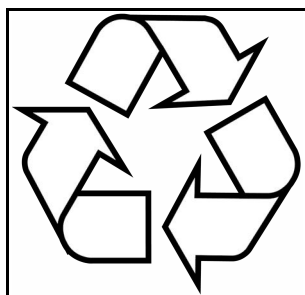
Dispose of packaging and used parts in accordance with the relevant national regulations. Do not dispose of N6/N7 with domestic waste; e. g. dispose of at the collection centre of a waste management utility.

Figure 31

9.   Appendix

9.1   Parameter configuration J1939

							J1939	
DID 0x...	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F202	inc_plane	Mounting position of the sensor (horizontal, vertical)	0	0	3	Configuration Index	2000	0x1
F203	inc_offset_yaw	Add an offset to the pitch angle	0	-60000	60000	0,001°	2000	0x4
F204	inc_offset_roll	Add an offset to the roll angle	0	-60000	60000	0,001°	2000	0x2
F205	inc_offset_pitch	Add an offset to the pitch angle	0	-60000	60000	0,001°	2000	0x3
F206	overhead_signal_debounce_time	Overhead signal debounce time. Filterring of the overhead signal in the J1939 Message ePSSI1 and TPDO1 in CANopen.	0	0	20000	ms		
F207	inc_sensor_fusion_enabled	Filter Selection. On N7 devices, it's possible to disable the sensor fusion.	1	0	1	0 = 3-DOF Angle Calculation 1 = 6-DOF Sensor Fusion	2003	0x1
F208	meas_overflow_fault_reaction	How the system reacts on a measurement overflow	4	0	5	0 = No reaction 1 = Signal SafeState (No Healing) 2 = Signal SafeState (Healing) 3 = System SafeState 4 = Reinit Algorithm 5 = Reset Sensor	2003	0x4
F209	legacy_filter_mode	Filter mode of the legacy filter	0	0	1	0 = Sensor mode 360 1 = Sensor mode 90	2008	0x1
F210	inc_lp_cutoff_freq	Inclination low pass filter cutoff frequency	0	0	25000	0,001 Hz	2000	0x5
F211	inc_lp_filter_len	inclination FIR length	32	6	512	0,5 ms	2000	0x6
F212	inc_lp_filter_profile	inclination FIR profile	0	0	1	0 = low pass filter with blackman harris window 1 = Moving average filter	2000	0x7
F213	raw_lp_cutoff_freq	Raw low pass filter cutoff frequency	0	0	25000	0,001 Hz	2001	0x1

DID 0x...	Parameter	Description	Default	Min	Max	Unit	J1939	
							Index 0x...	Sub-index
F214	raw_lp_filter_len	Raw FIR length	32	12	1024	0,25 ms	2001	0x2
F215	raw_lp_filter_pro-file	Raw FIR profile	0	0	1	0 = low pass fil-ter with black-man harris window 1 = Moving ave-rage filter	2001	0x3
F21E	accelerome-ter_range	Measurement range of accelerometer	8	2	16	g	2003	0x2
F21F	gyroscope_range	Measurement range of gyroscope	250	15	2000	*/s	2003	0x3
F250	swed_out-put_0_enable	Enable or disable swit-ched signal output	0	0	1	0 = output disa-bled 1 = output ena-bled	200A	0x1
F251	swed_out-put_0_hyst	Set the angle hysteresis value	0	0	45000	0,001°	200A	0x2
F252	swed_out-put_0_de-lay_switch_on_0	Signal delay after positive condition	0	0	20000	ms	200A	0x3
F253	swed_out-put_0_de-lay_switch_off_0	Signal delay after nega-tive condition	0	0	20000	ms	200A	0x11
F254	swed_out-put_0_logic_link	Overall logic operation to compare both axis	0	0	2	0 = only single axis 1 = AND 2 = OR	200A	0x4
F255	swed_out-put_0_axis_0_ang le	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200A	0x5
F256	swed_out-put_0_axis_0_lo-gic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200A	0x6
F257	swed_out-put_0_axis_0_con d_0_angle	Threshold angle that trig-gers compare function	0	-180000	180000	0,001°	200A	0x7
F258	swed_out-put_0_axis_0_con d_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0x8
F259	swed_out-put_0_axis_0_con d_1_angle	Threshold angle that trig-gers compare function	0	-180000	180000	0,001°	200A	0x9
F25A	swed_out-put_0_axis_0_con d_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0xA
F25B	swed_out-put_0_axis_1_ang le	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200A	0xB

