



Operating Instructions  
**inertial****SENSOR** **INC5502D**

INC5502D-360/90-P-S-CO  
INC5502D-360/90-P-OS-CO  
INC5502D-360/90-P-DS-CO

INC5502D-360/90-P-S-U  
INC5502D-360/90-P-S-I

INC5502D-360/90-P-S-J1939  
INC5502D-360/90-P-OS-J1939  
INC5502D-360/90-P-DS-J1939

## Inclination Sensor

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## 1. Safety

System operation assumes knowledge of the operating instructions.

### 1.1 Symbols Used

The following symbols are used in these operating instructions:



Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

**NOTICE**

Indicates a situation that may result in property damage if not avoided.



Indicates a user action.

i

Indicates a tip for users.

Measurement

Indicates hardware or a software button/menu.

### 1.2 Warnings



Connect the power supply according to the safety regulations for electrical equipment.

- > Risk of injury
- > Damage to or destruction of the sensor and controller

**NOTICE**

Avoid shocks and impacts to the sensor.

- > Damage to or destruction of the sensor and controller

The supply voltage must not exceed the specified limits.

- > Damage to or destruction of the sensor and controller

No sharp or heavy objects should be allowed to affect the cables. Avoid folding the cables. Do not bend the cables more tightly than the minimum bending radius.

- > Damage or destruction of the cable, failure of the measuring device

Do not crush the cables. Protect the cables against damage.

- > Damage or destruction of the cable, failure of the measuring device, data loss

Ensure that the coupling nuts of the connectors are firmly tightened.

- > Damage or destruction of the cable, failure of the measuring device

## 1.3 Notes on Product Marking

### 1.3.1 CE Marking

The following applies to the product:

- Directive 2014/30/EU (“EMC“)
- Directive 2011/65/EU (“RoHS“)

Products which carry the CE marking satisfy the requirements of the EU Directives cited and the relevant applicable harmonized European standards (EN). The product is designed for use in industrial and laboratory environments.

The EU Declaration of Conformity and the technical documentation are available to the responsible authorities according to the EU Directives.

### 1.3.2 UKCA Marking

The following applies to the product:

- SI 2016 No. 1091 (“EMC“)
- SI 2012 No. 3032 (“RoHS“)

Products which carry the UKCA marking satisfy the requirements of the directives cited and the relevant applicable harmonized standards. The product is designed for use in industrial and laboratory environments.

The UKCA Declaration of Conformity and the technical documentation are available to the responsible authorities according to the UKCA Directives.

### 1.3.3 Intended Use

- The inertialSENSOR INC5502D is designed for use in an industrial and laboratory applications. It is used for
  - measuring angles
  - determining the orientation of machine parts
  - measuring the position of maneuverable components
- The system must only be operated within the limits specified in the technical data, [see 2](#).
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the system.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

## 1.4 Proper Environment

- Protection class: IP67/IP69K
- Temperature range:
  - Operation: -40 ... +85 °C (-40 ... +185 °F)
  - Storage: -40 ... +85 °C (-40 ... +185 °F)
- Humidity: 5 ... 95 % RH (non-condensing)
- Ambient pressure: Atmospheric pressure

## 2. Functional Principle, Technical Data

### 2.1 Short Description

The inertialSENSOR INC5502D is an inclination sensor for the single- and dual-axis measurement of angles of inclination with a dynamically stabilized SensorFUSION filter, which combines the sensor technology of an acceleration sensor with that of a gyroscope.

This produces a stable output signal with practically no time delay, even in the case of dynamic movements.

The sensor is used in mobile machinery, such as agricultural and forestry machinery, as well as construction machinery and in crane and lifting technology.

### 2.2 Measuring Principle

The signal is reliable and stable even in the event of strong interference caused by vibrations and impacts, for example. Low-pass filters with different characteristics are optionally available.

The sensor has the following output signals, which can be activated as desired:

- Longitudinal (roll) Euler angle, measuring range either  $\pm 180^\circ$  or  $0^\circ \dots 360^\circ$  and lateral (pitch) Euler angle, measuring range  $\pm 85^\circ$  or  $95^\circ \dots 265^\circ$ ; sign reversible, axis orientation selectable, [see 4.4.1](#).
- Position angle Tilt x and Tilt y, measuring range  $\pm 90^\circ$ ; tilting of the axes with respect to the horizontal plane in the Earth's gravitational field, sign reversible, axis orientation selectable, [see 4.4.2](#).
- Acceleration axes x, y, z, measuring range  $\pm 2$  g
- Angular velocity axes x, y, z, measuring range  $\pm 500^\circ/\text{s}$

On request, the software can be adapted to the relevant application with a special set of parameters.

In addition, numerous setting parameters allow for optimal adaptation to the relevant application.

### 2.3 Properties and Electrical Connection

The sensor can be used for both static and dynamic angle measurements. The SensorFUSION filter is used for dynamic measurements during movements. The low-pass filter is used for a quasistatic or static measurement.

The inclination sensor is available with the interfaces SAE J1939 and CANopen as well as with the analog current or voltage interface (4 ... 20 mA, 0.5 ... 10 V, 0 ... 10 V) and the RS485 interface.

The sensor can be configured via both interfaces, [see 6.6](#) (SAE J1939), [see 5.5.6](#) (CANopen).

The program `sensorTOOL` is available for sensor configuration and can be downloaded free of charge from the website, [see 10](#).

To connect a sensor with an SAE J1939 or CANopen interface to `sensorTOOL`, it must be converted via the SAE J1939 or CANopen interface, [see 10.5.1](#), [see 10.5.2](#).

## 2.4 Technical Data

Model	INC5502D CO/J1939	INC5502D I	INC5502D U
Number of measuring axes	1 or 2		
Measuring range	Euler angle	Longitudinal (Roll): $\pm 180^\circ$ (switchable to $0^\circ \dots 360^\circ$ ) Lateral (Pitch): $\pm 85^\circ$ (switchable to $95^\circ \dots 265^\circ$ ) (sign reversible, axis orientation selectable)	
	Position angle	Tilt x and Tilt y: $\pm 90^\circ$ (sign reversible, axis orientation selectable)	
Resolution	0.01°		
Repeatability	$\leq \pm 0.05^\circ$		
System accuracy <sup>1</sup>	static: $\pm 0.15^\circ$ (measuring range $\leq \pm 30^\circ$ ) and $\pm 0.25^\circ$ (measuring range $> \pm 30^\circ$ ) dynamic: up to $\pm 0.3^\circ$ (typ. $\pm 0.5^\circ$ )	static: $\pm 0.2^\circ$ (measuring range $\leq \pm 30^\circ$ ) and $\pm 0.25^\circ$ (measuring range $> \pm 30^\circ$ ) dynamic: up to $\pm 0.^\circ$ (typ. $\pm 0.5^\circ$ )	
Measuring rate	200 Hz		
Temperature stability <sup>2</sup>	$\pm 0.008^\circ / K$		
Supply voltage	9 ... 32 VDC		
Max. current consumption	110 mA (12 VDC)	50 mA (24 VDC)	
Digital interface <sup>3</sup>	CANopen, SAE J1939	RS485, Ethernet, EtherCAT, PROFINET, Ethernet/IP	
Analog output	-	4 ... 20 mA (max. 300 $\Omega$ )	0 ... 10 V / 0.5 ... 4.5 V (min. 3 k $\Omega$ )
Connection <sup>4</sup>	1 or 2 x 5-pin M12 plug connectors (plug socket, daisy-chained)	1 x 8-pin M12 plug connector	
Mounting	Mounting holes $\varnothing$ 4 mm		
Temperature range	Storage	-40 ... +85 °C	
	Operation	-40 ... +85 °C	
Shock (DIN EN 60068-2-27)	1500 g / 0.5 ms in 3 axes (half-sine)		
Protection class (DIN EN 60529)	IP67 / IP69K (plugged)		
Material	Glass fiber reinforced polyamide (housing) PUR (potting)		
Weight	approx. 120 g		
Control and indicator elements	bicolor LED for status		
Special features	adjustable filters: sensorFUSION, low-pass filter. On request, predefined, application-specific config files can be provided. We can also set up individual parameter sets for series applications. Output of further measurement parameters (raw values): acceleration x, y, z axes, measuring range $\pm 2$ g; angular velocity x, y, z, axes, measuring range $\pm 500^\circ/s$		

1) All specifications are typical for 25 °C, unless otherwise stated

2) Typically in the temperature range -40...+85 °C

3) Ethernet, EtherCAT, PROFINET and EtherNet/IP require connection via interface module

4) Further connection options on request (e.g. integrated cable, Deutsch plug)

**Order Designation**

INC5502D	-360/90	-P	-OS	-CO
	Measuring range: Longitudinal (roll): $\pm 180^\circ$ (switchable to $0^\circ$ ... $360^\circ$ ) Lateral (pitch): $\pm 85^\circ$ (switchable to $95^\circ$ ... $265^\circ$ ) Tilt x and Tilt y: $\pm 90^\circ$ (sign reversible, axis orientation selectable)	Housing material: (glass fiber-reinforced) polyamide	Plug variant: OS: Plug and socket daisy-chained, 5-pin, 2xM12, A-coded, on front of housing S: Plug, 5-pin, 1xM12, A-coded DS: Plug and socket, daisy-chained, 5-pin, 2xM12, A-coded, on front or rear of housing	Interface: CO: CANopen J1939: SAE1939 U: Analog / Voltage I: Analog / Current RS485: RS485

<b>Emitted interference</b>			
Conducted interference / radio interference voltage EN55016-2-1	DIN EN 61326-1 MSR (CISPR 11) 0.15 ... 30 MHz		
Radiated interference / radio field strength EN55016-2-3	DIN EN 61326-1 MSR (CISPR 11) DIN EN ISO 13766-1 (construction machinery) (4.5 Broadband ESA   4.6 Narrowband ESA) 30MHz ... 1GHz (vertical and horizontal)		
<b>Immunity to electrostatic discharges (ESD)</b>			
Indirect contact discharge EN 61000-4-2	DIN EN 61326-1 MSR $\pm 6$ kV, assessment criterion B		
Contact discharge EN 61000-4-2	DIN EN 61326-1 MSR $\pm 6$ kV, assessment criterion B		
Air discharge EN 61000-4-2	DIN EN 61326-1 MSR $\pm 8$ kV, assessment criterion B		
<b>Immunity to radiated RF fields</b>			
EN 61000-4-3	EN 61326-1 MSR 80 – 1000 MHz 10V/m (RMS cw) 1.0 – 6.0 GHz 3V/m (RMS cw) DIN EN 13766-1 / DIN EN ISO 14982 200 - 1000 MHz 48V/m (modulated) Assessment criterion A		
<b>Immunity to fast transients (bursts)</b>			
EN 61000-4-4	$\pm 2$ kV, assessment criterion B		
<b>Immunity to surge voltages</b>			
EN 61000-4-5	$\pm 1$ kV, assessment criterion B		
<b>Immunity to conducted RF, asymmetric</b>			
EN 61000-4-6	0.15 - 80 MHz 10 V (RMS cw), assessment criterion A		
<b>Immunity to conducted disturbances (on-board power supply 12 VDC)</b>			
Pulses according to ISO 7637-2	Pulse	Severity	Criterion
	1	III (-75 V/0.5 s)	C
	2a	III (+37 V/0.2 s)	A
	3a	III (-112/90 ms)	A
	3b	III (+75V/90 ms)	A
	4	III (-6 V)	A
	5a	III (+65 V, Ri=4 $\Omega$ )	A

Fig. 1 Electromagnetic compatibility (EMC)

### 3. Delivery

#### 3.1 Unpacking/Included in Delivery

1 INC5502D sensor

1 Assembly instructions

- ▶ Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.
- ▶ Check the delivery for completeness and shipping damage immediately after unpacking.
- ▶ If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Optional accessories are available in the appendix, [see A 1](#).

#### 3.2 Storage

Temperature range: -40 ... +85 °C (-40 ... +185 °F)

Humidity: 5 ... 95 % RH (non-condensing)

## 4. Installation and Assembly

### 4.1 Notes for Operation

**i** Ensure careful handling during installation and operation!

### 4.2 Sensor Cable

**NOTICE**

No sharp or heavy objects should be allowed to affect the cables. Avoid folding the cables. Do not bend the cables more tightly than the minimum bending radius.  
 > Damage or destruction of the cable, failure of the measuring device

**NOTICE**

Do not crush the cables. Protect the cables against damage.  
 > Damage or destruction of the cable, failure of the measuring device

**NOTICE**

Ensure that the coupling nuts of the connectors are firmly tightened.  
 > Damage or destruction of the cable, failure of the measuring device

### 4.3 Mechanical Fastening, Dimensional Drawing

**▶** Fasten the sensor using three M4 screws.

#### 4.3.1 Dimensional Drawing INC5502D-360/90-P-OS

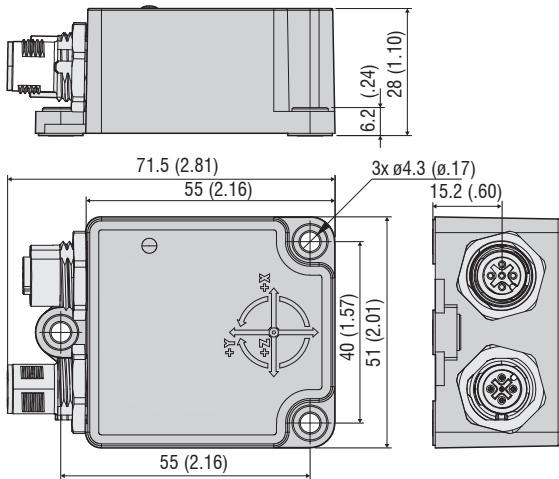


Fig. 2 Dimensional INC5502D-360/90-P-OS, dimensions in mm (inches, rounded off)

#### 4.3.2 Dimensional Drawing INC5502D-360/90-P-DS-CO

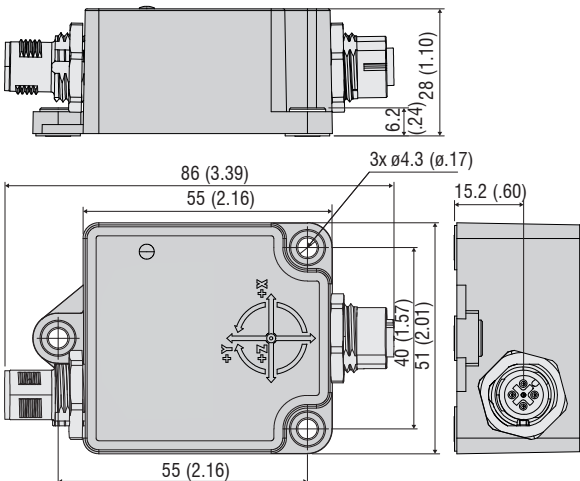


Fig. 3 Dimensional drawing INC5502D-360/90-P-DS-CO, dimensions in mm (inches, rounded off)

### 4.3.3 Dimensional Drawing INC5502D-360/90-P-S-CO

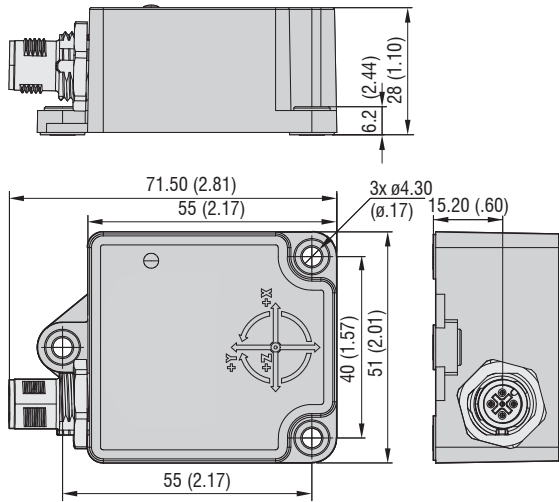


Fig. 4 Dimensional drawing INC5502D-360/90-P-S-CO, dimensions in mm (inches, rounded off)

### 4.3.4 Dimensional Drawing INC5502D-360/90-P-S-U and und INC5502D-360/90-P-S-I

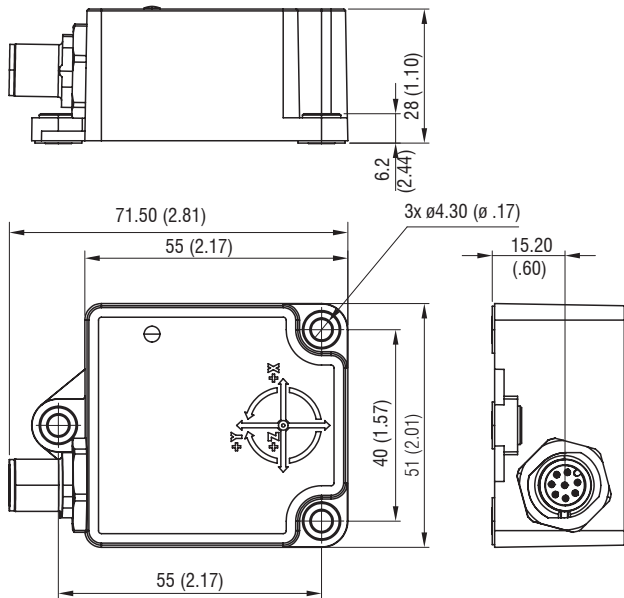


Fig. 5 Dimensional drawing INC5502D-360/90-P-S-U und INC5502D-360/90-P-S-I, dimensions in mm (inches, rounded off)

## 4.4 Coordinate System

After the sensor has been installed, it can be set as desired, [see 4.4.1](#), [see 4.4.2](#).

From the zero position, the sensor measures a longitudinal Euler angle:  $\pm 180^\circ$  and a lateral Euler angle:  $\pm 85^\circ$  (can be converted to  $0^\circ \dots 360^\circ$  and  $95^\circ \dots 265^\circ$  respectively, signs reversible, axial orientation freely selectable) or the position angles Tilt x and Tilt y:  $\pm 90^\circ$  (signs reversible, axial orientation freely selectable).

For more information on Euler angles and position angles, [see 4.4.1](#), [see 4.4.2](#).

### 4.4.1 Euler Angle

The longitudinal (roll) Euler angle indicates the rotation around the rotation axis. The lateral (pitch) Euler angle indicates the lateral tilting of the rotation axis.

With the parameter IncChooseLoLa (ID 50548), [see 9.1](#), the alignment can be adapted to the mounting situation.

