IMS365

Dynamic-compensated inclinometer with CANopen interface

User manual

145/25

Table of contents

1 General Information

1.1 Documentation

The following documents are associated with this document:

- The data sheet describes the technical data, the dimensions, the pin assignment, the accessories and the order key.
- The installation instructions describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.
- The User manual for sensor commissioning and integration into a fieldbus system.

You can also download these documents at **http://www.siko-global.com/p/ims365**.

1.1.1 History

Mod. status	Date	Description
155/24	23.06.2025	Document prepared
145/25	29.07.2025	Review results adopted

1.1 Definitions

Decimal values are given as numbers without addition (e. g. 1234), except when indicated in direct connection with binary or hexadecimal values. In which case the extension "d" will be used (e. g. 1234d). Binary values are identified by adding "b" (e. g. 1011b) to the figures whereas hexadecimal values are extended by "h" (e. g. 280h).

2 Intended use

The IMS365 captures the absolute position information. The sensor can be parameterized and read out via the CAN interface using the CANopen protocol. For diagnostic purposes, there is an LED (red, green) in the sensor that indicates error or status information.

2.1 Switching on the supply voltage

IMS365 initializes after being switched on. During initialization, the configuration parameters are loaded from the non-volatile memory into the controller's memory.

The sensor will work with its default values as long as no changes have been made to it. With parameters changed, the sensor will work with the changed data, which must be stored if they are intended to be used after power off/on (see object 1010h: Store Parameter). After the initialization procedure is complete, the sensor sends a specific NMT command, the boot-up message, which informs the system of its availability. The IMS365 is now in the pre-operational mode. In this state, the encoder can be parameterized using SDO commands according to the requirements of the application. This applies both the configuration parameters of the sensor unit and the way in which it makes its position values available to the system (asynchronous or synchronous data transmission).

3 LED signal

The sensor has a green and red LED for diagnostic and status purposes.

- A green LED for indicating the NMT status and the LSS configuration status (CAN Run LED)
- A red LED for CAN error states and the LSS configuration status (CAN Err LED)

The LSS waiting status is not displayed by the LED.

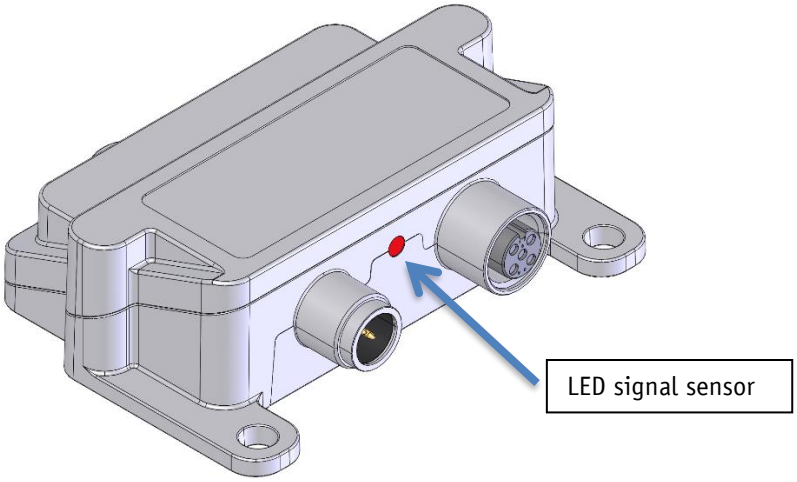

Fig. 1: LED signal

CAN diagnosis (green):

LED status	Description
On	LED is permanently on
Off	LED is permanently off
Flickering	LED flickers with a frequency of 10 Hz (50 ms on/off)
Flashing	LED flashes at a frequency of 2,5 Hz (200 ms on/off)
Single Flash	LED is 200 ms on, 1000 ms off
Double Flash	LED is 200 ms on, 200 ms off, 200 ms on, 1000 ms off

Table 1: CAN LED states according to CiA 303 Part 3

CAN Run LED (red):

Device status	LED status
Pre-Operational	Flashing
On	On
Stopped	Single Flash

Table 2: CAN Run LED

CAN Err LED:

Error states	LED status
No error	Off
Warning limit reached (at least one error counter (Transmit Error Counter CANTEC or Receive Error Counter CANREC) of the CAN controller has reached or exceeded the warning limit (too many error frames)).	Single Flash
Error control event: A Guard Event (if no RTR Node Guard has been received from the master within the lifetime set).	Double Flash
Bus off	On

Table 3: CAN Err LED

4 Functional description

4.1 Measuring range

The inclinometer supports 2 measurement ranges. A measuring range of 0 ... 360° and ±90°. The measurement range can be extended via the object 3120h: Sensor Configuration can be switched.

4.2 Calibration

Owing to the absolute system, calibration is required only once when the system is taken into operation and can be performed at any position. This allows the inclinometer zero point to be aligned with the mechanical zero point of the system. The device can be calibrated with the object 3200h: Auto Zero.

4.3 Definition of measuring axes

This section describes the axes of the various measured values that the sensor provides (acceleration, angular velocity, and angle). The following figures show how the axes behave toward the sensor housing. The angles are 0° in the display positions.