							J1939	
DID 0x...	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F25C	swed_output_0_axis_1_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200A	0xC
F25D	swed_output_0_axis_1_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0xD
F25E	swed_output_0_axis_1_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0xE
F25F	swed_output_0_axis_1_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0xF
F260	swed_output_0_axis_1_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0x10
F261	swed_output_0_default_state	Initial State relays	0	0	1	0 = OFF 1 = ON	200A	0x12
F262	swed_output_0_invert_switch	Invert the logic of the pins	0	0	1	0 = false 1 = true	200A	0x13
F263	swed_output_0_delay_switch_on_1	Signal delay after positive condition	0	0	20000	ms	200A	0x14
F264	swed_output_0_delay_switch_off_1	Signal delay after negative condition	0	0	20000	ms	200A	0x15
F270	swed_output_1_enable	Enable or disable switched signal output	0	0	1	0 = output disabled 1 = output enabled	200B	0x1
F271	swed_output_1_hyst	Set the angle hysteresis value	0	0	45000	0,001°	200B	0x2
F272	swed_output_1_delay_switch_on_0	Signal delay after positive condition	0	0	20000	ms	200B	0x3
F273	swed_output_1_delay_switch_off_0	Signal delay after negative condition	0	0	20000	ms	200B	0x11
F274	swed_output_1_logic_link	Overall logic operation to compare both axis	0	0	2	0 = only single axis 1 = AND 2 = OR	200B	0x4
F275	swed_output_1_axis_0_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200B	0x5
F276	swed_output_1_axis_0_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200B	0x6

DID 0x...	Parameter	Description	Default	Min	Max	Unit	J1939 Index 0x...	Sub-index
F277	swed_output_1_axis_0_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0x7
F278	swed_output_1_axis_0_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0x8
F279	swed_output_1_axis_0_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0x9
F27A	swed_output_1_axis_0_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0xA
F27B	swed_output_1_axis_1_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200B	0xB
F27C	swed_output_1_axis_1_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200B	0xC
F27D	swed_output_1_axis_1_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0xD
F27E	swed_output_1_axis_1_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0xE
F27F	swed_output_1_axis_1_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0xF
F280	swed_output_1_axis_1_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0x10
F281	swed_output_1_default_state	Initial state relays	0	0	1	0 = OFF 1 = ON	200B	0x12
F282	swed_output_1_invert_switch	Invert the switching logic of the relay	0	0	1	0 = false 1 = true	200B	0x13
F283	swed_output_1_delay_switch_on_1	Signal delay after positive condition	0	0	20000	ms	200B	0x14
F284	swed_output_1_delay_switch_off_1	Signal delay after negative condition	0	0	20000	ms	200B	0x15
F291	can_baudrate	Baudrate of the CAN	1000000	20000	1000000	bit/s	5999	0x01
F292	can_busoff_restore_attempts	Number of attempts to reset a detected bus off state (within on drive cycle) before stay in bus off state	32	0	0x7FFFFFFF		5001	0x0
F293	can_busoff_restore_timeout	Time betweeen to CAN bus reset events	250	0	1000	ms	3000	0x1