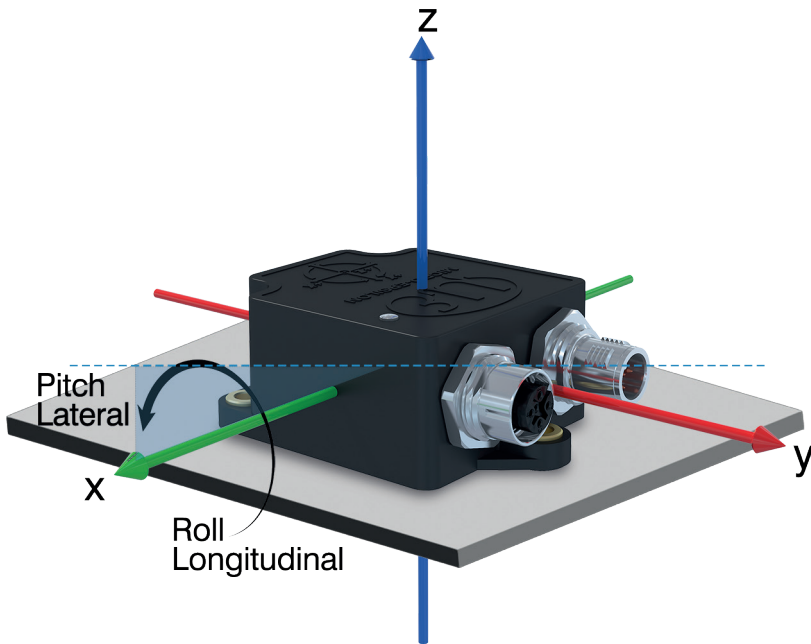


Fig. 6 Sensor orientation: Horizontal mounting x and X-axis selected as rotation axis

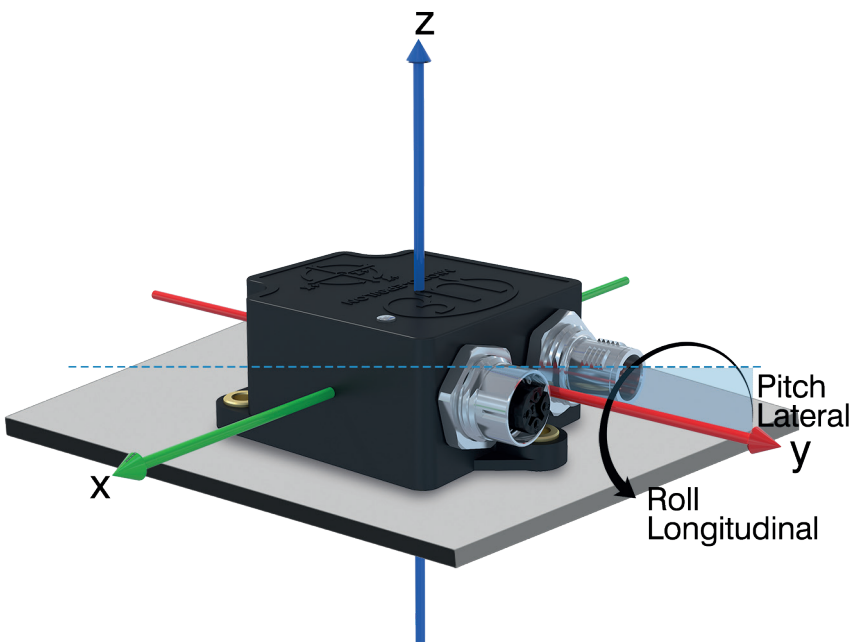


Fig. 7 Sensor orientation: Horizontal mounting y and Y-axis selected as rotation axis

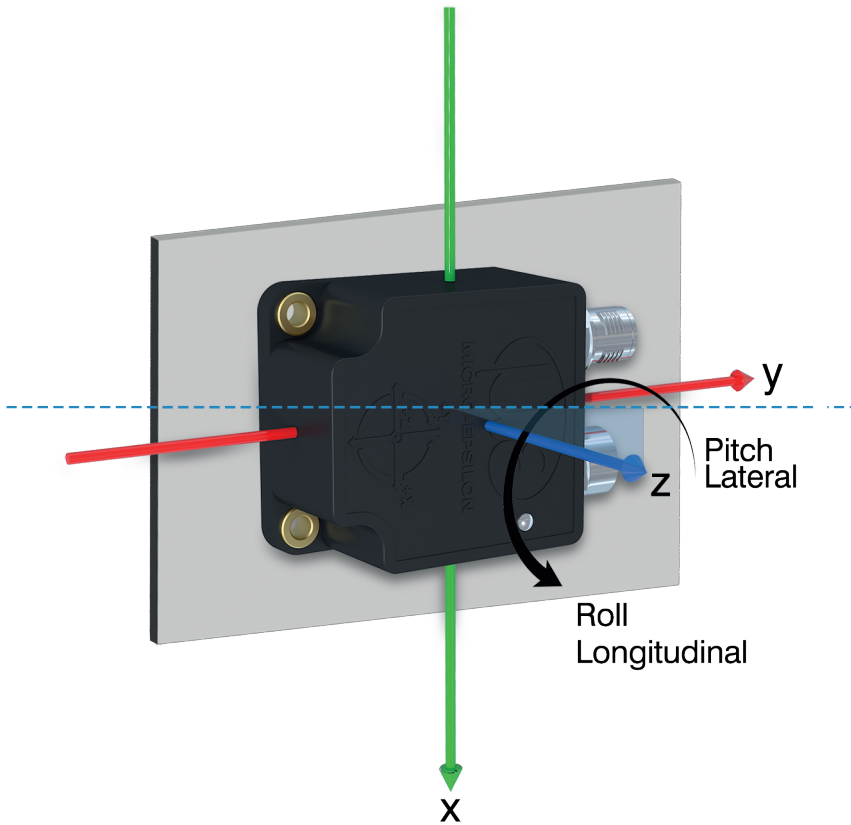


Fig. 8 Sensor orientation: Vertical mounting z and Z-axis selected as rotation axis

#### 4.4.1.1 Zeroing with Digital Sensor

In the mounted position, the angle values can be set to  $0^\circ$  with the measuring range selected as  $\pm 180^\circ / \pm 85^\circ$  or to  $180^\circ$  with the measuring range selected as  $0^\circ \dots 360^\circ / 95^\circ \dots 265^\circ$  (zeroing). As a result, in the mounted position, the angle values are in the mid of the measuring range. During the zeroing process, the rotation axis can be tilted up to an angle of  $+5^\circ$ . In other words, the lateral Euler angle may display an angle of up to  $+5^\circ$  during zeroing.

➤ Set the parameter TeachIn (ID 50081), see 9.1, to 1 for zeroing.

With the value 2, the zeroing is reversed, see 5.5.6. (CANopen), see 6.6.2 (J1939).

#### 4.4.1.2 Zeroing of Analog Sensor

The zero position in a sensor with an analog interface can be set not only via the sensorTOOL but also using the teach pin. To set the zero position, apply additional supply voltage (9 ... 32 V) to the teach pin 5 for at least 300 ms when the supply voltage is connected between pin 8 and pin 6. The current position of the sensor is now the new zero position. This procedure can be repeated as often as desired.

#### 4.4.2 Position Angle Tilt

In contrast to the Euler angles, the position angles indicate the inclination in the Earth's gravitational field, i.e. the tilt angle of two axes with respect to the global horizontal plane perpendicular to gravity. With the parameter `IncChooseTilt` (ID 50549), see 9.1, the alignment can be adapted to the mounting situation.

If the sensor is mounted vertically and the X-axis (parallel to gravity) is selected, the tilt angle of the Y-Z plane with respect to the global horizontal plane is measured, see Fig. 9. However, if the Y-axis is selected, the tilt angle of the X-Z plane with respect to the global horizontal plane is measured, see Fig. 10. If the sensor is mounted horizontally and the Z-axis (parallel to gravity) is selected, the tilt angle of the X-Y plane is displayed, see Fig. 11.

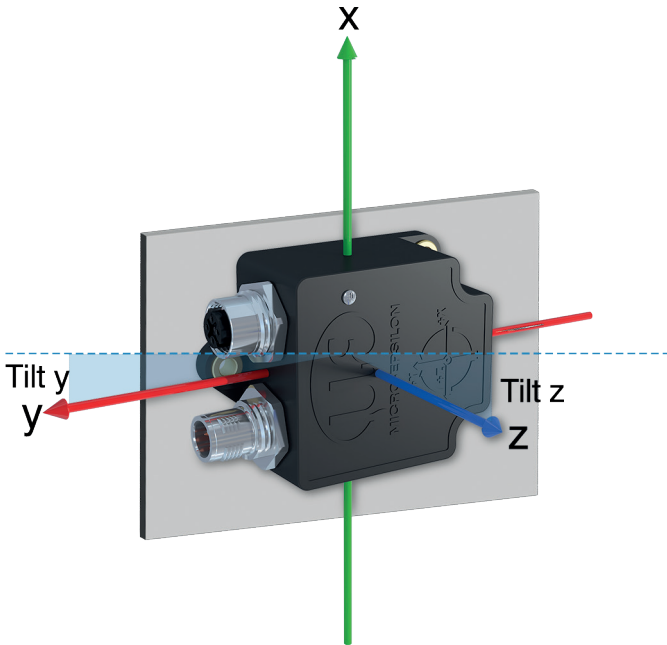


Fig. 9 Vertical mounting and selection of X-axis parallel to gravity (measurement of tilt angle of Y-Z plane)

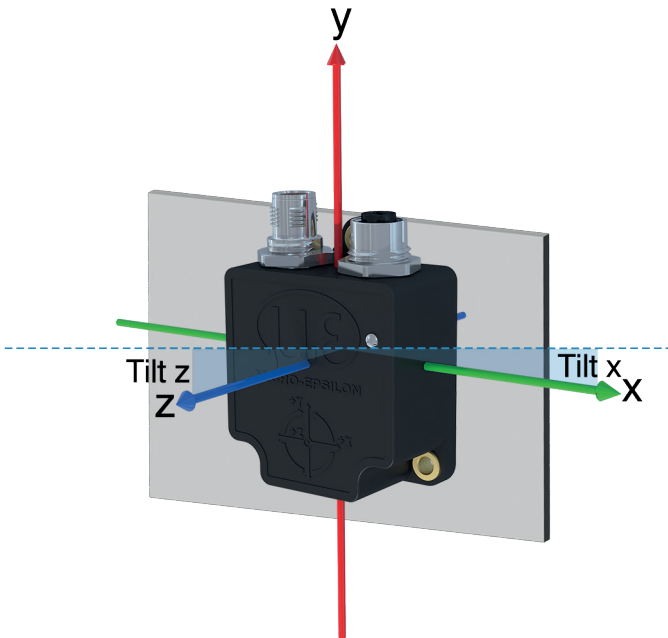
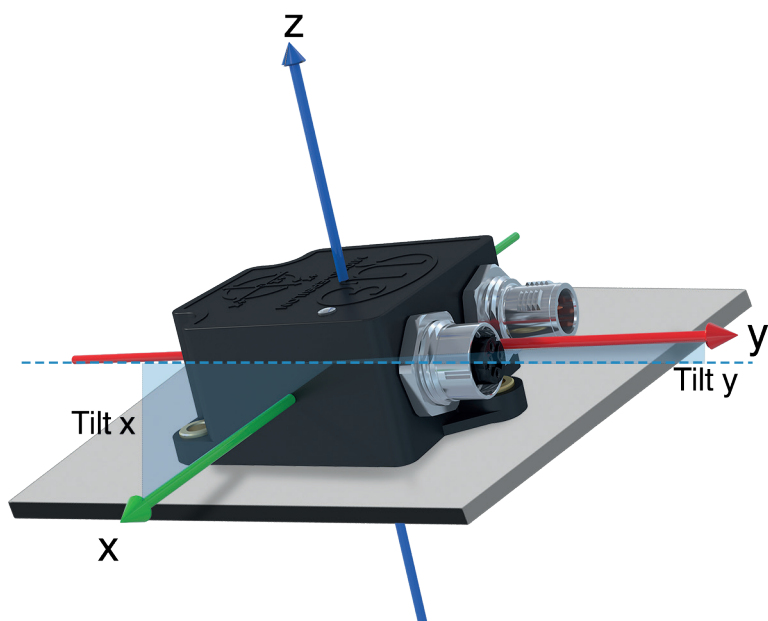


Fig. 10 Vertical mounting and selection of Y-axis parallel to gravity (measurement of tilt angle of X-Z plane)



*Fig. 11 Vertical mounting and selection of Z-axis parallel to gravity (measurement of tilt angle of X-Y plane)*

The angle values can be set to  $0^\circ$  in the mounted position (zeroing). During zeroing, it must be ensured that the sensor is oriented horizontally.

➤ Set the parameter `TeachIn` (ID 50081), [see 9.1](#), to 1 for zeroing.

With the value 2, the zeroing is reversed.

➤ Use the analog sensor for the zeroing, [see 4.4.1.2](#).

## 4.5 Pin Assignment

### 4.5.1 CAN-Bus


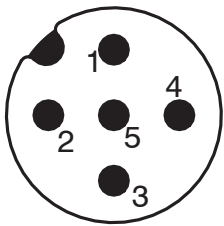

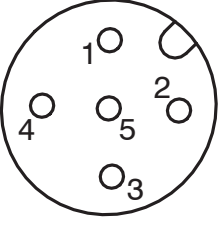
Pin	Assignment	Signal	Cable PC5/5		
1	Shield	CAN_SHLD	Brown	 	 
2	Supply voltage (9 ... 32 VDC)	$V_+$	White		
3	GND / 0 V / $V_-$	$V_-$	Blue		
4	CAN_H bus cable	CAN_H	Black		
5	CAN_L bus cable	CAN_L	Gray		
				5-pin housing connector View on pin side A-coded	5-pin housing connector View on socket side A-coded

Fig. 12 Pin assignment of the 5-pin M12 plug CAN bus and 5-pin M12 socket CAN bus

You can find the appropriate supply and output cable PC5/5 under Optional Accessories, [see A 1](#).

### 4.5.2 Analog


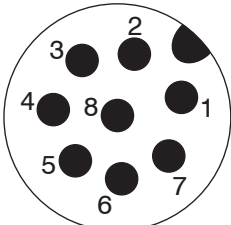
Pin	Assignment	Signal	Cable PCx8	
1	X-axis inclination	4 ... 20 mA/0.5 ... 4.5 V/0 ... 10 V	White	 
2	Signal GND		Brown	
3	Y-axis inclination	4 ... 20 mA/0.5 ... 4.5 V/0 ... 10 V	Green	
4	RS485 bus line	RS485+	Yellow	
5	Teach-in	9 ... 32 VDC, $\geq 300$ ms (IN)	Gray	
6	GND / 0 V / $V_-$	$V_-$	Pink	
7	RS485 bus line	RS485-	Blue	
8	Supply voltage 9 ... 32 VDC	$V_+$	Red	
				8-pin housing plug M12 View of pin side, A-coded

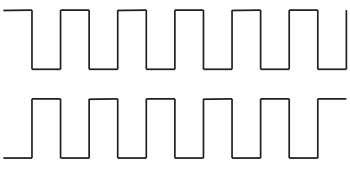

Fig. 13 Pin assignment for the 8-pin M12 analog connector

You can find the appropriate supply and output cable PC3/8 under Optional Accessories, [see A 1](#).

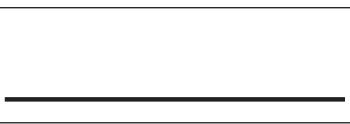
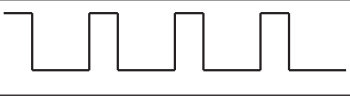
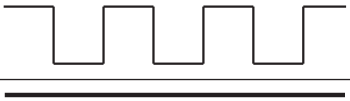

## 4.6 Status LED

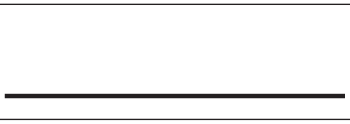

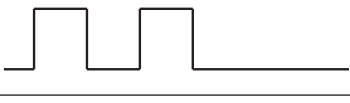

### General

The integrated status LED shows the current device state (operating LED, green) and any CAN communication errors that may have occurred (error LED, red). The states displayed differ based on the color and flashing frequency.



CAN-RUN LED & CAN-ERROR LED	Color	Status	Description
	Green/red	Alternating flickering	Initialization phase
		Permanently off	Sensor has no power supply or is defective.


### CANopen

CAN-RUN LED	Color	Status	Description
	Green	Off	Sensor is being reset or has no power supply.
		Short flashing	Sensor is in the <<Stopped>> state.
		Flashing	Sensor is in the <<Pre-Operational>> state.
		Permanent	Sensor is in the <<Operational>> state.



CAN-ERROR LED	Color	Status	Description
	Red	Off	The sensor is working error-free or has no power supply.
		Flashing four times with longer off phase	Sensor is in the <<Bus passive>> state.
		Flashing twice with subsequent longer off phase	Sensor is in the <<Bus warn>> state.
		Permanently on	Sensor is in the <<Bus off>> state.



**J1939**

CAN-RUN LED	Color	Status	Description
	Green	Off	Sensor is being reset or has no power supply.
		Permanently on	Sensor is ready for operation.

CAN-ERROR LED	Color	Status	Description
	Red	Permanently off	The sensor is working error-free or has no power supply.

**U and I**

RUN LED	Color	Status	Description
	Green	Off	Sensor is being reset or has no power supply.
		Continuous	Sensor is ready for operation.

CAN-ERROR LED	Color	Status	Description
	Red	Continuous	Error state
	Orange	Briefly lights up	Start-up

## 5. CANopen Interface

### 5.1 Overview of Functions

The sensor has a standardized CANopen interface according to CiA-301 and CiA-DS410 device profile. All measured values generated are accessible via the object directory. Any settings made can be saved in the permanent memory of the sensor.

Available functionalities:

- Four process data objects (TxPDO1 – TxPDO4)
  - Dynamically mappable process data
  - Event-driven process data transmission triggered by measurement data change
  - Interval time-driven process data transmission
  - Transmission of process data in response to the receipt of a SYNC telegram
- A service data object (standard SDO)
- Monitoring mechanism Heartbeat
- Saving and restoring function for all parameters that can be saved in the device
- Error messages via emergency object (EMCY)
  - General error register
  - Manufacturer-specific error register (manufacturer status)
  - Error list (pre-defined error field)
- Status and error display via bicolor LED (does not meet CiA DR-303-3)

The following can be found in the device profile-specific or manufacturer-specific configuration options:

- Setting of node ID and baud rate by means of LSS (CiA DSP-305)
- Sign reversal of inclination angle
- Zero-point setting of inclination angle at the perpendicular angles
- Sensor fusion filter
- Configurable frequency response for the low-pass filter
- Various other configuration options can be found in chapter, [see 9.1](#).