							J1939	
DID 0x...	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F294	can_busoff_de-crement_time	Time of fault free CAN bus which leads to a decrementing of the error counter	300000	0	1000000	ms	3000	0x2
F295	can_s27_ext_key	Please contact elobau, if your application requires your own Seed&Key	0x0	0x8000 0000	0x7FF FFFFF			
F296	can_s27_prog_key	Please contact elobau, if your application requires your own Seed&Key	0x0	0x8000 0000	0x7FF FFFFF			
F2A0	can_protocol	Used CAN protocol	0	0	1	0 = J1939 1 = CANopen	599B	0x0
F2A1	can_node_sour-ce_address	Node source address	0xE2	0x00	0xFE			
F2A2	can_com_sig_on_change_send	Com default mode	0	0	1	0 = cyclic trans-mission 1 = send on sig-nal change	3000	0x3
F2A3	can_com_sig_on_change_min_del-ta_time	Minimum delta time bet-ween signal changed	20	0	100	ms	3000	0x4
F2B0	can_com_msg_ssi_cycle_time	Configure the cycle time of SSI message	0	0	10000	ms		
F2B1	can_com_msg_ssi2_cycle_time	Configure the cycle time of SSI2 message	0	0	10000	ms		
F2B2	can_com_msg_ari_cycle_time	Configure the cycle time of ARI message	0	0	10000	ms		
F2B3	can_com_msg_accs_cycle_time	Configure the cycle time of ACCS message	0	0	10000	ms		
F2B4	can_com_msg_epssi1_cycle_time	Configure the cycle time of ePSSI1 message	0	0	10000	ms		
F2B8	can_com_msg_epssi5_cycle_time	Configure the cycle time of ePSSI5 message	0	0	10000	ms		
F2D0	can_j1939_dm1_enable	Enable cyclic transmis-sion of DM1	0	0	1			
F2D1	can_j1939_dm1_transmit_if_zero	Transmit if zero	1	0	1			
F2D2	customer_ecuid_0	Free customer entry	0	0x8000 0000	0x7FF FFFFF		2009	0x1
F2D3	customer_ecuid_1	Free customer entry	0	0x8000 0000	0x7FF FFFFF		2009	0x2
F2D4	customer_softid_0	Free customer entry	0	0x8000 0000	0x7FF FFFFF		2009	0x3
F2D5	customer_softid_1	Free customer entry	0	0x8000 0000	0x7FF FFFFF		2009	0x4

Table 56

9.2 Parameter configuration CANopen

DID 0x...	Typ	Parame-ter	Description	Default	Min	Max	Unit	CANopen Index 0x...	Sub-index
	U32	(read only)	Device Type	0x0002 019A			Device profile DS410 (Two axis with resolution max. 16-bit)	1000	
	U8	(read only)	Error Register	0xx00			0 = generic error 1 = current 2 = voltage 3 = temperature 4 = communication error 5 = device-profile specific error 6 = reserved = 0 7 = manufacturer specific	1001	
	strg	(read only)	Manufacturer Device Name	NGS			„NGS": Neigungs-sensor (Tilt sensor)	1008	
	strg	(read only)	Manufacturer Hardware Version				„Maj.MinMin"	1009	
	strg	(read only)	Manufacturer Software Version				„Maj.MinMin"	100A	
		Store Parameter	**Attention:** **Please use this service with care. Make sure before saving parameters, that only volitional parameters are changed.**						
	U8	(read only)	Number of Entries	1				1010	0x0
	U32		Save all Parameters	1			„save" (0x65766173) to save all parameters (objects with mar-king PARA except LSS parameter)	1010	0x1
		Restore Defaulot Parameter							
	U8	(read only)	Number of Entries					1011	0x0
	U32		Restore all Default Para-meters				„load" (0x64616F6C) to restore all parame-ters (objects with marking PARA) to factory settings.	1011	0x1
	U32	(read only)	COB-ID EMCY	0x80+N ode-ID	1			1014	
	U16		Producer Heartbeat Time - PARA (Unit 1 ms)	300			0 = not used	1017	
		Identity Object							
	U8	(read only)	Number of Entries	4				1018	0x0