## 5.2 Positioning of CANopen in the Layer Model

CANopen was standardized by the association “CAN in Automation” (CiA) and provides an open protocol standard in automation technology using the CAN bus as the transmission medium. As with almost all field buses, CANopen is also based on the ISO/OSI 7-layer model. CANopen defines the elements for network management, the use of the CAN identifiers (message address), the temporal behavior on the bus, the type of data transmission, and application-related profiles. This makes it possible for CANopen devices from different manufacturers to be used in combination in a network. CANopen describes the application layer as a communication profile in order to ensure a consistent type of communication; this was specified by the CiA in CiA DS-301. In addition, various device and application profiles were also defined. These can be found in the standards CiA DS-4xx.

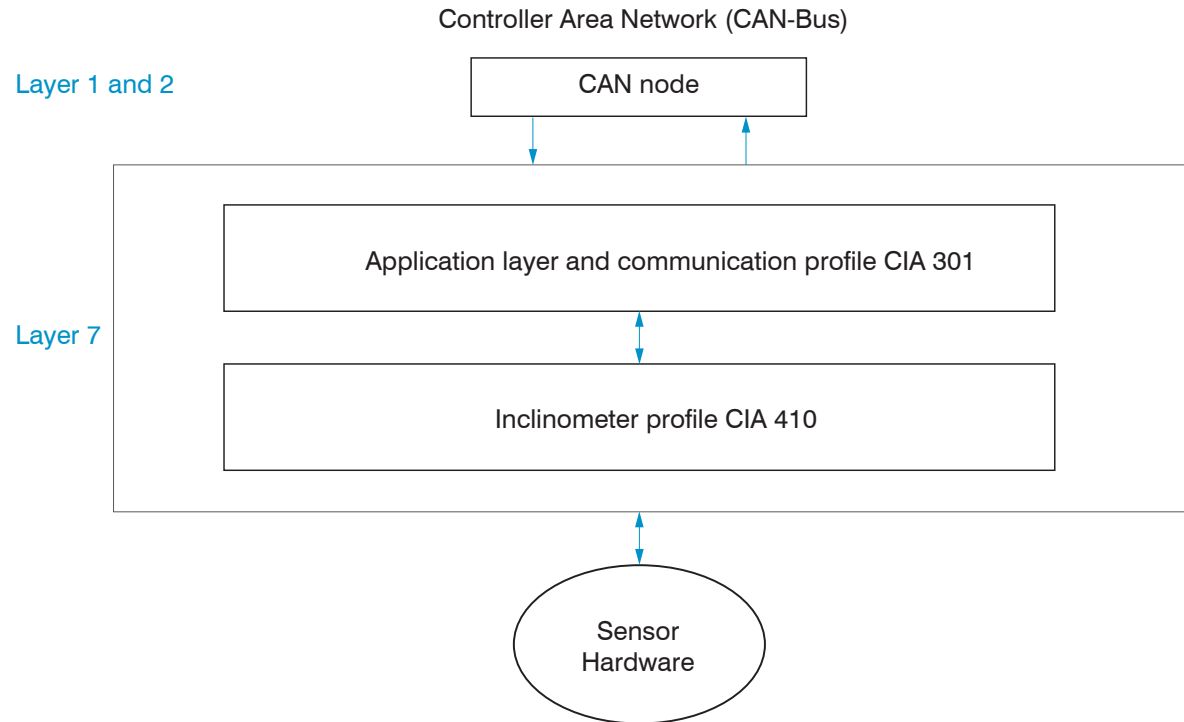


Fig. 14 Layer model of the CAN bus interface

## 5.3 Device Model

Communication with a CANopen device (CAN node), see Fig. 14, takes place via so-called data objects.

For this purpose, the CiA has defined various objects for the different fields of application.

Firstly, there are high-priority process data objects (PDOs). These telegrams are used for exchanging process data. Regardless of the profile, PDOs can be telemetry data or data for parameterization. Typically, the parameters of the object directory of a device are accessed by means of a service data object (SDO).

For network management, there are the NMT objects, by means of which the state machine of the CANopen device is controlled. Additionally, they are used to monitor the state of the network nodes.

Other objects have been defined for synchronization, error messages, and time stamps. Every CANopen device has its own object directory in which the parameters for all CANopen objects can be entered. Every CANopen device has its own object directory in which the parameters for all CANopen objects can be entered.

## 5.4 Communication-Specific Standard Objects

The CAN identifiers of the communication objects (COB-IDs) are determined according to the pre-defined connection set, depending on the node ID that has been set. By default, this is set to 11d or 0Bh. The communication objects are calculated as follows.

Communication object (COB)	Standard value	Calculation of COB-ID
NMT	0h	0h
SYNC	80h	80h
EMCY	8Bh	80h + node ID
TPDO1	18Bh	180h + node ID
TPDO2	28Bh	280h + node ID
TPDO3	38Bh	380h + node ID
TPDO4	48Bh	480h + node ID
Standard SDO (CANopen master / client → CANopen slave / server)	60Bh	600h + node ID
Standard SDO (CANopen slave / client → CANopen master / client)	58Bh	580h + node ID
Heartbeat	70Bh	700h + node ID

Fig. 15 COB-ID calculation according to predefined connection set

## 5.5 Object Directory

This contains all existing parameters that must be accessible by other bus participants in order to be able to parameterize the sensor.

Status machines, communication behavior, and the application itself are affected by these influencing variables.

CANopen subdivides an object directory as shown in Fig. 16 .

The ranges **1000h - 1FFFh**, **2000h - 5FFFh** and **6000h - 9FFFh** are most relevant here, since communication and grouping within a particular device profile take place via these ranges. In addition, manufacturer-specific features that would not be permissible in either of the two other ranges can be implemented in these ranges.

Index	Use
0000	Not used
0001-009F	Data types (special case)
00A0-0FFF	Reserved
1000-1FFF	Communication profile
2000-5FFF	Manufacturer-specific range
6000-9FFF	Up to 8 standardized device profiles
A000-AFFF	Process images from IEC61131 devices
B000-BFFF	Process images from CANopen gateways according to CiA 302-7.
C000-FFFF	Reserved

Fig. 16 Subdivision of object directory

### 5.5.1 Access to Parameter Data via Service Data Object (SDO)

A CANopen device is generally parameterized via SDOs. The corresponding COB-IDs are described in the previous chapter, see 5.4. The data field of this CAN message is structured as in the following image.

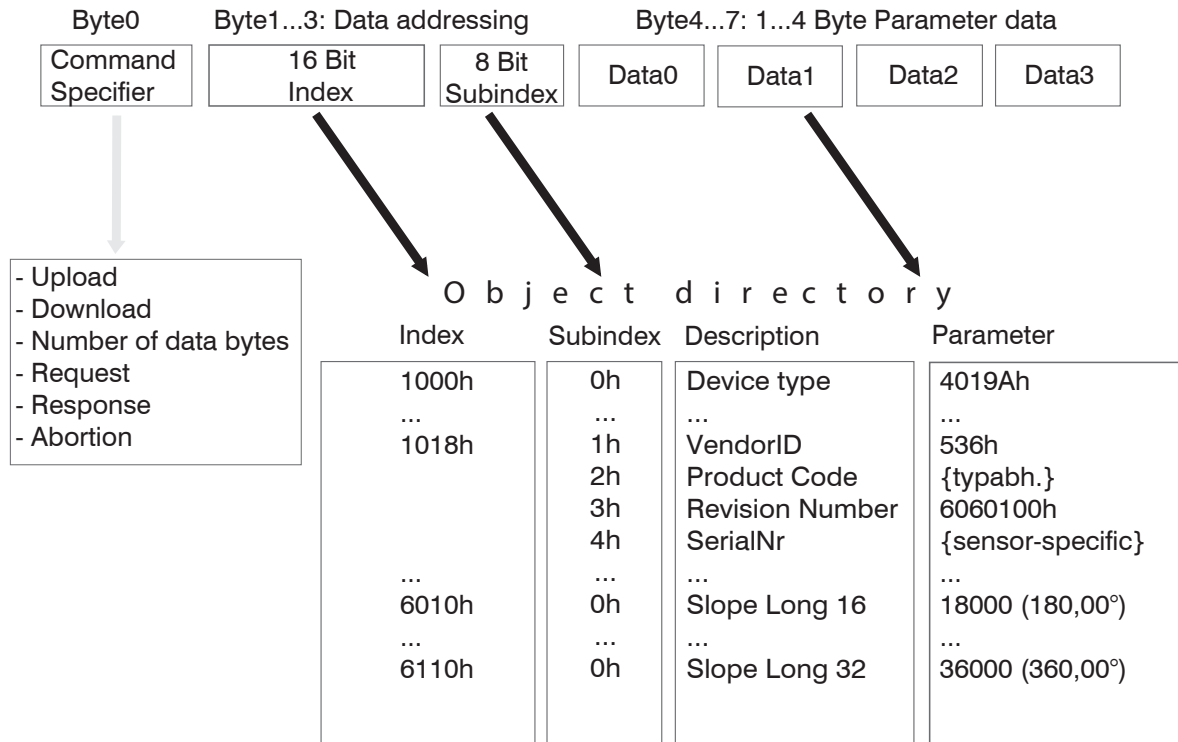


Fig. 17 Data field of a CAN message

It is possible to access the factors mentioned in the chapter Object Directory, see 5.5, via the service data objects. As shown in the graphic, a corresponding parameter can be addressed via a combination of 16-bit index and 8-bit subindex. The graphic also shows that a total of 8 bytes are accommodated in the data part of the CAN message and contain the command specifier, the addressing, and the parameter data.

### 5.5.2 Communication Parameters According to CIA DS-301

Index	Subindex	Parameter	Data type	Attribute	Standard value	Ability to store value	Mapping
1000h	0h	Device type	UNS32	const	4019Ah		-
1001h	0h	Error register	UNS8	ro	0h		0
1002h	0h	Manufacturer status register	UNS32	ro	0h		0
1003h	Predefined error field						-
	0h	Number of field entries	UNS32	rw	0h		-
	1h .. 5h	Error codes (latest error on lowest index)	UNS32	ro	0h		-
1005	0h	COB-ID SYNC	UNS32	rw	80h		-
1008	0h	Device name	VSTR	const	Product-specific		-
100Ah	0h	Software version	VSTR	const	Product-specific		-
1010h	Save parameters ("s", "a", "v", "e" – 73h, 61h, 76h, 65h)						-
	0h	Number of entries	UNS32	ro	4h		-
	1h	Save all settings	UNS32	rw	0h		-
	2h	Save communication parameters	UNS32	rw	0h		-
	3h	Save profile-specific parameters	UNS32	rw	0h		-
	4h	Save manufacturer-specific parameters	UNS32	rw	0h		-

Index	Subindex	Parameter	Data type	Attribute	Standard value	Ability to store value	Mapping
1011h	Restore standard parameters ("l", "o", "a", "d" – 6Ch, 6Fh, 61h, 64h)						-
	0h	Number of entries	UNS32	ro	4h		-
	1h	Set all to factory settings	UNS32	rw	0h		-
	2h	Factory setting for communication-specific parameters, ...	UNS32	rw	0h		-
	3h	Factory setting for profile-specific parameters, ...	UNS32	rw	0h		-
	4h	Factory setting for manufacturer-specific parameters, ...	UNS32	rw	0h		-
1014h	0h	COB-ID EMCY	UNS32	ro	80h + node ID		-
1015h	0h	Blocking time between two EMCY messages (multiple of 100µs)	UNS16	rw	0h	x	-
1017h	0h	Interval time for Heartbeat (multiple of 1ms, 0h = deactivated)	UNS16	rw	0h	x	-
1018h	Identify object						
	0h	Highest supported subindex	UNS8	ro	4h		-
	1h	Manufacturer ID Micro-Hybrid Electronic GmbH	UNS32	ro	0335h		-
	2h	Product code / article number	UNS32	ro	4C4F3Ch		-
	3h	Revision number	UNS32	ro	6060100h		-
	4h	Serial number	UNS32	ro	Product-specific		-
1022h	0h	Number of defect classes	UNS8	ro	2h		-
	1h	Communication parameter	UNS8	rw	0h		-
	2h	Specific defect classes	UNS8	rw	0h		-
1800h	Transmit PDO1 communication parameter						
	0h	Highest supported subindex	UNS8	ro	5h		-
	1h	COB-ID	UNS32	rw	180h + node ID	x	
	2h	Transmission type (synchronous/asynchronous/with change of measured value)	UNS8	rw	1h	x	-
	3h	Compatibility entry	UNS16	rw	0h	x	-
	4h	Compatibility entry	UNS8	rw	0h	x	-
	5h	Interval time for cycl. transmission (multiple of 1ms, 0h = deactivated)	UNS16	rw	0h	x	-
1801h	Transmit PDO2 communication parameter						
	0h	Highest supported subindex	UNS8	ro	5h		-
	1h	COB-ID	UNS32	rw	280h + node ID	x	-
	2h	Transmission type (synchronous/asynchronous/with change of measured value)	UNS8	rw	1h	x	-
	3h	Compatibility entry	UNS16	rw	0h	x	-
	4h	Compatibility entry	UNS8	rw	0h	x	-
	5h	Interval time for cycl. transmission (multiple of 1ms, 0h = deactivated)	UNS16	rw	0h	x	-

Index	Subindex	Parameter	Data type	Attribute	Standard value	Ability to store value	Mapping
1802h	Transmit PDO3 communication parameter						
	0h	Highest supported subindex	UNS8	ro	5h		-
	1h	COB-ID	UNS32	rw	380h + node ID		-
	2h	Transmission type (synchronous/asynchronous/with change of measured value)	UNS8	rw	1h	x	-
	3h	Compatibility entry	UNS16	rw	0h	x	-
	4h	Compatibility entry	UNS8	rw	0h	x	-
	5h	Interval time for cycl. transmission (multiple of 1ms, 0h = deactivated)	UNS16	rw	0h	x	-
1803h	Transmit PDO4 communication parameter						
	0h	Highest supported subindex	UNS8	ro	5h		-
	1h	COB-ID	UNS32	rw	480h + node ID	x	-
	2h	Transmission type (synchronous/asynchronous/with change of measured value)	UNS8	rw	1h	x	-
	3h	Compatibility entry	UNS16	rw	0h	x	-
	4h	Compatibility entry	UNS8	rw	0h	x	-
	5h	Interval time for cycl. transmission (multiple of 1ms, 0h = deactivated)	UNS16	rw	0h	x	-
1A00h	TxPDO1 mapping parameter						
	0h	Highest supported subindex	UNS8	ro	2h	x	-
	1h	Slope long 16	UNS32	rw	60100010h	x	-
	2h	Slope lat 16	UNS32	rw	60200010h	x	-
	3h .. 8h	Mapping entry 3 .. 8	UNS32	rw	0h	x	-
1A01h	TxPDO2 mapping parameter						
	0h	Highest supported subindex	UNS8	ro	0h	x	-
	1h	Mapping entry 1	UNS32	rw	0h	x	-
	... 8h	.. Mapping entry 8					
1A02h	TxPDO3 mapping parameter						
	0h	Highest supported subindex	UNS8	ro	0h	x	-
	1h	Mapping entry 1	UNS32	rw	0h	x	-
	... 8h	.. Mapping entry 8					
1A03h	TxPDO4 mapping parameter						
	0h	Highest supported subindex	UNS8	ro	0h	x	-
	1h	Mapping entry 1	UNS32	rw	0h	x	-
	... 8h	.. Mapping entry 8					
1F80h	0h	NMTStartup	UNS32	ro	Ch	x	-

## 5.5.3 Manufacturer-Specific Communication Parameters

Index	Subindex	Parameter	Data type	Attribute	Standard value	Saving	Mapping
2000h	Sensor information						
	0h	Highest supported subindex	UNS8	ro	Dh	-	-
	1h	Block version	UNS8	ro	-	-	-
	2h	Endian	UNS8	ro	-	-	-
	3h	Option	INT32	ro	-	-	-
	4h	Batch number	INT32	ro	-	-	-
	5h	Change index	INT32	ro	-	-	-
	6h	Day of calibration	INT32	ro	-	-	-
	7h	Month of calibration	UNS8	ro	-	-	-
	8h	Year of calibration	UNS8	ro	-	-	-
	9h	Calibration software version	UNS8	ro	-	-	-
Ah	CANopen interface software version	UNS8	ro	-	-	-	
2100h	Configuration interface						
	0h	Highest supported subindex	UNS8	ro	9h	-	-
	1h	Total number of configuration IDs	UNS32	ro	-	-	-
	2h	Configuration ID to be written or read	UNS16	rw	-	-	-
	3h	Subindex pertaining to selected ID for reading or writing process	UNS8	ro	-	-	-
	4h	Value range of selected ID "minimum value"	DOMAIN	ro	-	-	-
	5h	Value range of selected ID "maximum value"	DOMAIN	ro	-	-	-
	6h	Field for writing/reading a total comma quantity	REAL32	rw	-	x	-
	7h	Field for writing/reading a signed whole number	INT32	rw	-	x	-
	8h	Field for writing/reading an unsigned whole number	UINT32	rw	-	x	-
9h	Field for writing/reading a character string	VSTR	rw	-	x	-	
2200h	Diagnostics						
	0h	Highest supported subindex	UNS8	ro	3h	-	-
	1h	Maximum number of diagnostic text pages	UNS8	ro	-	-	-
	2h	Diagnostic text page to be read	UNS8	wo	-	-	-
	3h	Field for reading the diagnostic text page	VSTR	ro	-	-	-

Index	Subindex	Parameter	Data type	Attribute	Standard value	Saving	Mapping
3000h	Tilt angle						
	0h	Highest supported subindex	UNS8	ro	2h	x	-
	1h	Tilt x <sup>1</sup>	INT16	ro	0h	-	x
	2h	Tilt y <sup>1</sup>	INT16	ro	0h	-	x
3100h	Acceleration values						
	0h	Highest supported subindex	UNS8	ro	3h	x	-
	1h	Acceleration X <sup>2</sup>	INT16	ro	0h	-	x
	2h	Acceleration Y <sup>2</sup>	INT16	ro	0h	-	x
	3h	Acceleration Z <sup>2</sup>	INT16	ro	0h	-	x
3200h	Rotation rates						
	0h	Highest supported subindex	UNS8	ro	3h	x	x
	1h	Rotation rate X <sup>1</sup>	INT32	ro	0h	-	x
	2h	Rotation rate Y <sup>1</sup>	INT32	ro	0h	-	x
	3h	Rotation rate Z <sup>1</sup>	INT32	ro	0h	-	x
3900	0h	Temperature <sup>1</sup>	INT16	ro	0h	-	x
5FFFh	0h	Switch to RS485 mode ("m", "e", "b", "u" - 6Dh, 65h, 62h, 75h)	UNS32	wo	0h	-	-

1) Scaling factor 100

2) Scaling factor 10000

#### 5.5.4 Communication Parameters According to CIA DS-410

Index	Subindex	Parameter	Data type	Attribute	Standard value	Saving	Mapping
6000h	0h	Resolution <sup>1</sup>	UNS16	ro	Ah	x	-
6010h	0h	Slope long 16	INT16	ro	0h	-	x
6011h	0h	Slope long 16 operational parameter	UNS8	ro	0h	x	-
6020h	0h	Slope lat 16	INT16	ro	0h	-	x
6021h	0h	Slope lat 16 operational parameter	UNS8	ro	0h	x	-
6110h	0h	Slope long 32 <sup>2</sup>	INT32	ro	0h	-	x
6111h	0h	Slope long 32 operational parameter	UNS8	ro	0h	x	-
6120h	0h	Slope lat 32 <sup>2</sup>	INT32	ro	0h	-	x
6121h	0h	Slope lat 32 operational parameter	UNS8	ro	0h	x	-

1) When the value range of the sensor has been set to 0.00° .. 360.00°, the 32-bit slope values should be used (ID50541 and ID50542, see 9.1)

2) Scaling factor 100

#### 5.5.5 LSS Services

The CiA DSP 305 CANopen Layer Setting Service and Protocol (LSS) services and protocols were implemented in order to make it possible to read and change the following parameters via the network:

- CANopen node ID
- CAN baud rate
- LSS address

An LSS master is responsible for configuring these parameters on one or more LSS slaves in the CANopen network.