								CANopen	
DID 0x...	Typ	Parame-ter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
	U32	(read only)	Vendor ID	0x0000 00B4			elobau Vendor ID: 0x000000B4	1018	0x1
	U32	(read only)	Product Code	0x0000 0301				1018	0x2
	U32	(read only)	Revision Number	0x0000 0000				1018	0x3
	U32	(read only)	Serial Number					1018	0x4
			Error behaviour						
	U8	(read only)	Number of Entries	1				1029	0x0
	U8		Communication Error	0x00			0 = Pre-Operational (only if current state is operational) 1 = No state change 2 = Stopped 3-127 = Reserved	1029	0x1
			SDO #0 Server Parameter						
	U8	(read only)	Number of Entries	2	2	2		1200	0x0
	U32	(read only)	COB-ID Client->Server (Rx)	0x600 + Node-ID				1200	0x1
	U32	(read only)	COB-ID Client->Server (Tx)	0x580 + Node-ID				1200	0x2
F202	I32	inc_plane	Mounting position of the sensor (horizontal, verti-cal)	0	0	3	Configuration Index	2000	0x1
F203	I32	inc_off-set_yaw	Add an offset to the pitch angle	0	-60000	60000	0,001°	2000	0x4
F204	I32	inc_off-set_roll	Add an offset to the roll angle	0	-60000	60000	0,001°	2000	0x2
F205	I32	inc_off-set_pitch	Add an offset to the pitch angle	0	-60000	60000	0,001°	2000	0x3
F207	I32	inc_sen-sor_fusi-on_enabl ed	Filter Selection. On N7 devices, it's possible to disable the sensor fusion.	1	0	1	0 = 3-DOF Angle Calculation 1 = 6-DOF Sensor Fusion	2003	0x1
F208	I32	meas_ove rflow_fault _reaction	How the system reacts on a measurement over-flow	4	0	5	0 = No reaction 1 = Signal SafeS-tate (No Healing) 2 = Signal SafeS-tate (Healing) 3 = System SafeS-tate 4 = Reinit Algorithm 5 = Reset Sensor	2003	0x4

DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	CANopen Index 0x...	Sub-index
F209	I32	legacy_filter_mode	Filter mode of the legacy filter	0	0	1	0 = Sensor mode 360 1 = Sensor mode 90	2008	0x1
F210	I32	inc_lp_cutoff_freq	Inclination low pass filter cutoff frequency	0	0	25000	0,001 Hz	2000	0x5
F211	I32	inc_lp_filter_len	inclination FIR length	32	6	512	0,5 ms	2000	0x6
F212	I32	inc_lp_filter_profile	inclination FIR profile	0	0	1	0 = low pass filter with blackman harris window 1 = Moving average filter	2000	0x7
F213	I32	raw_lp_cutoff_freq	Raw low pass filter cutoff frequency	0	0	25000	0,001 Hz	2001	0x1
F214	I32	raw_lp_filter_len	Raw FIR length	32	12	1024	0,25 ms	2001	0x2
F215	I32	raw_lp_filter_profile	Raw FIR profile	0	0	1	0 = low pass filter with blackman harris window 1 = Moving average filter	2001	0x3
F21E	I32	accelerometer_range	Measurement range of accelerometer	8	2	16	g	2003	0x2
F21F	I32	gyroscope_range	Measurement range of gyroscope	250	15	2000	*/s	2003	0x3
F250	I32	swed_output_0_enable	Enable or disable switched signal output	0	0	1	0 = output disabled 1 = output enabled	200A	0x1
F251	I32	swed_output_0_hyst	Set the angle hysteresis value	0	0	45000	0,001°	200A	0x2
F252	I32	swed_output_0_delay_switch_on_0	Signal delay after positive condition	0	0	20000	ms	200A	0x3
F253	I32	swed_output_0_delay_switch_off_0	Signal delay after negative condition	0	0	20000	ms	200A	0x11
F254	I32	swed_output_0_logic_link	Overall logic operation to compare both axis	0	0	2	0 = only single axis 1 = AND 2 = OR	200A	0x4
F255	I32	swed_output_0_axis_0_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200A	0x5
F256	I32	swed_output_0_axis_0_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200A	0x6