The master uses COB-ID 7E5h and the sensor uses 7E4h. Access to the LSS services is only available if the CANopen node is in the *Stopped* state.

Two examples of command sequences for possible changes are given below. Upon making the changes, it is recommended to reboot the sensor. When the node ID is changed, a bootup message containing the new node number should appear. After changing the bit rate, the bootup message only appears after a reboot if the counterpart has also been set to the changed bit rate.

### 5.5.5.1 Changing the Bit Rate

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
00h	02h	0Bh	-	-	-	-	-	-	Switch to NMT state <<stopped>>
7E5h	04h	01h	00h	00h	00h	00h	00h	00h	LSS configuration
7E5h	13h	00h	02h	00h	00h	00h	00h	00h	Select bit rate of 500kbit
7E5h	17h	00h	00h	00h	00h	00h	00h	00h	Save
00h	81h	00h	-	-	-	-	-	-	Reset node

Fig. 18 LSS - Changing bit rate to 500 kbit

Index	Bit rate
0	1 Mbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s
5	Not used/implemented
6	Not used/implemented
7	Not used/implemented
8	Not used/implemented
9	Not used/implemented

Fig. 19 LSS baud rate table with the bit rates available in CANopen

### 5.5.5.2 Changing the Node ID

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
00h	02h	0Bh	-	-	-	-	-	-	Switch to NMT state <<stopped>> example node ID 11
7E5h	40h	36h	05h	00h	00h	00h	00h	00h	Manufacturer ID (from index 1018h/01)
7E5h	41h	3Ch	4Fh	4Ch	00h	00h	00h	00h	Product code (from index 1018h/02)
7E5h	42h	00h	01h	06h	06h	00h	00h	00h	Revision number (from index 1018h/03)
7E5h	43h	78h	56h	34h	12h	00h	00h	00h	Serial number (from index 1018h/04) example 12345678h
7E5h	11h	0Ch	00h	00h	00h	00h	00h	00h	Assign new node ID (0Ch), example node ID 12
7E5h	17h	00h	00h	00h	00h	00h	00h	00h	Save
00h	81h	0Bh	-	-	-	-	-	-	Reset node, example node ID 11

Fig. 20 LSS - Changing the node ID

### 5.5.6 Parameterizing the Sensor

The object 2100h is available for parameterizing the sensor.

Index	Subindex	Description
2100h		Config. interface
	0h	Number of subindices of the directory entry
	1h	Number of setting parameters available in the sensor
	2h	Selection of setting parameter ID to be accessed
	3h	Field displaying the associated subindex for write/read access regarding data type.
	4h	Minimum value (interpretation of data type dependent on subindex 3h)
	5h	Maximum value (interpretation of data type dependent on subindex 3h)
	6h	Write/read subindex for float value range
	7h	Write/read subindex for INT32 value range
	8h	Write/read subindex for UINT32 value range
9h	Write/read subindex for VSTRING value range	

Fig. 21 Extract from the manufacturer-specific area of the object directory

Parameterization is carried out as follows:

- Set the ID of the desired setting parameter in subindex 2h.
- Perform read or write access via the subindex (6h - 9h) appropriate for the parameter value range.

If the subindex is not known, you can identify it via subindex 3h after step 1. In addition, you can output the upper and lower limit of the parameter value range with the subindices 4h and 5h. However, these only output a suitable value after step 1 has been completed. The interpretation takes place according to the data type identified via subindex 3h.

#### Example of zeroing:

The following example illustrates the procedure on a sensor with node ID 11<sub>d</sub> / B<sub>n</sub>. The setting parameter ID 50081 (TeachIn), see 9.1, is used for this.

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
60Bh	2Bh	00h	21h	02h	A1h	C3h	00h	00h	Selection of setting parameter C3A1h
58Bh	60h	00h	21h	02h	00h	00h	00h	00h	Confirmation of writing process
60Bh	40h	00h	21h	03h	00h	00h	00h	00h	Reading of associated index
58Bh	4Fh	00h	21h	03h	07h	00h	00h	00h	Response with index
60Bh	23h	00h	21h	07h	01h	00h	00h	00h	Setting of value for the setting parameter C3A1h = 01h
58Bh	60h	00h	21h	07h	00h	00h	00h	00h	Confirmation of writing process

The following commands are also possible:

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
60Bh	40h	00h	21h	04h	00h	00h	00h	00h	Read minimum of setting parameter
60Bh	40h	00h	21h	05h	00h	00h	00h	00h	Read maximum of setting parameter
60Bh	23h	00h	21h	06h	XXh	XXh	XXh	XXh	Write REAL32 value of a setting parameter
60Bh	40h	00h	21h	06h	01h	00h	00h	00h	Read REAL32 value of a setting parameter
60Bh	23h	00h	21h	07h	XXh	XXh	XXh	XXh	Write INT32 value of a setting parameter
60Bh	40h	00h	21h	07h	01h	00h	00h	00h	Read INT32 value of a setting parameter
60Bh	23h	00h	21h	08h	XXh	XXh	XXh	XXh	Write UINT32 value of a setting parameter
60Bh	40h	00h	21h	08h	01h	00h	00h	00h	Read UINT32 value of a setting parameter
60Bh	23h	00h	21h	08h	XXh	XXh	XXh	XXh	Write VSTR value of a setting parameter (string < 5 characters)
60Bh	21h	00h	21h	08h	XXh	XXh	XXh	XXh	Write VSTR value of a setting parameter (string > 4 characters)

You can find the setting parameters in the chapter Setting Parameters of the Sensor, [see 9.1](#).

## 5.6 Process Data Objects: PDO (TxPDO1 - TxPDO4)

The sensor contains up to four transmission process data objects (TxPDO1 - TxPDO4). As standard, the current longitudinal and lateral inclination values are contained in the first transmission object. You can dynamically fill the information in the transmission objects with parameters (dynamic PDO mapping).

Standard mapping of inclination sensor INC5502D:

Data field of TxPDO1							
Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Longitudinal inclination value (object: 6010h)		Lateral inclination value (object: 6020h)		Empty			

Fig. 22 Default TPDO1

The TxPDOs can be assigned the objects listed in the table below by means of a standardized mapping sequence.

Index	Subindex	Name	Format	Scaling factor	Value range
3000h	1h	Tilt-X	16bit signed	100	-90.00 ... 90.00
3000h	2h	Tilt-Y	16bit signed	100	-90.00 ... 90.00
3100h	1h	Acceleration X-axis	16bit signed	10000	-3.00000 ... 3.00000
3100h	2h	Acceleration Y-axis	16bit signed	10000	-3.00000 ... 3.00000
3100h	3h	Acceleration Z-axis	16bit signed	10000	-3.00000 ... 3.00000
3200h	1h	Gyro values X-axis	32bit signed	100	-500.00 ... 500.00
3200h	2h	Gyro values Y-axis	32bit signed	100	-500.00 ... 500.00
3200h	3h	Gyro values Z-axis	32bit signed	100	-500.00 ... 500.00
3900h	0h	Temperature	16bit signed	100	-100.00 ... 100.00
6010h	0h	Longitudinal 16bit	16bit signed	100	-180.00 ... 180.00
6020h	0h	Lateral 16bit	16bit signed	100	-85.00 ... 85.00
6110h	0h	Longitudinal 32bit	32bit signed	100	0 ... 360.00
6120h	0h	Lateral 32bit	32bit signed	100	0 ... 360.00

Fig. 23 Mappable objects

Types of communication for process data objects

The behavior of process data communication can be influenced using the objects 1800h - 1803h. The type of communication is defined here via subindex 02h.

### 5.6.6.1 Synchronized Transmission

All activated TxPDOs can be queried at any time (if Operational state is active) by sending a SYNC message to the device. Multiple sensors can be queried at the same time. To do this, subindex 02h in object 1800h must contain a value between 01h and F0h. This value specifies the number of received SYNC messages after which the PDOs configured therewith are sent.

### 5.6.6.2 Cyclical Transmission

In addition to synchronized transmission, other cyclical transmission modes can also be selected. Firstly, there is purely event-driven transmission when a value is changed. The value in subindex 02h must be set to FEh for this. Secondly, there is timer event-driven transmission. This is also influenced by application-driven events and is therefore only suitable for very slow systems. Transmission takes place cyclically based on the time in subindex 05h, which is given in milliseconds. In addition, transmission takes place when a value is changed. When this type of communication is used, subindex 02h must contain the value FFh and subindex 05h must contain a value of greater than 00h.

## 5.7 Error Messages - EMCY Codes

So-called emergency messages are used to report significant internal errors as well as CAN communication errors to the other participants in the bus. If the status signals that an error has occurred, the objects 1001h (error register) and 1003h (predefined error field) are additionally updated. When errors are rectified, an emergency message with the code 0000h is generally sent. In the case of EMCY code FFFDh - FFFFh, the following applies: The lower 3 bytes of the EMCY message contain the EMCY code, the upper 5 bytes potentially also contain a manufacturer-specific error code that can be used to narrow down the exact cause of the error.

EMCY code	Description
0000h	No error present or error reset
8100h	Bus warning state reached
8110h	Buffer overflow, loss of CAN messages
8120h	CAN warning state limit exceeded
8130h	Failure of guarding master detected
8140h	Exit Bus-Off state
8150h	CAN ID collision
8210h	PDO is not being processed, as the wrong length was used during data assignment (mapping)
FFFDh	Warning message, currently there is measured value drift
FFFEh	Error message about an existing internal error within the sensor component
FFFFh	Error message about existing error within the interface component

### 5.7.1 Error Handling

If an error or warning occurs in the device, this is reported to all participants in the bus.

In the event of errors with error codes FFFEh and FFFFh, there is generally a switch to the `Stopped` state. However, this behavior can be altered via object 1029h and its subindices.

### 5.7.2 Manufacturer Status Register

The object 1002h (manufacturer status register) is continuously updated with a manufacturer-specific status code.

Status code	Explanation
0	Status ok
1	Measurement data overflow during internal communication
2	Reboot of sensor controller
4	Switching signal switching output no. 1
8	Rest position detected
16	Error: Sensor controller reports error signal to CAN interface
32	Drift in data detected
64	Switching signal switching output no. 2
128	Error: Malfunction during internal communication between sensor controller and CAN interface detected
256	Error: No measurement data are being provided by the sensor controller

Fig. 24 Overview of the manufacturer-specific status codes

### 5.7.3 Manufacturer-Specific Error Codes

The table below lists the possible manufacturer-specific codes that may occur in conjunction with the EMCY codes FFF-Dh-FFFFh.

Error code hexadecimal	Error
0h	ERROR_NONE
1h	ERROR_CHECK_CONFIG
2h	ERROR_PROCEDURE_INIT
3h	ERROR_GET_DATA
4h	ERROR_CALC_OUTPUT
5h	ERROR_SENSOR_OUTPUT
6h	ERROR_INVALID_PROC_STATE
7h	ERROR_TEACH_IN
8h	ERROR_SWITCH_INIT
9h	ERROR_GET_BLOCKMAP_ENTRY_0X80
Ah	ERROR_FETCH_FIFO
Bh	ERROR_WRITE_OLD_BAUD_BACK
Ch	ERROR_BAUD_STATE_ERROR
Dh	ERROR_HANDLE_CONFIG_DATA
Eh	ERROR_INTO_BUFFER_CHN_INDEX
Fh	ERROR_INTO_BUFFER_MAX_NUMBER_EXCEEDED
10h	ERROR_INTO_BUFFER_MCPY
11h	ERROR_INTERNAL_SW
12h	ERROR_SET_FACTORY_DEFAULT
13h	ERROR_SET_SIGNALS_TO_CHANNELS
14h	ERROR_EXECUTE_CONFIG_WRITE_RAM_TO_FLASH
15h	ERROR_CHECK_CONFIG_PARAM
16h	ERROR_INIT_TIMER45
17h	ERROR_EXT_PERIPHERAL_INIT
18h	ERROR_INIT_MEMS
19h	ERROR_GET_MEMS_DATA
1Ah	ERROR_INTO_BUFFER
1Bh	ERROR_SWITCH_ON_CONDI1_INVALID
1Ch	ERROR_SWITCH_OFF_CONDI1_INVALID
1Dh	ERROR_SWITCH_ON_CONDI2_INVALID
1Eh	ERROR_SWITCH_OFF_CONDI2_INVALID
1Fh	ERROR_SWITCH_ON_CONDI3_INVALID
20h	ERROR_SWITCH_OFF_CONDI3_INVALID
21h	ERROR_SWITCH_ON_CONDI4_INVALID
22h	ERROR_SWITCH_OFF_CONDI4_INVALID
23h	ERROR_EXECUTE_CONFIG
24h	ERROR_CHECK_CALIB
25h	ERROR_INIT_MOVG_AVG_FILTER
26h	ERROR_INIT_SF_FILTER
27h	ERROR_INIT_CRIT_DAMP_IIR
28h	ERROR_INIT_SWITCH_HDL
29h	ERROR_CALC_CALIB_CORRECTION
2Ah	ERROR_CALC_MOVG_AVG_AXES
2Bh	ERROR_CALC_MOVG_AVG_GYRO

2Ch	ERROR_CALC_CRIT_DAMP_IIR
2Dh	ERROR_CALC_SF_FILTER
2Eh	ERROR_CALC_MOVG_AVG_GYRO_OFFS
2Fh	ERROR_TEACH_IN_WRITE_RAM_TO_FLASH
30h	ERROR_INIT_DATA_PROCESSING
31h	ERROR_INIT_INPUT
32h	ERROR_INIT_OUTPUT
33h	ERROR_SF_CALC_MOVG_AVG
34h	ERROR_SF_STATE_INVALID
35h	ERROR_MEMS_SELF_TEST
36h	ERROR_INIT_SENSOR_FIFO
37h	ERROR_CHECK_CONFIG_PARAM_WRITE_RAM_TO_FLASH
38h	ERROR_CHECK_PARAM_MIN_MAX
39h	ERROR_MEMS_TIMEOUT
3Ah	ERROR_RUNTIME_EXCEEDED
3Bh	ERROR_INVALID_AXIS_MAPPING_CH1
3Ch	ERROR_INVALID_AXIS_MAPPING_CH2
3Dh	ERROR_INVALID_AXIS_MAPPING_CH3
3Eh	ERROR_INVALID_LOW_PASS_FREQ
3Fh	ERROR_SWITCH_ON_OFF_CONDI1_INCONSISTENT
40h	ERROR_SWITCH_ON_OFF_CONDI2_INCONSISTENT
41h	ERROR_SWITCH_ON_OFF_CONDI3_INCONSISTENT
42h	ERROR_SWITCH_ON_OFF_CONDI4_INCONSISTENT
43h	ERROR_CANOPEN_SAVE
44h	ERROR_INTERNAL_COMMUNICATION_FAILED
45h	ERROR_TIMEOUT_REGARDING_NEW_DATA_SIGNAL_AT_INTERNAL_COMMUNICATION

## 6. SAE J1939 Interface

### 6.1 Basics - Message Format

The basic structure of SAE J1939 messages is shown below, see Fig. 25.

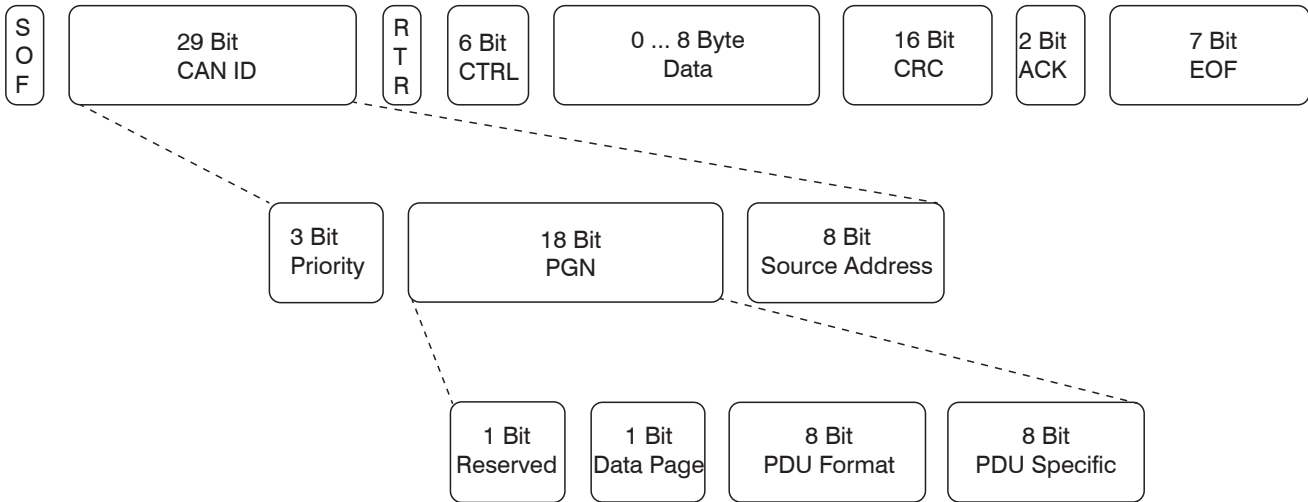


Fig. 25 Structure of a J1939 message

Communication takes place via addressing of so-called PDUs (protocol data units), the composition of which is shown below, see Fig. 26.

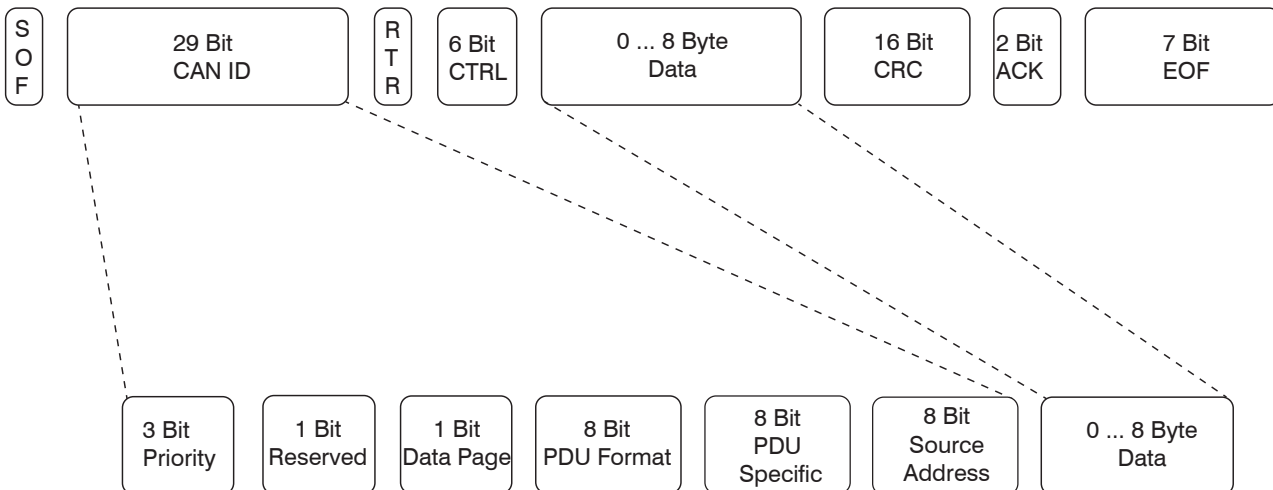


Fig. 26 Structure of a J1939 protocol data unit

### 6.2 Communication Options

There are three options for communication:

- Targeted communication
- Broadcast communication
- Proprietary communication

#### 6.2.1 Targeted Communication

PDU1 (PDU format 0 ... 239) is used for targeted communication. The global destination address (255) is used as the destination address.

### 6.2.2 Broadcast Communication

PDU2 (PDU format 240 ... 255) is used for this type of communication. This can mean that

- a message is sent from one or more sources to a single destination, or
- a message is sent from one or more sources to multiple destinations.

### 6.2.3 Proprietary Communication

Proprietary communication offers scope for manufacturer-specific parameterization commands. It also offers the option of

- broadcast communication
- targeted communication

A separate PGN (Parameter Group Number) was defined for this method.

## 6.3 Message Types

The following types of message are available in SAE J1939:

- Command
- Request
- Broadcast/response
- Confirmation
- Group functions

Specific PGNs are defined for requests, confirmations, and group functions.

In order to ensure that users without J1939 experience can get started faster, two examples for composing a request and for using proprietary PGNs are given below.

### 6.3.1 Request

The PGN 59904 (00EA00h) is defined for a request. It can be used for global requests as well as in a targeted manner. The PGN to be queried must be stored in the data part of the message. The next graphic, see Fig. 27, illustrates querying of the PGN 00FF00h.

In this example, color highlighting has also been used to show how the identifier is composed. Due to the actual bit positions, the first three fields, which have the values 6h, 0h and 0h, result in a total value of 18h in the first section of the identifier.

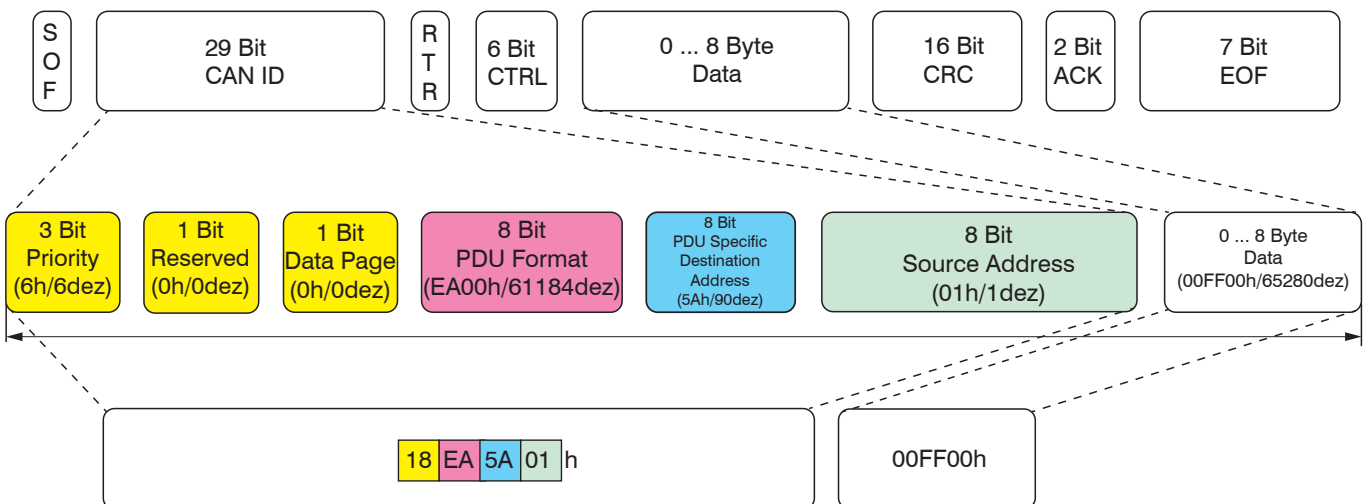


Fig. 27 Representation of a request based on the example of PGN 00FF00h

### 6.3.2 Proprietary PGNs

Several numbers are defined for the proprietary PGNs. In this case, 61184 (00EF00h) is assigned to Proprietary A. This is used for sensor configuration.

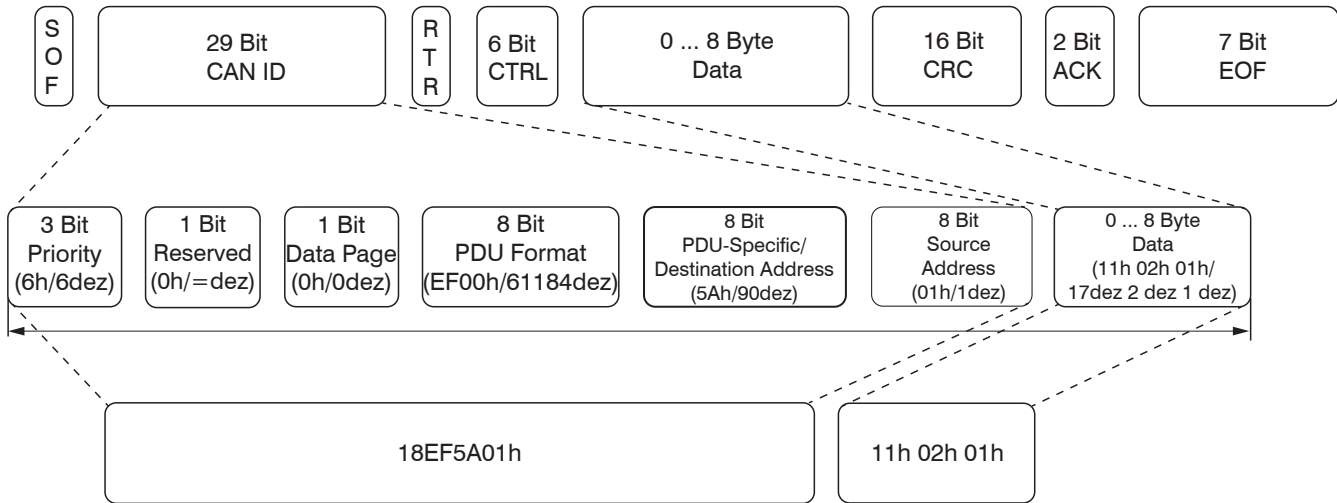


Fig. 28 Structure of a Proprietary A PGN (changing the bit rate to 500 kbit)

Furthermore, there is Proprietary A2 with the number 126720 (01EF00h) and the range 65280 – 65535 (00FF00h – 00FFFFh) for the Proprietary B PGNs. These are addressed globally when transmitted to the bus.

### 6.4 Device Name and Default Address

If the sensor is set to factory settings, it starts with the address 90 (5Ah). It supports dynamic address assignment. When the sensor is started up, an address claim telegram is transmitted on the bus. A 64-bit device name is encoded in the telegram and can be used to uniquely identify the sensor. In addition, the priority on the bus is also defined via the name.

The fields mentioned below are encoded in the 64-bit device name:

- Arbitrary address capable, support of dynamic address assignment (1 bit)
- Industry group (3 bit)
- Vehicle system instance (4 bit)
- Vehicle system (7 bit)
- Function (8 bit)
- Function instance (5 bit)
- ECU instance (3 bit)
- Manufacturer code (11 bit)
- Identity number (21 bit)

The manufacturer code is the ID for Micro-Hybrid Electronic GmbH (value 1138 decimal). The identity number corresponds to the SAE J1939 serial number of the sensor. The following fields of the device name are preset ex works:

Manufacturer code: 1138 (Micro-Hybrid Electronic GmbH)

Identity number: SAE J1939 serial number of sensor

Industry group: 0

Vehicle system: 0

Function: 145 (inertial sensor)

## 6.5 Process Data Overview (Transmit PGNs)

The recorded measurement data is transmitted by a series of parameter groups that are combined into various Proprietary B messages (broadcast). The PGNs are transmitted every 10 ms and can be activated and deactivated as desired.

Available PGNs:

PGN	Name	SPN name	SPN position (bit)	SPN width (bit)	Resolution	Offset	Value range	Unit
65280 (FF00h)	Proprietary B TxPGN1	Rotation rate X-axis	0	32	0.01	-600	-600 ... 600 (°/s)	°/s
		Acceleration X-axis	32	16	0.0001	-3	-3 ... 3 (g)	g
		Status	48	8	1	0	0 ... 255	-
65281 (FF01h)	Proprietary B TxPGN2	Rotation rate Y-axis	0	32	0.01	-600	-600 ... 600	°/s
		Acceleration Y-axis	32	16	0.0001	-3	-3 ... 3	g
		Status	48	8	1	0	0 ... 255	-
65282 (FF02h)	Proprietary B TxPGN3	Rotation rate Z-axis	0	32	0.01	-600	-600 ... 600	°/s
		Acceleration Z-axis	32	16	0.0001	-3	-3 ... 3	g
		Status	48	8	1	0	0 ... 255	-
65283 (FF03h)	Proprietary B TxPGN4	Inclination value, longitudinal (roll)	0	16	0.01	-180	-180.00 ... 180.00	°
		Inclination value, lateral (pitch)	16	16	0.01	-180	-180.00 ... 180.00	°
		Status	32	8	1	0	0 ... 255	-
65284 (FF04h)	Proprietary B TxPGN5 <sup>1</sup>	Inclination value, longitudinal (roll)	0	16	0.01	0	0 ... 360	°
		Inclination value, lateral (pitch)	16	16	0.01	0	0 ... 360	°
		Status	32	8	1	0	0 ... 255	-
65285 (FF05h)	Proprietary B TxPGN6	Tilt X-axis	0	16	0.01	-90	-90 ... 90	°
		Tilt Y-axis	16	16	0.01	-90	-90 ... 90	°
		Status	32	8	1	0	0 ... 255	-
65286 (FF06h)	Proprietary B TxPGN7 <sup>1</sup>	Inclination value, longitudinal (roll)	0	16	0.01	-180	-180.00 ... 180.00	°
		Inclination value, lateral (pitch)	16	16	0.01	0	0 ... 360	°
		Status	32	8	1	0	0 ... 255	-

PGN	Name	SPN name	SPN position (bit)	SPN width (bit)	Resolution	Offset	Value range	Unit
65287 (FF07h)	Proprietary B TxPGN8	Inclination value, longitudinal (roll)	0	16	0.01	0	0 ... 360	°
		Inclination value, lateral (pitch)	16	16	0.01	-180	-180 ... 180	°
		Status	32	8	1	0	0 ... 255	-
65288 (FF08h)	Proprietary B TxPGN9	Temperature	0	16	0.01	-100	-100 ... 100	°C
		Status	16	8	1	0	0 ... 255	-

1) PGN5 is to be selected within the value range 0 ... 360° and PGN7 within the value range -180 ... +180°. (ID50541 and ID50542, see 9.1).

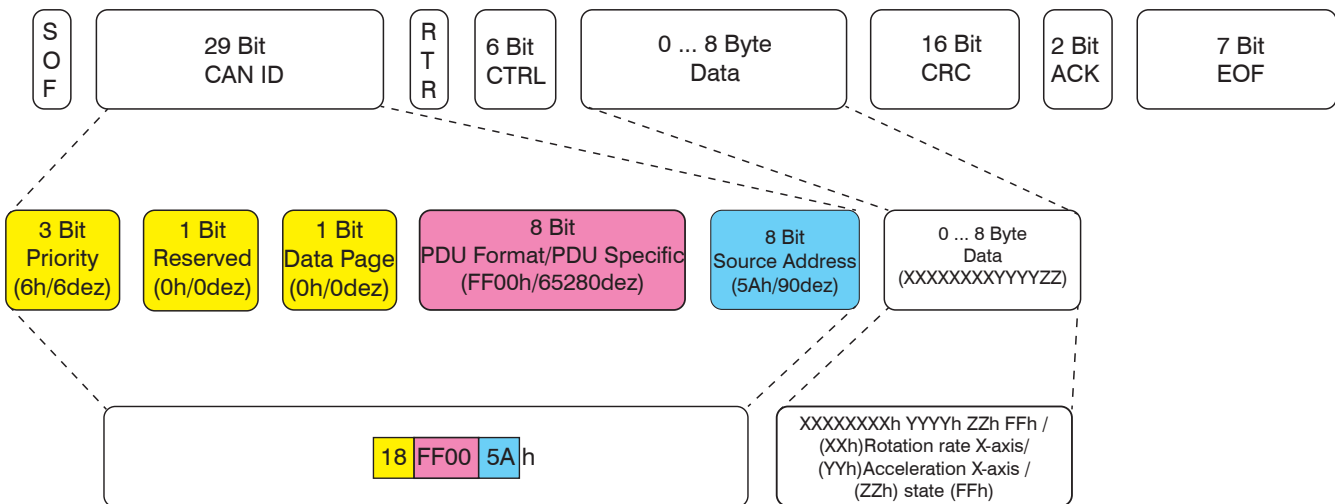


Fig. 29 Structure of the PGN FF00n with color highlighting of the components

## 6.6 Configuring the SAE J1939 Interface

The sensor is configured via a Proprietary A PGN61184 (00EF00h point-to-point connection). The following various functions are possible with the PGN.

Command code description	Command code	Function code description	Function code	Possible parameters
Reading a configuration value	40			PGN
Writing a configuration value	22			PGN + data (, see Fig. 34, see Fig. 36, see Fig. 37)
Configuration functions	11	Switch to RS485 interface	0	00h (Fig. 72)
		Activation/deactivation of individual PGNs	1	01h/00h + PGN (, see Fig. 44)
		Configuration of the bit rate	2	ID of the bit rate (, see Fig. 39)
		Reboot of sensor	4	00h (, see Fig. 42)
Response code description	Command code	Function code description	Function code	Possible parameters
Write process successful	60	-	-	PGN + [data byte 3 .. data byte 7] = 00h
An error has occurred	80	-	-	Error code (, see Fig. 44)

### 6.6.1 Reading Parameter Value Using ID

Read access to parameter values is granted by filling the data bytes with the command code 40h and subsequently with the parameter ID to be read (of data type uint16), see the following examples.

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
40h (reading)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID					

Fig. 30 Format for read command

Response:

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
40h (reading)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	Length of response in bits	Result data [byte 0 ... byte 3]			

Fig. 31 Format for response to read command

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	40h	6Fh	C5h	-	-	-	-	-	Read Inc-DirTiltX
18EF015Ah	40h	6Fh	C5h	00h	00h	00h	00h	FFh	Result of read command

Fig. 32 Successful reading of parameter "IncDirTiltX"

In character strings, however, the response is announced by Broadcast Announce Message and then transmitted via numbered transport protocol data transfer packets. The packets each contain up to 7 bytes of the response character string. Unused bytes in the message are denoted by FFh. In this case, the transmission is not addressed to the caller, but in the current version as broadcast communication. Unlike for numerical values, the command code contained in the response is 41h for character strings.

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	40h	84h	C5h	-	-	-	-	-	Read C584h
1CECFF5Ah	20h	17h	00h	04h	FFh	00h	EFh	00h	Response/announcement of the result of the operation in a transmission in multiple segments
1CEBFF5Ah	01h	41h	84h	C5h	13h	28h	34h	68h	Response / 1st segment
1CEBFF5Ah	02h	33h	3Eh	34h	30h	29h	7Ch	7Ch	Response / 2nd segment
1CEBFF5Ah	03h	28h	43h	68h	33h	3Ch	2Dh	34h	Response / 3rd segment
1CEBFF5Ah	04h	30h	29h	FFh	FFh	FFh	FFh	FFh	Response / final segment

Fig. 33 Successful reading of a configuration value whose return value is more than 5 data bytes

The table illustrates a request for reading the parameter with the ID C584h and the response to successful read access (data type string, with a length of 19 (13h) characters, value "(Ch3>40) |(Ch3<- 40) "28h 43h 68h 33h 3Eh 34h 30h 29h 7Ch 7Ch 28h 43h 68h 33h 3Ch 2Dh 34h 30h 29h").