								CANopen	
DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F257	I32	swed_output_0_axis_0_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0x7
F258	I32	swed_output_0_axis_0_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0x8
F259	I32	swed_output_0_axis_0_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0x9
F25A	I32	swed_output_0_axis_0_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0xA
F25B	I32	swed_output_0_axis_1_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200A	0xB
F25C	I32	swed_output_0_axis_1_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200A	0xC
F25D	I32	swed_output_0_axis_1_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0xD
F25E	I32	swed_output_0_axis_1_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0xE
F25F	I32	swed_output_0_axis_1_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200A	0xF
F260	I32	swed_output_0_axis_1_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200A	0x10
F261	I32	swed_output_0_default_state	Initial State relays	0	0	1	0 = OFF 1 = ON	200A	0x12
F262	I32	swed_output_0_invert_switch	Invert the logic of the pins	0	0	1	0 = false 1 = true	200A	0x13
F263	I32	swed_output_0_delay_switch_on_1	Signal delay after positive condition	0	0	20000	ms	200A	0x14

								CANopen	
DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F264	I32	swed_output_0_delay_switch_off_1	Signal delay after negative condition	0	0	20000	ms	200A	0x15
F270	I32	swed_output_1_enable	Enable or disable switched signal output	0	0	1	0 = output disabled 1 = output enabled	200B	0x1
F271	I32	swed_output_1_hyst	Set the angle hysteresis value	0	0	45000	0,001°	200B	0x2
F272	I32	swed_output_1_delay_switch_on_0	Signal delay after positive condition	0	0	20000	ms	200B	0x3
F273	I32	swed_output_1_delay_switch_off_0	Signal delay after negative condition	0	0	20000	ms	200B	0x11
F274	I32	swed_output_1_logic_link	Overall logic operation to compare both axis	0	0	2	0 = only single axis 1 = AND 2 = OR	200B	0x4
F275	I32	swed_output_1_axis_0_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200B	0x5
F276	I32	swed_output_1_axis_0_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200B	0x6
F277	I32	swed_output_1_axis_0_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0x7
F278	I32	swed_output_1_axis_0_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0x8
F279	I32	swed_output_1_axis_0_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0x9
F27A	I32	swed_output_1_axis_0_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0xA
F27B	I32	swed_output_1_axis_1_angle	Input signal to use to compare axis	0	0	2	0 = yaw 1 = pitch 2 = roll	200B	0xB
F27C	I32	swed_output_1_axis_1_logic_link	Overall logic operation to compare operators of axis 0	0	0	2	0 = only single operator 1 = AND 2 = OR	200B	0xC

								CANopen	
DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F27D	I32	swed_output_1_axis_1_cond_0_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0xD
F27E	I32	swed_output_1_axis_1_cond_0_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0xE
F27F	I32	swed_output_1_axis_1_cond_1_angle	Threshold angle that triggers compare function	0	-180000	180000	0,001°	200B	0xF
F280	I32	swed_output_1_axis_1_cond_1_cmp	Compare function to use	0	0	2	0 = none 1 = less than 2 = greater than	200B	0x10
F281	I32	swed_output_1_default_state	Initial state relays	0	0	1	0 = OFF 1 = ON	200B	0x12
F282	I32	swed_output_1_invert_switch	Invert the switching logic of the relay	0	0	1	0 = false 1 = true	200B	0x13
F283	I32	swed_output_1_delay_switch_on_1	Signal delay after positive condition	0	0	20000	ms	200B	0x14
F284	I32	swed_output_1_delay_switch_off_1	Signal delay after negative condition	0	0	20000	ms	200B	0x15
F291	I32	can_baudrate	Baudrate of the CAN	1000000	20000	1000000	bit/s	5999	0x01
F292	I32	can_bus-off_restore_attempts	Number of attempts to reset a detected bus off state (within on drive cycle) before stay in bus off state	32	0	0x7FFFFFFF		5001	0x0
F293	I32	can_bus-off_restore_timeout	Time betweeen to CAN bus reset events	250	0	1000	ms	3000	0x1
F294	I32	can_bus-off_decrement_time	Time of fault free CAN bus which leads to a decrementing of the error counter	300000	0	1000000	ms	3000	0x2
F2A0	I32	can_protocol	Used CAN protocol	0	0	1	0 = J1939 1 = CANopen	599B	0x0
F2A2	I32	can_com_sig_on_change_send	Com default mode	0	0	1	0 = cyclic transmission 1 = send on signal change	3000	0x3