## 6.6.2 Writing Parameter Value Using ID

### 6.6.2.1 Numerical Values up to Data Type Size 32 Bit or Strings up to a Maximum Length of 5 Characters

For write access, the command code 22h is used, followed by the parameter ID and the data to be written. This data can take up 4, and in the case of strings up to 5, bytes.

- Fill unused bytes with FFh.

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	
22h (writing)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	Up to 4 data bytes for numerical values (LSB first)					
			Up to 5 data bytes for strings (character string in readable order)					

Fig. 34 Format for write command

The associated response then contains the command code 60h, the ID that was written, and bytes with the value FFh.

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	
60h (write suc- cess)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	FFh FFh FFh FFh FFh					

Fig. 35 Format for response to write command

#### Examples:

The following table illustrates write access to the parameter with the ID C56Dh (01h is to be written), as well as the response to successful write access:

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	22h	6Fh	C5h	00h	-	-	-	-	Set parameter C56Fh to the value 0h
18EF015Ah	60h	6Fh	C5h	FFh	FFh	FFh	FFh	FFh	Response / success message, writing

Fig. 36 Practical example of successful writing of the parameter "IncDirTiltX" of the type UINT32

The following table illustrates write access to the parameter with the ID C584h ("43 68 31 3E 39h" / "Ch1>9" are to be written).

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	22h	84h	C5h	43h	68h	31h	3Eh	39h	Set parameter C584h to "43 68 31 3E 39h" / "Ch1>9"
18EF015Ah	60h	84h	C5h	FFh	FFh	FFh	FFh	FFh	Response / success message, writing

Fig. 37 Practical example: successful writing of a configuration value of the string type (< 6 bytes)

### 6.6.2.2 Strings up to a Length of 64 Characters

When transmitting more than 5 and less than 64 characters, the transport protocol must be used. A Broadcast Announce Message (BAM) is sent beforehand, announcing a larger amount of data for the Proprietary A PGN and reserving a corresponding receive buffer in the sensor. Then, the corresponding data packets are sent to the sensor individually one after the other by means of the transport protocol data transfer PGN. An interval of 50 ms between the messages must be maintained.

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
20h	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	Number of packets with data	FFh (reserved)	00h	EFh	00h

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
01h (packet number)	22h (writing)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	Data byte 4 .. data byte 7 are filled with the first characters of the string			

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
XXh (packet number)	Data byte 1 .. data byte 7 are filled with characters from the string to be transmitted. If the data are not sufficient for filling the final segment with characters from the string, the remaining data bytes are filled with FFh.						

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
1CEC5A01h	20h	16h	00h	04h	FFh	00h	EFh	00h	Announcement of operation by transmission in multiple segments to PGN 61184
1CEB5A01h	01h	22h	84h	C5h	28h	43h	68h	33h	1st Segment (contains command, ID of configuration parameter and first characters of the quantity to be transmitted)
1CEB5A01h	02h	3Eh	34h	30h	29h	7Ch	7Ch	28h	2nd segment
1CEB5A01h	03h	43h	68h	33h	3Ch	2Dh	34h	30h	3rd segment
1CEB5A01h	04h	29h	FFh	FFh	FFh	FFh	FFh	FFh	Final segment
18EF015Ah	60h	84h	C5h	FFh	FFh	FFh	FFh	FFh	Response / success message, writing

Fig. 38 Practical example: successful writing of a configuration value of the string type (> 5 bytes)

### 6.6.3 Setting the Bit Rate

The SAE-compliant bit rates of 250 kbit and 500 kbit as well as the non-compliant bite rate of 1 Mbit are implemented in the sensor. These bit rates can be parameterized as follows using the command code 11h and the function code 02h:

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
11h (interface settings)	02h (setting the bit rate)	00h (250 kbit) 01h (500 kbit) 02h (1 Mbit)					

Fig. 39 Command for changing the bit rate to 500 kbit

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	11h	02h	01h	-	-	-	-	-	Changing the bit rate to 500 kbit
18EEFF5Ah	01h <sup>1</sup>	00h <sup>1</sup>	20h	A2h	00h	FFh	00h	80h	Address Claim Message

Fig. 40 Configuration message for changing the bit rate

Immediately after the configuration message has been sent, the sensor is re-registered on the bus by means of an Address Claim Message (ACM), using the newly set bit rate.

### 6.6.4 Rebooting the Sensor

This reboot procedure takes place via the following command:

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
11h (interface settings)	04h (reboot)						

Fig. 41 Rebooting the sensor via command with subsequent re-registration at bus.

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	11h	04h	-	-	-	-	-	-	Restart command
18EEFF5Ah	01h <sup>1</sup>	00h <sup>1</sup>	20h	A2h	00h	FFh	00h	80h	Address Claim Message

Fig. 42 Rebooting the Sensor

### 6.6.5 Selecting / Deselecting Cyclically Sent Process Data

In the delivery state, the output of all process data is active. The system designer can deactivate any irrelevant process data in a targeted manner as shown below.

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
11h (interface settings)	01h (activation/deactivation PGNs)	LOWBYTE of parameter ID	HIGHBYTE of parameter ID	00h (off) 01h (on)			

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	11h	01h	01h	FFh	00h	-	-	-	Deactivate PGN 00FF01
18EF5A01h	11h	01h	01h	FFh	01h	-	-	-	Activate PGN 00FF01

Fig. 43 Deactivating / activating a broadcast PGN

1) Example of serial number 1

### 6.6.6 Error-Response Telegrams

If an error occurs during access via the Proprietary A PGN, the response telegram begins with 80h in the data part.

The following error codes exist:

Error code	Description
F001h	Configuration ID not available, <a href="#">see Fig. 45</a>
F002h	Error during internal communication, <a href="#">see Fig. 46</a>
F003h	Unknown function code, <a href="#">see Fig. 47</a>

Fig. 44 Error code table

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	22h	EFh	C5h	01h	-	-	-	-	Set parameter C5EFh to 1h
18EF015Ah	80h	EFh	C5h	01h	F0h	00h	00h	00h	Response / error message, writing - object does not exist

Fig. 45 Writing failed as parameter does not exist

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	22h	6Fh	C5h	01h	-	-	-	-	Set parameter C56Fh to 1h
18EF015Ah	80h	6Fh	C5h	02h	F0h	00h	00h	00h	Response / error message, writing - error occurred during internal communication

Fig. 46 Error during internal communication

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	22h	6Fh	C5h	02h	-	-	-	-	Set parameter C56Fh to 2h
18EF015Ah	80h	6Fh	C5h	03h	F0h	00h	00h	00h	Response / error message, writing - unknown function code

Fig. 47 Error message "unknown function code"

## 7. Analog Interface

### 7.1 Pin Assignment

You can find the pin assignment for the analog interface at, [see 4.5.2](#).

### 7.2 Strom- und Spannungsausgang

The sensor provides the angle values as analog output variables either as a current or as a voltage value at separate pins, depending on the sensor configuration carried out with `sensorTOOL`.

The symmetrical measuring range is scaled to the corresponding analog range in the unit of angular degrees. The analog range can be adjusted as desired, i.e. a smaller angle range, both symmetrically and asymmetrically with respect to the zero point. The sensitivity increases as the measuring range narrows, since only a small angle range is scaled to the entire output range. The assignment of the angles to the analog output (longitudinal / lateral or Tilt\_x/Tilt\_y) can be selected using `sensorTOOL`.

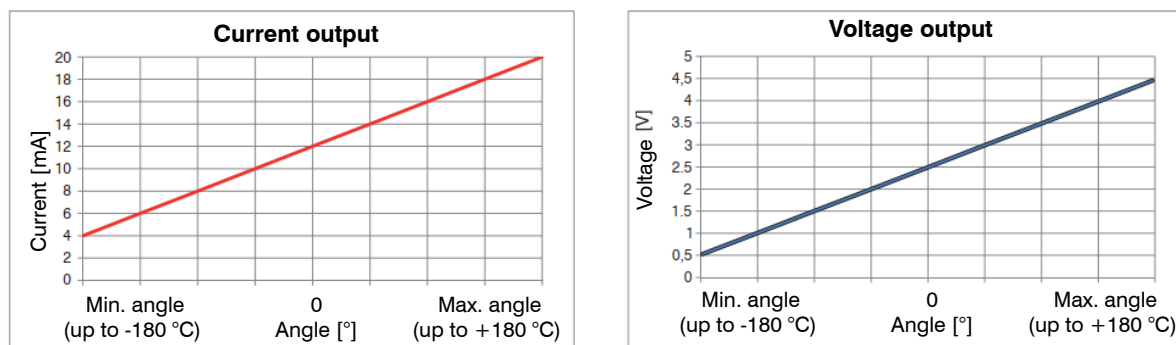


Fig. 48 Scaling options for the current and voltage output

#### Examples of possible analog output settings

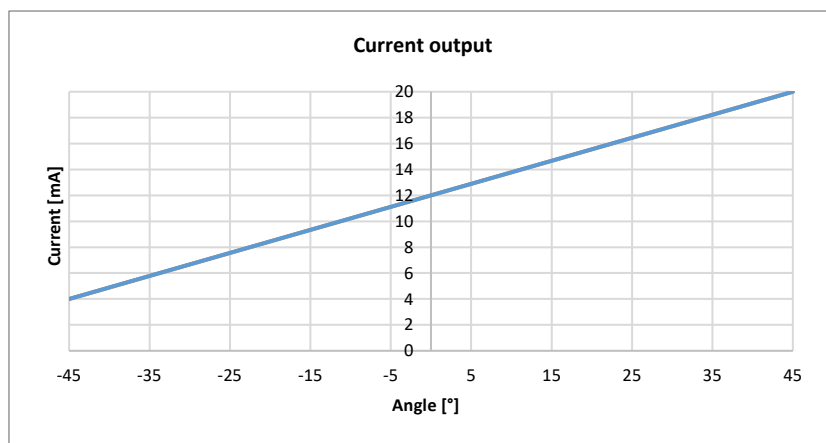


Fig. 49 Example for current output  $-45^{\circ}$  ...  $+45^{\circ}$

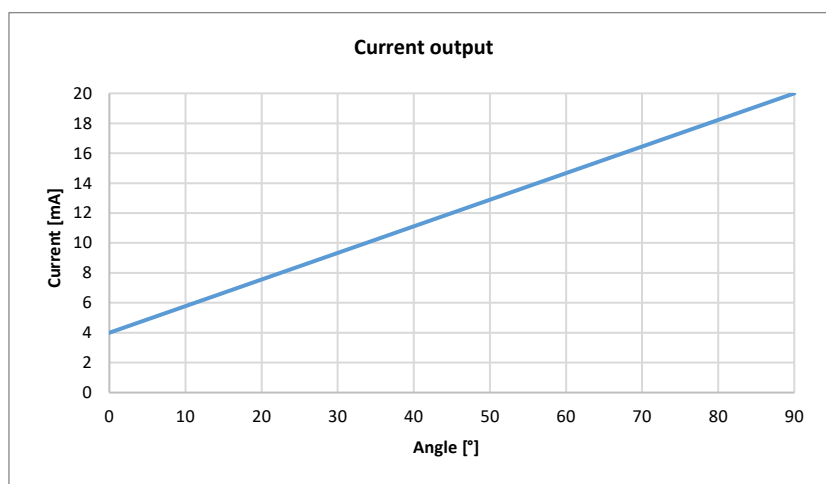


Fig. 50 Example for current output  $0^{\circ}$  ...  $+90^{\circ}$

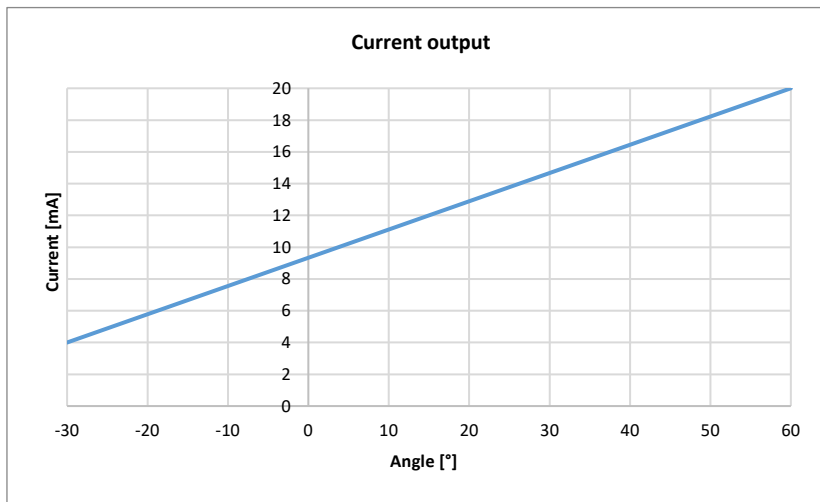


Fig. 51 Example for current output  $-30^{\circ}$  ...  $+60^{\circ}$

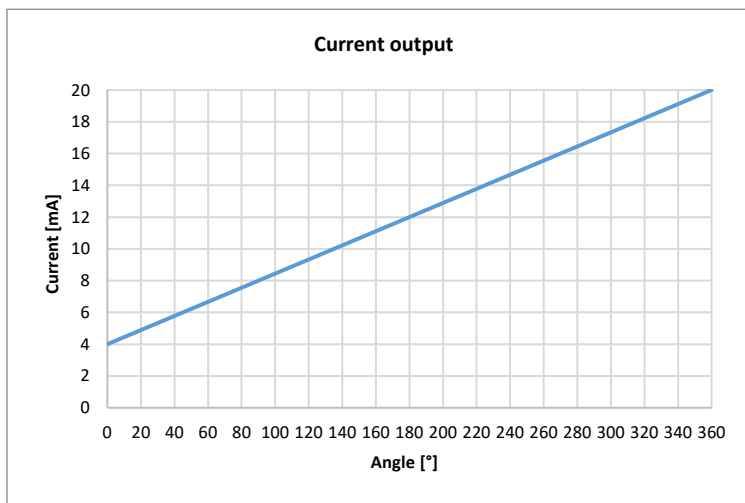


Fig. 52 Example for current output  $0^{\circ}$  ...  $+360^{\circ}$

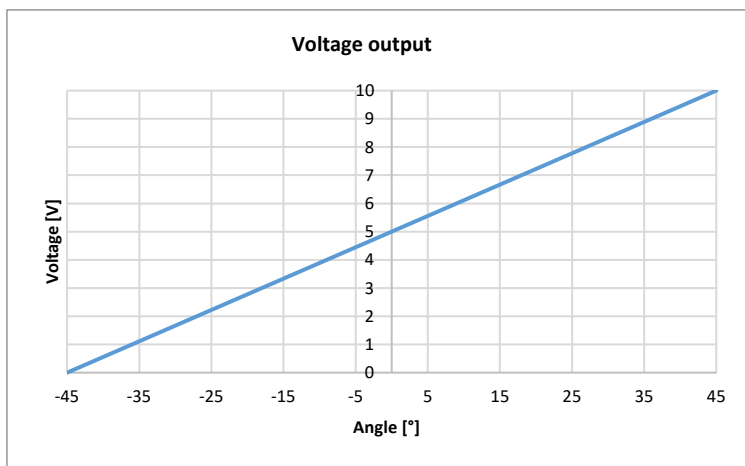


Fig. 53 Example for voltage output  $-45^{\circ}$  ...  $+45^{\circ}$

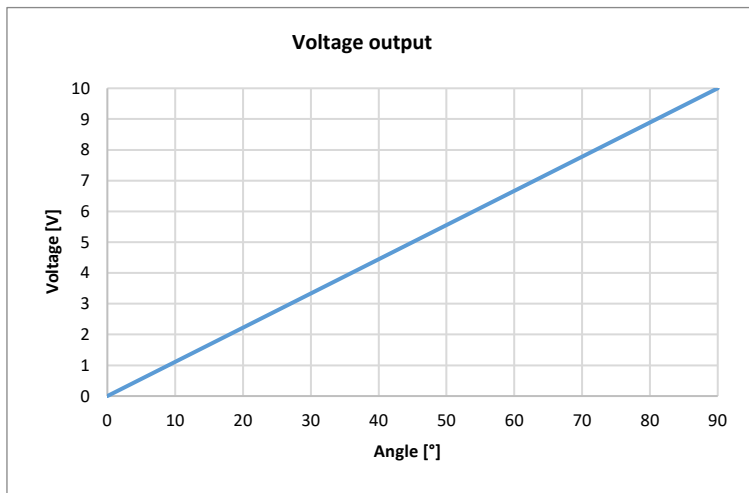


Fig. 54 Example for voltage output 0° ... +90°

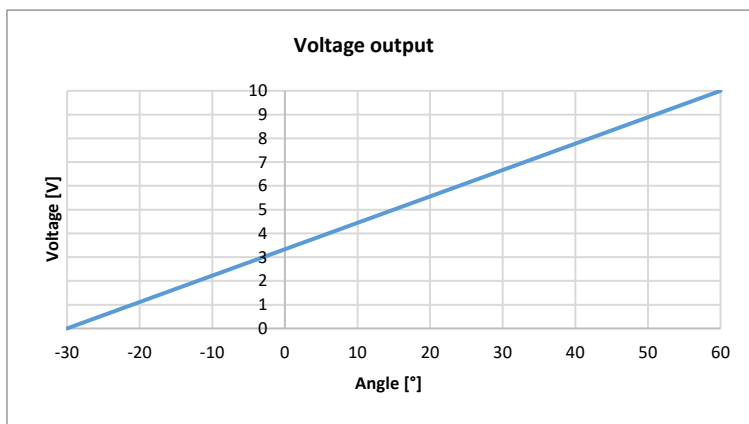


Fig. 55 Example for voltage output -30° ... +60°

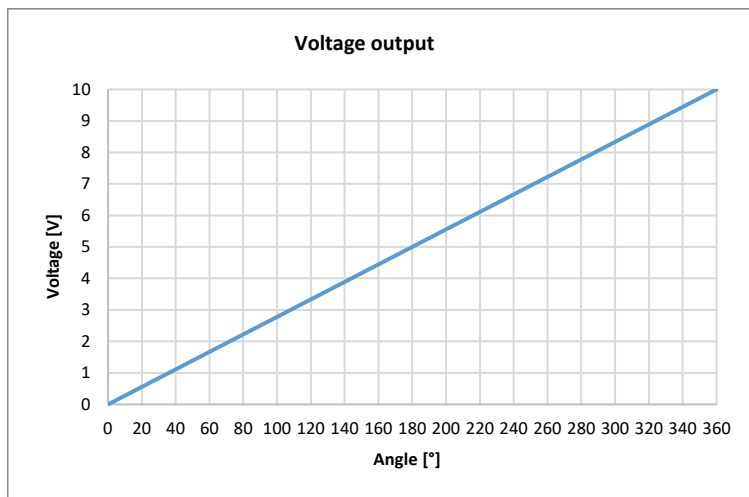


Fig. 56 Example for voltage output 0° ... +360°

### 7.3 Behavior in Case of Error

In the event of a sensor error, the signal output at the analog outputs is stopped. The outputs have a high impedance and the status LED lights up red. An error flag is set in the status byte in the digital data protocol of the RS485 interface.