								CANopen	
DID 0x...	Typ	Parame-ter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F2A3	I32	can_com_sig_on_change_min_delta_time	Minimum delta time between signal changed	20	0	100	ms	3000	0x4
F2D2	I32	custo-mer_ecu-id_0	Free customer entry	0	0x8000 0000	0x7FFF FFFF		2009	0x1
F2D3	I32	custo-mer_ecu-id_1	Free customer entry	0	0x8000 0000	0x7FFF FFFF		2009	0x2
F2D4	I32	custo-mer_sof-tid_0	Free customer entry	0	0x8000 0000	0x7FFF FFFF		2009	0x3
F2D5	I32	custo-mer_sof-tid_1	Free customer entry	0	0x8000 0000	0x7FFF FFFF		2009	0x4
F2E0	I32	co_no-de_id	can open node id	32	1	127		5999	0x2
F2E1	I32	co_sync_cob_id	Defines the COBID der SYNC Message.	0x80	0x8000 0000	0x7FFF FFFF		1005	0x00
F2E2	I32	co_produ-cer_heart-beat_time	Interval for heart beat message	300	0	0xFFFF	ms	1017	0x0
F2E3	I32	co_tpdo1com_cob_id	COBID used	0x4000 0180	0x8000 0000	0x7FFF FFFF		1800	0x1
F2E4	I32	co_tpdo1com_trans-missi-on_type	Transmission type	254	0	254	0x00 = after each sync 0xFE = Async with the cycle time of cano-pen_tpdo1com_eventtimer, zero deactivates the event timer.	1800	0x2
F2E5	I32	co_tpdo1com_inhi-bit_time	It is expressed in multiples of 100 microseconds. A value of zero will disable the inhibit time. This time is the minimum interval for PDO transmissions if transmission type is set to 0xFE or 0xFF. This value limits the transmission rate of the TPDOs even if the event time is set to a smaller time or the mapped objects change faster than the inhibit time	0	0	0xFFFF	us	1800	0x3

								CANopen	
DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F2E6	I32	co_tpdo1com_event timer	The time is the maximum interval for PDO transmission if the transmission type is set to 0xFE	10	0	0xFFFF	ms	1800	0x5
F2E7	I32	co_tpdo1 map_parameter1	object 0x6010.00 (X-Axis)	0x6010 0010	0x8000 0000	0x7FFF FFFF	co object address	1A00	0x1
F2E8	I32	co_tpdo1 map_parameter2	object 0x6020.00 (Y-Axis)	0x6020 0010	0x8000 0000	0x7FFF FFFF	co object address	1A00	0x2
F2E9	I32	co_tpdo1 map_parameter3	object 0x2030.00 (Z-Axis)	0x2030 0010	0x8000 0000	0x7FFF FFFF	co object address	1A00	0x3
	I32	(read only)	Manufacturer Specific Error	0			0x0000: No error 0x0002: Parameter checksum error 0x0010: Operating voltage error 0x0020: Internal 5V error 0x0040: Internal 3,3V error 0x0080: Internal Uref error 0x0100: Temperature error 0x0200: Configuration error 0x0400: Internal HW error	4001	
F2EA	I32	co_tpdo1 _resolution	Resolution	10	1	1000	1 = 0.001 deg 10 = 0.01 deg 100 = 0.1 deg 1000 = 1.0 deg	6000	0x0
F2EB	I32	co_slope_long_ operation_parameter	Slope long16 operating parameter	2	0	255	7...5: Manufacturer 4...2: reserved 1: scaling enabled 0: inversion enabled	6011	0
F2EC	I32	co_slope_long_ preset_value	Slope long16 preset value	0	0xFFF F8000	0x7FFF	Set the current position to a fixed value.	6012	0
F2ED	I32	co_slope_long_ offset (read only)	Slope long16 offset	0	0xFFF F8000	0x7FFF	Add offset value to the slope value	6013	0
F2EE	I32	co_slope_long_ diff_offset	Differential slope long16 offset	0	0xFFF F8000	0x7FFF	Additional offset to add	6014	0