## 8. Digital Interface RS485

You can read the measured data in digital form using the RS485 interface. The PC software `sensorTOOL`, see 10, allows you to configure the sensor and view the measured data.

The bus protocol required for reading out the measured data for your own applications is described below, see 8.2.

You can also use the IF1032/ETH interface converter for Ethernet and the IF2035 converter from Micro-Epsilon, see A 1, to read out the measured data via PROFINET, EtherCat, EtherNet/IP.

### 8.1 Hardware Interface

The interface is a half-duplex RS485 interface. This means that a cable pair is used for transmitting and receiving.

Baud rate	230400 b/s
Data format	1 start bit, 8 data bits, even parity, 1 stop bit
Bus address	126

A terminating resistor of 120 Ω is required between the A and B line of the RS485 interface at the start and end of the RS485 bus. A terminating resistor of the RS485 line is not integrated in the sensor.

### 8.2 Protocol

The inertialSENSOR INC5502D acts as an RS485 slave. As the system uses a half-duplex protocol, only the master can initiate communication. Each device on the RS485 bus requires its own address. The master sends a request with the target address to the bus and only the slave with this address can answer the request. The digital output signal of the sensor contains the output values of the set filter type (low-pass filter IIR or FIR or sensorFUSION).

#### 8.2.1 Reading out the Measurement Data

Master: Query data						
Byte	SD	DA	SA	FC	FCS	ED
Value	0x10	x	x	0x4C	x	0x16
FCS						

Master: Query data						
Byte	SD	DA	SA	FC	FCS	ED
Value	0x10	x	x	0x4C	x	0x16
FCS						

Descriptions	
SD	Start delimiter (0x10: datagram without data; 0x68 datagram with variable length)
LE	Length (number of bytes without SD, LE, LE rep, SD rep, FCS, ED)
LE rep	LE repeated
SD rep	SD repeated
DA	Destination address (default 0x7E = 126)
SA	Source address (e.g. 0x01)
FC	Function code
FCS	Checksum (sum of all bytes without SD, LE, LE rep, SD rep, FCS, ED, overflow at 256)
ED	End delimiter
Data []	Measurement data, variable number, little endian

**i** A measurement value is displayed as a 4-byte data type float in the unit of angular degrees [°].

The measurement data consist of a status byte, a measurement value counter, the number of measurement values, and the measurement values themselves. The measurement value counter continuously counts in ascending order with each sampled value. The number of measurement values stored in the sensor since the last query by the master indicates the number of measurement values transmitted in this packet, see Fig. 59. The measurement values are displayed in various data types depending on the signal, see Fig. 57, see Fig. 58.

Mebus channel	Signal	Signal number	Data type
1	Euler Longitudinal [°]	8	Int32, factor 100 (2 decimal places)
2	Euler Lateral [°]	9	Int32, factor 100
3	Rate of rotation x [°/s]	1	Int32, factor 100
4	Rate of rotation y [°/s]	2	Int32, factor 100
5	Rate of rotation z [°/s]	3	Int32, factor 100
6	Acceleration x [g]	4	Int16, factor 10.000
7	Acceleration y [g]	5	Int16, factor 10.000
8	Acceleration z [g]	6	Int16, factor 10.000

Fig. 57 Measurement data channel configuration with Euler angles

Mebus channel	Signal	Signal number	Data type
1	Tilt_x [°]	10	Int16, factor 100
2	Tilt_y [°]	11	Int16, factor 100
3	Rate of rotation x [°/s]	1	Int32, factor 100
4	Rate of rotation y [°/s]	2	Int32, factor 100
5	Rate of rotation z [°/s]	3	Int32, factor 100
6	Acceleration x [g]	4	Int16, factor 10.000
7	Acceleration y [g]	5	Int16, factor 10.000
8	Acceleration z [g]	6	Int16, factor 10.000

Fig. 58 Measurement data channel configuration with tilt angles

Internal sampling at 200 Hz generates a new value every 5 ms. The maximum number of measurement values stored in the sensor is:

- Euler angle setting: 8
- Tilt angle setting: 10

Therefore, a request from the master must reach the sensor within  $8 * 5 \text{ ms} = 40 \text{ ms}$  or  $10 * 5 \text{ ms} = 50 \text{ ms}$  in order to read the content from the internal memory and to ensure uninterrupted sampling (regular querying). If the queries are not made in a timely manner, an overflow flag is set in the status byte and the measurement values are discarded.

The overflow flag is automatically deleted as soon as the master recommences regular querying. The analog output is not affected by this. The first measurement value in the Data[] packet is the oldest measurement value.

### 8.2.2 Example of the Transmission of a Measurement Value

Master: Query data						
Byte	SD	DA	SA	FC	FCS	ED
Wert	0x10	0x7E	0x01	0x4C	0xCB	0x16
FCS						

DA = Destination address = 0x7E = 126 (slave)

SA = Source Address = 0x01 (master)

$$\begin{aligned} \text{FCS} = \text{Checksum} &= 0x7E + 0x01 + 0x4C = 0xCB \\ &= 126 + 1 + 76 = 203 \text{ (no overflow)} \end{aligned}$$

Data [] contains 86 bytes:

8 bytes for status and counter (Table 3)

3 measurement value for Euler angle = 78 bytes (3 \* 26 bytes, Table 1)

LE = Length = 89 Bytes (DA, SA, FC, 78 bytes of data, 8 bytes for status and counter) = 0x59

DA = Destination address = 0x01 (master)

SA = Source address = 0x7E = 126 (slave, sensor)

FCS = Checksum = 0x01 + 0x7E + 0x08 + 0x00 (status) + ... = 0x67 (overflow at 256, i.e. reset sum to 0 and continue adding up)

Number of bytes	Function
1	Status
4	Measurement value counter
1	Number of measurement values in packet
2	Padding bytes

Fig. 59 Measurement data format

Position	Hex value	Meaning
1	01	Status
2	15	Measurement value counter: UInt32 hex 0x00080D15 decimal 527637
3	0D	
4	08	
5	00	
6	03	Number of measurement values: 3
7	00	Filler byte (padding)
8	00	Filler byte (padding)
9	14	Longitudinal factor 100 Int32 hex 0x00001914 decimal 6420 = 64.2°
10	19	
11	00	
12	00	
13	14	Longitudinal factor 100 Int32 hex 0x00001914 decimal 6420 = 64.2°
14	19	
15	00	
16	00	
17	14	Longitudinal factor 100 Int32 hex 0x00001914 decimal 6420 = 64.2°
18	19	
19	00	
20	00	
21	9E	Lateral factor 100 Int32 hex 0xFFFF69E decimal -2402 = -24.02°
22	F6	
23	FF	
24	FF	
25	9E	Lateral factor 100 Int32 hex 0xFFFF69E decimal -2402 = -24.02°
26	F6	
27	FF	
28	FF	
29	9E	Lateral factor 100 Int32 hex 0xFFFF69E decimal -2402 = -24.02°
30	F6	
30	FF	
31	FF	
32	15	Rate of rotation X factor 100 Int32 hex 0x00000015 decimal 21 = 0.21 °/s
33	00	
34	00	
35	00	
36	12	Rate of rotation X factor 100 Int32 hex 0x00000012 decimal 18 = 0.18 °/s
37	00	
38	00	
39	00	

Position	Hex value	Meaning
40	0C	Rate of rotation X factor 100 Int32 hex 0x0000000C decimal 12 = 0.12 °/s
41	00	
42	00	
43	00	
44	09	Rate of rotation Y factor 100 Int32 hex 0x00000009 decimal 9 = 0.09 °/s
45	00	
46	00	
47	00	
48	06	Rate of rotation Y factor 100 Int32 hex 0x00000006 decimal 6 = 0.06 °/s
49	00	
50	00	
51	00	
52	02	Rate of rotation Y factor 100 Int32 hex 0x00000002 decimal 2 = 0.02 °/s
53	00	
54	00	
55	00	
56	00	Rate of rotation Z factor 100 Int32 hex 0x00000000 decimal 0 = 0.00 °/s
57	00	
58	00	
59	00	
60	FD	Drehrate Z factor 100 Int32 hex 0xFFFFFFFFD decimal -3 = -0.03 °/s
61	FF	
62	FF	
63	FF	
64	F9	Rate of rotation Z factor 100 Int32 hex 0xFFFFFFFF9 decimal -7 = -0.07 °/s
65	FF	
66	FF	
67	FF	
68	47	Acceleration X factor 10000 Int16 hex 0x2047 decimal 8263 = 0.8263 g
69	20	
70	47	Acceleration X factor 10000 Int16 hex 0x2047 decimal 8263 = 0.8263 g
71	20	
72	3B	Acceleration X factor 10000 Int16 hex 0x203B decimal 8251 = 0.8251 g
73	20	
74	94	Acceleration Y factor 10000 Int16 hex 0x0F94 decimal 3988 = 0.3988 g
75	0F	
76	A3	Acceleration Y factor 10000 Int16 hex 0x0FA3 decimal 4003 = 0.4003 g
77	0F	
78	9A	Acceleration Y factor 10000 Int16 hex 0x0F9A decimal 3994 = 0.3994 g
79	0F	

Position	Hex value	Meaning
80	2D	Acceleration Z factor 10000
81	F0	Int16 hex 0xF02D decimal -4051 = -0.4051 g
82	14	Acceleration Z factor 10000
83	F0	Int16 hex 0xF02D decimal -4076 = -0.4076 g
84	FB	Acceleration Z factor 10000
85	EF	Int16 hex 0xEFFB decimal -4101 = -0.4101 g
86	F7	FCS (check sum)
87	16	End

Fig. 60 Data in the Data [] array, big endian

## 9. Configuration Parameters and Factory Settings

### 9.1 Digital Sensor

The sensor offers several parameters for optimal adaptation to the relevant application.

The following table lists the parameters. The ID is required for the corresponding CAN message, [see 5.5.6](#).

Name	Function	ID (decimal, hex)	Data type (value for object 2100_3h)	Value	Effect	Factory setting
TeachIn	Zeroing	50081, C3A1h	UINT32 8h	0	Normal	0
				1	Set current position to zero	
				2	Undo zeroing	
IncDirTiltX	Direction reversal for angle Tilt x	50543, C56Fh	UINT32 8h	0	Normal (right hand rule)	0
				1	Inverted	
IncDirTiltY	Direction reversal for angle Tilt y	50544, C570h	UINT32 8h	0	Normal	0
				1	Inverted	
IncChooseTilt	Axis orientation for tilt angle	50549, C575h	UINT32 8h	0	Tilting y-z plane	2
				1	Tilting x-z plane	
				2	Tilting x-y plane	
IncRangeLon	Measuring range for longitudinal (roll) Euler	50541, C56Dh	UINT32 8h	0	$\pm 180^\circ$	0
				1	$0^\circ \dots 360^\circ$	
IncRangeLat	Measuring range for lateral (pitch) Euler	50542, C56Eh	UINT32 8h	0	$\pm 180^\circ$	0
				1	$0^\circ \dots 360^\circ$	
IncDirLon	Direction reversal longitudinal (roll) Euler	50539, C56Bh	UINT32 8h	0	Normal	0
				1	Inverted	
IncDirLat	Direction reversal lateral (pitch) Euler	50540, C56Ch	UINT32 8h	0	Normal	0
				1	Inverted	

Name	Function	ID (decimal, hex)	Data type (value for object 2100_3h)	Value	Effect	Factory setting
IncChooseLoLa	Axis orientation for Euler angle	50548, C574h	UINT32 8h	0	x-axis is rotation axis for longitudinal (roll) angle	2
				1	y-axis is rotation axis for longitudinal (roll) angle	
				2	z-axis is rotation axis for longitudinal (roll) angle	
FilterType	Selection of filtering for angle signals	50091, C3ABh	UINT32 8h	0	Sensor fusion filter	0
				1	Low-pass filter	
LowPassFreq	3dB frequency response of low-pass filter	50100, C3B4h	REAL32 6h	0.5 Hz ... 25 Hz	Freely selectable	1.0 Hz
FactoryDefault		2001 7D1h	UINT32 8h	0	Normal	0
				1	Set factory settings	

## 9.2 Analog Sensor

Name	Function	ID (decimal)	Data type	Value	Effect	Factory settings
FilterType	Selection of filtering for angle signals	50091	UINT32	0	Sensor fusion	0
				1	Low-pass IIR	
				2	Low-pass FIR	
AnalogMode	Selection of current or voltage	50598	UINT32	0	Off	1
				1	4 ... 20mA	
				2	0.5 V ... 4.5 V	
				3	0 V ... 10 V	
AnalogRangeMin1	Minimum angle value for analog output 1	50604	Float	-180 ... 360		-180
AnalogRangeMax1	Maximum angle value for analog output 1	50605	Float	-180 ... 360		180
AnalogRangeMin2	Minimum angle value for analog output 2	50606	Float	-180 ... 360		-180
AnalogRangeMax2	Maximum angle value for analog output 2	50607	Float	-180 ... 360		180

## 10. sensorTOOL Software

sensorTOOL is a documented software package with which you can adjust the sensor and visualize and document measurement data.

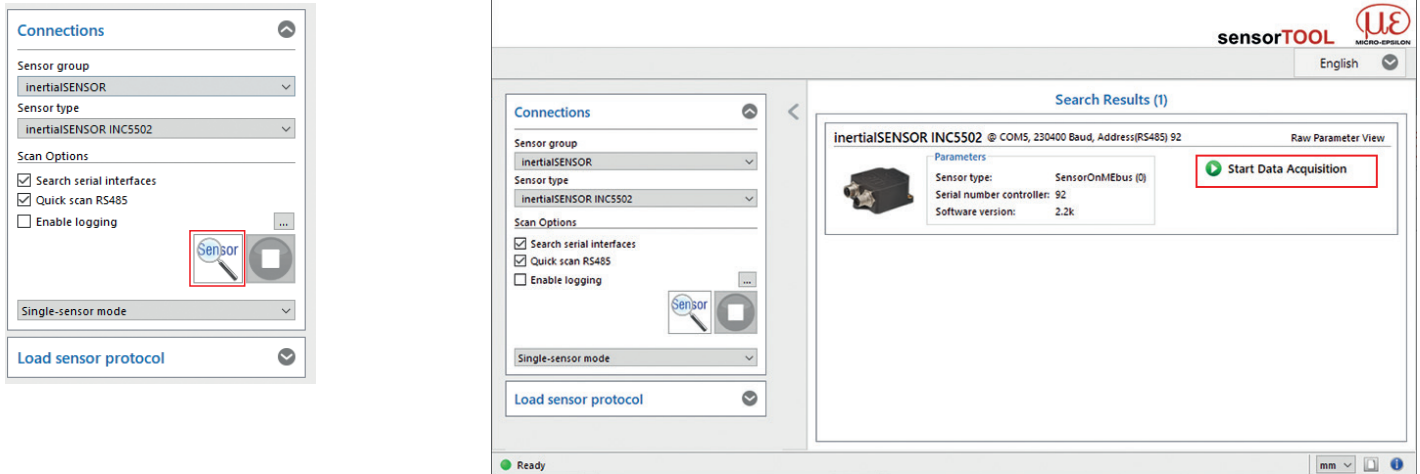
➡ Connect the sensor to a PC/Notebook via the USB interface.

The supply voltage is supplied via the USB interface.

➡ Start the sensorTOOL program.

You can find this program online at

<https://www.micro-epsilon.de/download/software/sensorTOOL.exe>.



➡ Select the connected sensor.

➡ Click on the **Sensor** button with the magnifying glass icon.

The program will now search for connected sensors on the available interfaces.

Fig. 61 First interactive site after calling the sensorTOOL

All available channels will now be displayed in the overview.

➡ Select a desired sensor.

➡ Click on the **Start Data Acquisition** button to start the measurement.

### 10.1 Data Acquisition Menu

➡ Start the data acquisition by clicking on the **Start Data Acquisition** button or on the image of the sensor.

The following window appears.

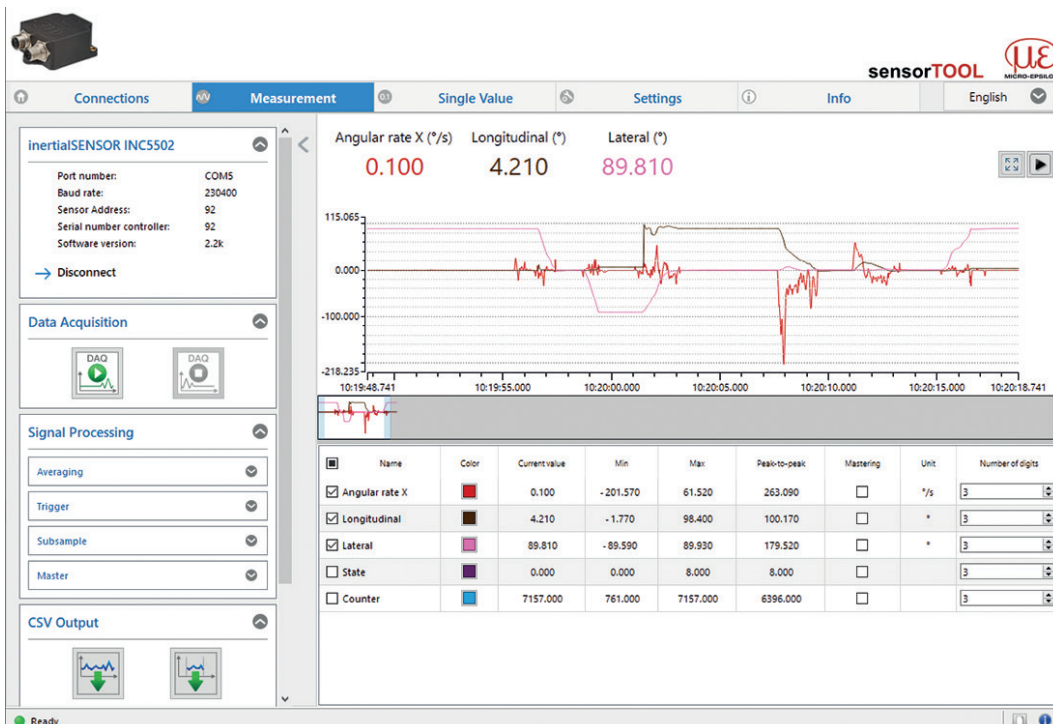


Fig. 62 Data acquisition menu view

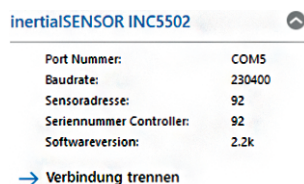


Fig. 63 Disconnection view

When you click on the Disconnect button, the menu jumps back to the sensor search, see Fig. 63,.