								CANopen	
DID 0x...	Typ	Parameter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F2EF	I32	co_slope_lat_operation_parameter	Slope lateral16 operating parameter	2	0	255	7...5: Manufacturer 4...2: reserved 1: scaling enabled 0: inversion enabled	6021	0
F2F0	I32	co_slope_lat_preset_value	Slope lateral16 preset value	0	0xFFFF8000	0x7FFF	Set the current position to a fixed value.	6022	0
F2F1	I32	co_slope_lat_offset (read only)	Slope lateral16 offset	0	0xFFFF8000	0x7FFF	Add offset value to the slope value	6023	0
F2F2	I32	co_slope_lat_diff_offset	Differential slope lateral16 offset	0	0xFFFF8000	0x7FFF	Additional offset to add	6024	0
F2F3	I32	co_auto_nmt	CANopen auto NMT start	0	0	1	0: not activated 1: activated (starts the PDO transmission automatically after power on - no CANopen; standard)	5000	0
F2F4	I32	co_error_mode	Behaviour of the sensor in „signal safe state"	2	2	4	2: Preoperational 3: Operational 4: Stop	1029	0x3
F2F5	I32	co_tpdo2com_cob_id	COBID used	0x40000280	0x80000000	0x7FFFFFFF		1801	0x1
F2F6	I32	co_tpdo2com_transmission_type	Transmission type	254	0	254	0x00 = after each sync 0xFE = Async with the cycle time of canopen_tpdo1com_eventtimer, zero deactivates the event timer.	1801	0x2
F2F7	I32	co_tpdo2com_inhibit_time	It is expressed in multiples of 100 microseconds. A value of zero will disable the inhibit time. This time is the minimum interval for PDO transmissions if transmission type is set to 0xFE or 0xFF. This value limits the transmission rate of the TPDOs even if the event time is set to a smaller time or the mapped objects change faster than the inhibit time	0	0	0xFFFF	us	1801	0x3

								CANopen	
DID 0x...	Typ	Parame-ter	Description	Default	Min	Max	Unit	Index 0x...	Sub-index
F2F8	I32	co_tpdo2com_event timer	The time is the maximum interval for PDO transmission if the transmission type is set to 0xFE	0	0	0xFFFF	ms	1801	0x5
F2F9	I32	co_tpdo3com_cob_id	COBID used	0x40000380	0x80000000	0x7FFFFFFF		1802	0x1
F2FA	I32	co_tpdo3com_transmission_type	Transmission type	254	0	254	0x00 = after each sync 0xFE = Async with the cycle time of canopen_tpdo1com_eventtimer, zero deactivates the event timer.	1802	0x2
F2FB	I32	co_tpdo3com_inhibit_time	It is expressed in multiples of 100 microseconds. A value of zero will disable the inhibit time. This time is the minimum interval for PDO transmissions if transmission type is set to 0xFE or 0xFF. This value limits the transmission rate of the TPDOs even if the event time is set to a smaller time or the mapped objects change faster than the inhibit time	0	0	0xFFFF	us	1802	0x3
F2FC	I32	co_tpdo3com_event timer	The time is the maximum interval for PDO transmission if the transmission type is set to 0xFE	10	0	0xFFFF	ms	1802	0x5

Table 57

9.3   Switching output

UDS 0x...	Switch output	Description	Unit
F250	1	Enable switching output	0 = Switched off 1 = Switched on
F251	1	Hysteresis	0,001°
F252	1	Switch-on delay measuring axis 1	ms
F263	1	Switch-on delay measuring axis 2	ms
F253	1	Switch-off delay measuring axis 1	ms
F264	1	Switch-off delay measuring axis 2	ms
F254	1	Logical operator of measuring axis 1 with measuring axis 2	0 = Only result from measuring axis 1 1 = (Measuring axis 1) AND (Measuring axis 2) 2 = (Measuring axis 1) OR (Measuring axis 2)
F255	1	Measuring axis 1: for Switching point 1 and Switching point 2	0 = Z 1 = X 2 = Y
F256	1	Logical operator of Switching point 1 and Switching point 2	0 = Only Switching point 1. Switching point 2 is not evaluated 1 = AND 2 = OR
F257	1	Switching point 1	0,001°
F258	1	Switching point 1: Logical operator	0 = Disabled 1 = less than 2 = greater than
F259	1	Switching point 2	0,001°
F25A	1	Switching point 2: Logical operator	0 = Disabled 1 = less than 2 = greater than
F25B	1	Measuring axis 2: for Switching point 3 and Switching point 4	0 = Z 1 = X 2 = Y
F25C	1	Logical operator of switching point 3 and switching point 4	0 = Only switching point 3. Switching point 4 is not evaluated 1 = AND 2 = OR
F25D	1	Switching point 3	0,001°
F25E	1	Switching point 3: Logical operator	0 = Disabled 1 = less than 2 = greater than
F25F	1	Switching point 4	0,001°
F260	1	Switching point 4: Logical operator	0 = Disabled 1 = less than 2 = greater than
F261	1	Initial state of the relay	0 = Switched off 1 = Switched on
F262	1	If the inversion is active (closed-circuit current principle), the relay switches off when the switching points are exceeded and the NC contact of the relay is closed. of the relay is closed. If the inversion is deactivated, the NC contact opens when the switching points are exceeded.	0 = Disabled 1 = Enables

UDS 0x...	Switch output	Description	Unit
F270	2	Activate switching output	0 = Switched off 1 = Switched on
F271	2	Hysterese	0,001°
F272	2	Switch-on delay measuring axis 1	ms
F283	2	Switch-on delay measuring axis 2	ms
F273	2	Switch-off delay measuring axis 1	ms
F284	2	Switch-off delay measuring axis 2	ms
F274	2	Logical operator of measuring axis 1 with measuring axis 2	0 = Only result from measuring axis 1 1 = (Measuring axis 1) AND (Measuring axis 2) 2 = (Measuring axis 1) OR (Measuring axis 2)
F275	2	Measuring axis 1: for switching point 1 and switching point 2	0 = Z 1 = X 2 = Y
F276	2	Logical operator of setpoint 1 and setpoint 2	0 = Only switching point 1. Switching point 2 is not evaluated 1 = AND 2 = OR
F277	2	Switching point 1	0,001°
F278	2	Switching point 1: Logical operator	0 = Disabled 1 = less than 2 = greater than
F279	2	Switching point 2	0,001°
F27A	2	Switching point 2: Logical operator	0 = Disabled 1 = less than 2 = greater than
F27B	2	Measuring axis 1: for switching point 3 and switching point 4	0 = Z 1 = X 2 = Y
F27C	2	Logical operator of setpoint 3 and setpoint 4	0 = Only switching point 3. Switching point 4 is not evaluated 1 = AND 2 = OR
F27D	2	Switching point 3	0,001°
F27E	2	Switching point 3: Logical operator	0 = Disabled 1 = less than 2 = greater than
F27F	2	Switching point 4	0,001°
F280	2	Switching point 4: Logical operator	0 = Disabled 1 = less than 2 = greater than
F281	2	Initial state of the relay	0 = Switched off 1 = Switched on
F282	2	If the inversion is active (closed-circuit current principle), the relay switches off when the switching points are exceeded and the NC contact of the relay is closed. If the inversion is deactivated, the NC contact opens when the switching points are exceeded.	0 = Disabled 1 = Enables

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