	Click on the Reset Scaling button to reset the Y-scale to the original setting (e.g. after zoom).
	Click on the Jump to current time to display the current signal course.

### 10.1.1 Start / Stop

Start the data acquisition by clicking on the Start button, see Fig. 64.

The acquisition is completely restarted and the record stopped before is deleted.

Stop the data acquisition by clicking on the Stop button, see Fig. 65.

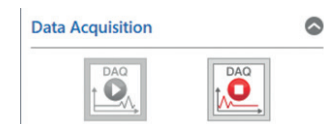


Fig. 64 Start      Fig. 65 Stop

### 10.1.2 Signal Processing

You can select the following options for signal processing:

Data acquisition	Signal processing	Averaging	Deactivated	Deactivated; basic settings
			Moving mean	
			Moving median	
			Recursive mean	
		Trigger	Deactivated	Deactivated; basic settings
			Continuous	Manual trigger
			One-shot (sample-based)	Sample can be set; records the signal course according to the set samples; the more samples, the longer the course
			One-shot (time-based)	Milliseconds can be set; records the signal course according to the time set.
		Subsampling	Deactivated	Deactivated; basic settings
			Sample-based	Number of samples is adjustable; every xth measurement is recorded.
			Time-based	Time-based; time can be set in milliseconds
		Master	Master now	Sets the master. The button only becomes active when the mastering checkbox is activated in the data acquisition table, see Fig. 66. Mastering only has an effect on the measured values displayed in sensorTOOL. Mastering has not effect on the measured values output by the sensor.
Reset	Resets the master.			

1) For example, every 5000 ms: After this time, the displayed curve is updated.

### 10.1.3 Data Acquisition Table

Here you can select the measurement data to be displayed in the time graph as well as the number of decimal points in said data.

<input type="checkbox"/>	Name	Color	Current value	Min	Max	Peak-to-peak	Mastering	Unit	Number of digits
<input checked="" type="checkbox"/>	Angular rate X		-0.070	-1.100	1.740	2.840	<input checked="" type="checkbox"/> 0.00	°/s	3
<input checked="" type="checkbox"/>	Angular rate Y		-0.020	-2.010	3.350	5.360	<input checked="" type="checkbox"/> 0.00	°/s	3
<input checked="" type="checkbox"/>	Angular rate Z		-0.040	-0.160	0.170	0.330	<input checked="" type="checkbox"/> 100.00	°/s	3
<input checked="" type="checkbox"/>	Acceleration X		0.002	-0.008	0.008	0.016	<input type="checkbox"/>	g	3
<input checked="" type="checkbox"/>	Acceleration Y		-0.011	-0.016	-0.002	0.014	<input type="checkbox"/>	g	3
<input checked="" type="checkbox"/>	Acceleration Z		1.021	1.007	1.031	0.024	<input type="checkbox"/>	g	3
<input checked="" type="checkbox"/>	Temperature		38.870	38.750	39.870	1.120	<input type="checkbox"/>	°C	3
<input checked="" type="checkbox"/>	Longitudinal		-0.580	-0.640	-0.550	0.090	<input type="checkbox"/>	°	3
<input checked="" type="checkbox"/>	Lateral		-0.110	-0.160	-0.030	0.130	<input type="checkbox"/>	°	3
<input checked="" type="checkbox"/>	Tilt X		-0.110	-0.160	-0.030	0.130	<input type="checkbox"/>	°	3
<input type="checkbox"/>	State		0.000	0.000	8.000	8.000	<input type="checkbox"/>		3

Fig. 66 Extract from table

<b>Name</b>	Show or hide signal curves of the channels.
<b>Color</b>	Change the color settings of the single signal curves.
<b>Current value</b>	Displays the current measured value.
<b>Min</b>	Minimum of the determined measured value.
<b>Max</b>	Maximum of the determined measured value.
<b>Peak-to-peak</b>	Difference between max. and min.
<b>Mastering</b>	By activating the <b>Mastering</b> checkbox, see Fig. 66, you can manually enter the master value. Master now in the <b>Data Acquisition &gt; Signal Processing</b> menu in the <b>Master</b> tab menu sets the master value. Select an appropriate value within the range of -1000 to +1000.
<b>Unit</b>	Selection of the output to be displayed. The outputs are preset in the <b>Settings</b> menu under <b>Output / Output range and adjustment</b> .
<b>Decimal places</b>	0 - 12

### 10.1.4 Recording and Saving Measurement Data

The measurement data are only displayed in the data acquisition and not automatically saved on the PC. However, you can start data transmission into a \*.CSV file in the CSV output or only save the current visible area from the time graph.

	Click on this button to start recording measurement data.
	Click on this button to save the current measurement value selection.

Data acquisition	CSV output	Format	Point / comma
		Separator	Comma / semicolon / tab

Fields with gray background require a selection. Value Fields with dark border require entry of a value.

## 10.2 Single Value Menu

➡ Switch to the Single value menu.

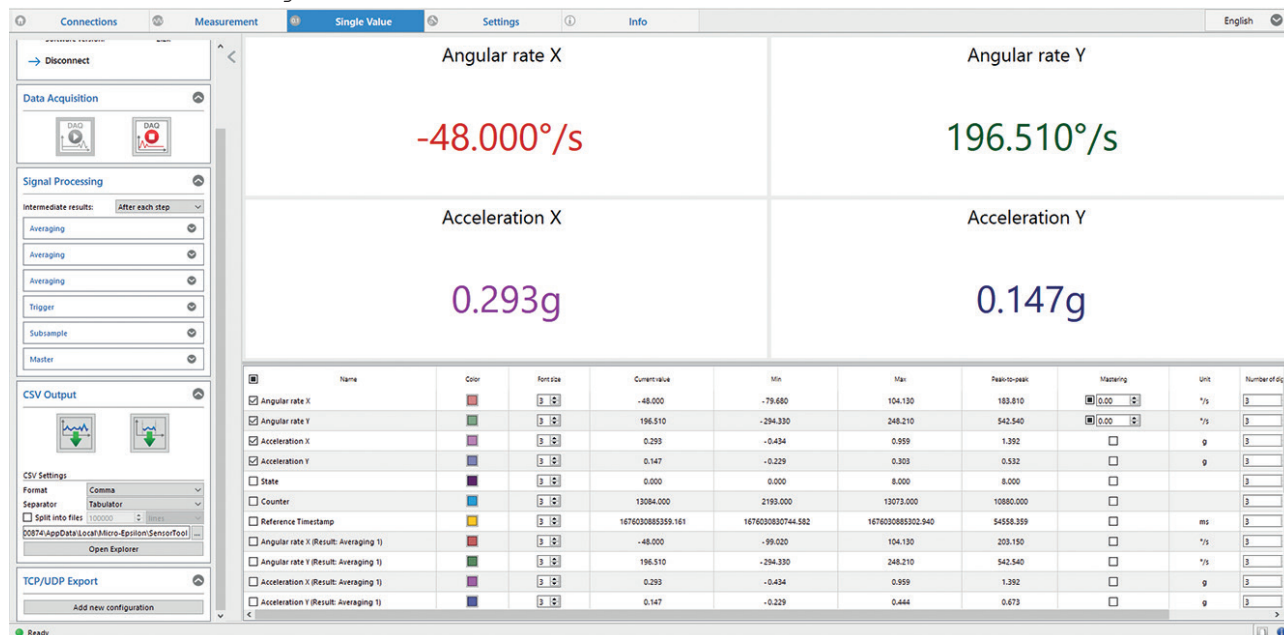


Fig. 67 Measurement view (single value menu) in the sensorTOOL program

In this menu, you can magnify the display of up to 9 measured values. You can select this function by activating it in the list.

## 10.3 Settings Menu

➡ Switch to the Settings menu.

### 10.3.1 Signal Processing

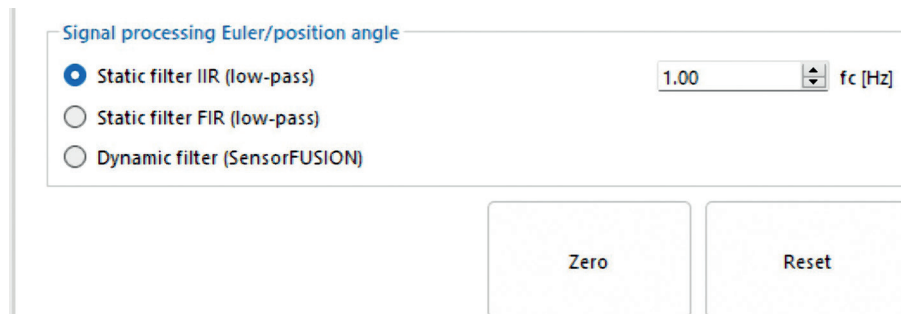


Fig. 68 Euler/position angle signal processing view

In the Signal processing area, you can now select between two different low-pass filters (frequency 0.5 ... 25 Hz) or dynamic filtering of the output signal.

### 10.3.2 Signal Selection

Signal selection

<input checked="" type="checkbox"/> Rotation rate X	<input checked="" type="checkbox"/> Acceleration X
<input checked="" type="checkbox"/> Rotation rate Y	<input checked="" type="checkbox"/> Acceleration Y
<input checked="" type="checkbox"/> Rotation rate Z	<input type="checkbox"/> Acceleration Z
<input checked="" type="checkbox"/> Controller temperature	<input type="checkbox"/> Tilt X position angle
<input checked="" type="checkbox"/> Longitudinal Euler angle	<input type="checkbox"/> Tilt Y position angle
<input checked="" type="checkbox"/> Lateral Euler angle	<input type="checkbox"/> Test

Fig. 69 Signal selection view

In the Signal selection section, the output of signals via the RS485 interface can be activated and deactivated as desired.

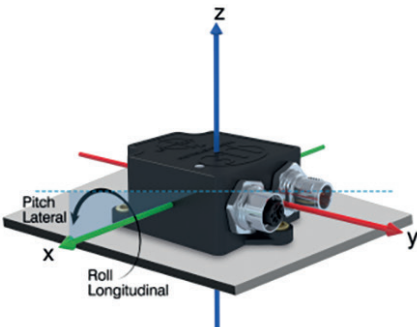
### 10.3.3 Measurement Configuration for Euler Angle / Position Angle Tilt

Zero	Reset
------	-------

The Zeroing button can be used to set the sensor to the mid of the measuring range in each position. The zeroing is reversed using the Reset button.

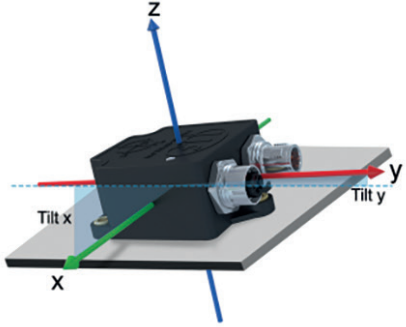
Measurement configuration for Euler angle

Sensor orientation	x
Measuring range longitudinal Euler angle [°]	+/- 180°
Measuring range lateral Euler angle [°]	+/- 85°
Longitudinal Euler angle direction	Normal
Lateral Euler angle direction	Normal



Measurement configuration for position angle Tilt

Sensor orientation	z
Measuring range Tilt x [°]	+/- 90°
Measuring range Tilt y [°]	+/- 90°
Tilt x direction	Normal
Tilt y direction	Normal



In the measurement configuration section, you can adapt the orientation of the sensor to the mounting position, see 4.4.1, see 4.4.2.

### 10.3.4 Configuration of Analog Outputs

These settings can be used to determine the angle selection and the type of analog output. Both analog outputs can be scaled for this.

**Analog Output**

Angle Selection Euler: Longitudinal (O1), Lateral (O2) ▾

Analog Output Mode Current Output (4-20mA) ▾

---

Measurement Range Analog Output O1

Minimum -180.00 ▾ Maximum 180.00 ▾

---

Measurement Range Analog Output O2

Minimum -180.00 ▾ Maximum 180.00 ▾

Fig. 70 Analog output view

## 10.4 Info Menu

➤ Switch to the `Info` menu.

This view gives you additional information about the connected system. In addition, the settings can be exported or imported, or copied to a clipboard, and the system can be reset to factory settings.



By confirming the `To clipboard` button, you can save the information and settings relating to the selected controller to the clipboard.



By confirming the `Factory settings` button, you can restore the factory state. All deactivated channels are reactivated, and the intensity adjustments and special channel-related settings are reset. Confirm the dialog box that opens with `Yes` to reset the controller.



Clicking on `Export settings` opens the Explorer, which provides the option of saving the controller settings to a specified \*.csv file on the PC.



Clicking on `Import settings` opens the Explorer, which provides the option of importing the controller settings from a specified \*.csv file on the PC.



The `CANOpen mode` button allows you to change the bus mode., [see 10.5.2](#)

**i** It is recommended that you always back up the current settings externally on your computer after setting up the system.

When you click on the `Disconnect` button, the menu jumps back to the sensorTOOL start page.

## 10.5 Switching Operating Mode

### 10.5.1 CAN Mode (J1939 or CANopen) to RS485 Mode

To get to know the functioning of the INC5502D, the sensor can also be connected to the PC tool sensorTOOL. For this purpose, the INC5502D is switched from CAN mode to RS485 mode. After receiving the configuration message, see Fig. 72, the sensor immediately switches to RS485 mode and can be connected via USB to sensorTOOL, see A 1, with the parameterization cable, see 10.

**i** The driver needed for operating the sensor on the PC is available on the website:  
<https://www.micro-epsilon.de/service/download/software/>

**i** After the sensor is switched over, it can no longer be reached via the CAN bus. However, the sensor can be reset from RS485 mode to CAN bus mode via sensorTOOL, see 10.5.2.

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
60Bh	23h	FFh	5Fh	00h	6Dh	65h	62h	75h	Switching operating mode to RS485

Fig. 71 Switching operating mode from CANopen to RS485

Data byte 0	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7
11h (interface settings)	00h (switching operating mode)						

CAN identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comments
18EF5A01h	11h	00h							Switching operating mode to RS485

Fig. 72 Switching operating mode from J1939 to RS485

### 10.5.2 RS485 Mode to CAN Mode (J1939 or CANopen)

In sensorTOOL, there is the option to switch the sensor back into CAN mode.

You can find basic information on the program sensorTOOL, see 10.

➤ Go to the **Info** menu and click on the **CANopen Mode** button.

Then, a dialog will appear with information on the consequences of switching from RS485 mode to CAN mode.

➤ Confirm the dialog with the **Ok** button to activate CAN mode.

**i** The connection is closed and the sensor will no longer be accessible via RS485.

## 11. Operation

The measurement device is already calibrated when delivered. Calibration by the user is not necessary. After connection to the power supply, the sensor is immediately ready for operation and independently initiates the measurement.

The sensor can be configured via SAE J1939, [see 6](#) or CANopen, [see 5](#).

After the connection to the power supply has been established, the analog sensor starts outputting data via the analog interface immediately according to the settings stored on the sensor – if these settings have not been changed yet, then they correspond to factory settings.

## 12. Disclaimer

All components of the device have been checked and tested for functionality in the factory. However, should any defects occur despite careful quality control, these shall be reported immediately to Micro-Hybrid or to your distributor / retailer. Micro-Hybrid undertakes no liability whatsoever for damage, loss or costs caused by or related in any way to the product, in particular consequential damage, e.g., due to

- non-observance of these instructions/this manual,
- improper use or improper handling (in particular due to improper installation, commissioning, operation and maintenance) of the product,
- repairs or modifications by third parties,
- the use of force or other handling by unqualified persons.

This limitation of liability also applies to defects resulting from normal wear and tear (e.g., to wearing parts) and in the event of non-compliance with the specified maintenance intervals (if applicable).

Micro-Hybrid is exclusively responsible for repairs. It is not permitted to make unauthorized structural and / or technical modifications or alterations to the product. In the interest of further development, Micro-Hybrid reserves the right to modify the design.

## 13. Service, Repair

If the sensor or the cable is defective:

- If possible, save the current sensor settings in a parameter set to reload them into the sensor after the repair.
- Please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

Micro-Hybrid Electronic GmbH  
Heinrich-Hertz-Straße 8  
07629 Hermsdorf / Germany


Tel. +49 36601 592100  
contact@microhybrid.com  
www.microhybrid.com

## 14. Decommissioning, Disposal

In order to avoid the release of environmentally harmful substances and to ensure the reuse of valuable raw materials, we draw your attention to the following regulations and obligations:

- Remove all cables from the sensor and/or controller.
- Dispose of the sensor and/or the controller, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.
- You are obliged to comply with all relevant national laws and regulations

For Germany / the EU, the following (disposal) instructions apply in particular:

- Waste equipment marked with a crossed garbage can must not be disposed of with normal industrial waste (e.g. residual waste can or the yellow recycling bin) and must be disposed of separately. This avoids hazards to the environment due to incorrect disposal and ensures proper recycling of the old appliances. 
- A list of national laws and contacts in the EU member states can be found at [https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee\\_en](https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en). Here you can inform yourself about the respective national collection and return points.
- Old devices can also be returned for disposal to Micro-Hybrid at the address given in the legal details at <https://www.microhybrid.com/de/impressum>.
- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.
- Under the registration number WEEE-Reg.-Nr. DE83469679, we are registered at the foundation Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg, as a manufacturer of electrical and/or electronic equipment.

**Appendix**

<b>Part No.</b>	<b>Description</b>
VKM055384	PC1/5 Parametrization kit incl. power supply for INC5502D*CO/J1939 connection to sensorTOOL
VKM055385	PC5/5 M12 5-wire, supply and signal cable, 5 m
VKM055419	PC1/8 Parametrization kit incl. power supply for digital inertial sensors M12, 8 pin
VKM055421	PC3/8 M12 8-wire, supply and signal cable

## A 2 Factory Setting

Factory setting for the sensor parameters, [see 9.1](#).



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