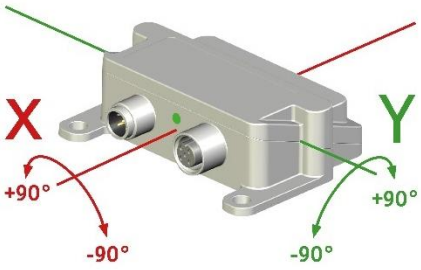

Fig. 2: Measuring axes inclination (2-axes)

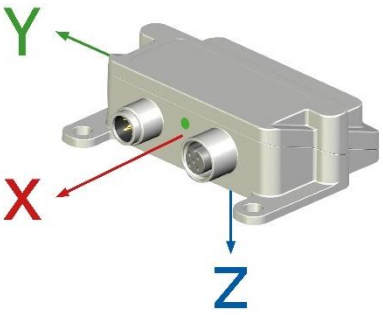

Fig. 3: Measuring axes acceleration

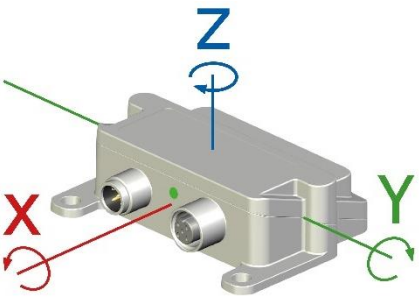

Fig. 4: Measuring axes rotation rate

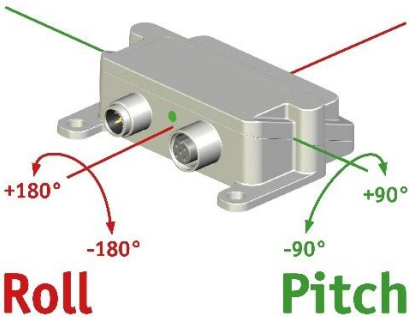

Fig. 5: Measuring axes Euler angle

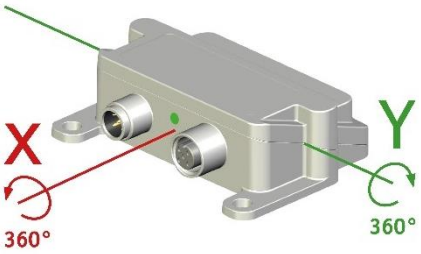

Fig. 6: Measuring axes rotation X and Y

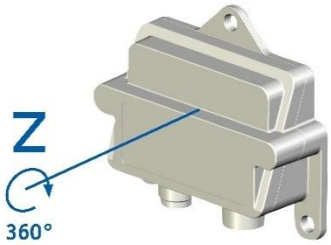

Fig. 7: Measuring axes rotation Z

4.4 Reset to factory settings

The following options are available for resetting the device parameters or setting them to the factory settings:

Access	Coding		Load settings from EEPROM
see object 1011h: Restore Parameter	1011h "load"	Sub-index 1	All user parameters
		Sub-index 2	Only communication parameters
		Sub-index 3	Only CiA 406 parameters
		Sub-index 4	Only manufacturer-specific parameters
		Sub-index 5	Reset all parameters to factory settings

Table 4: Access to factory settings

5 Signal processing and filtering

The IMS365 is equipped with two different types of filters:

- Low-pass filter "Critical Damped" and Butterworth
- Kalman filter (only if sensor fusion is activated)

The following figure illustrates the data flow of the measured values through these filters.

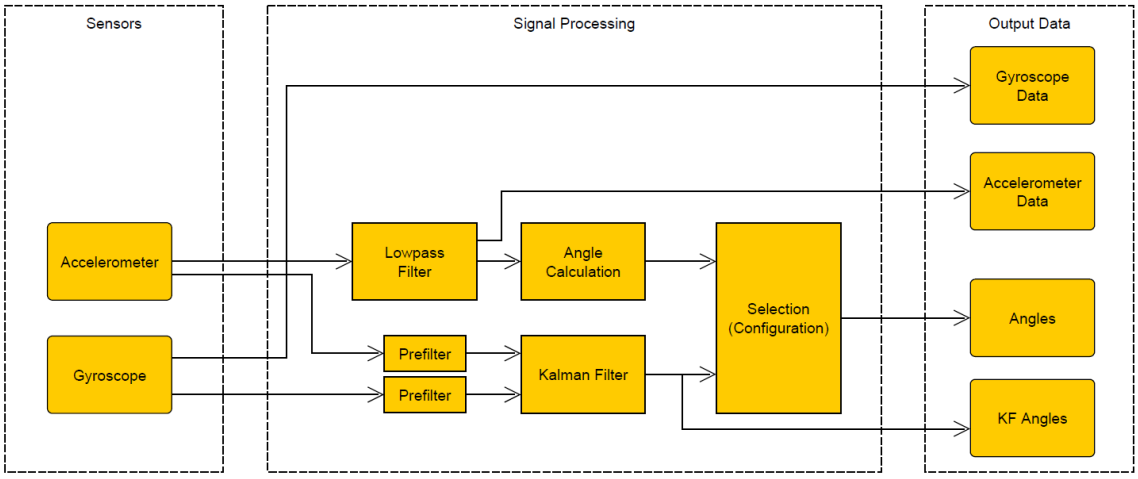

Fig. 8: Sensor data flow

Depending on the sensor configuration, the angles are calculated by the Kalman filter using accelerometer and gyroscope data or by an algorithm. This only uses the low-pass filtered accelerometer data.

5.1.1 Low-Pass Filter

The tilt data can be filtered with digital low-pass filters. The IMS360 is equipped with two adjustable low-pass filters for signal correction:

- 8th order Critical Damped filter
- 8th order Butterworth filter

The following table shows the filter characteristics in comparison:

Critical Damped Filter	Butterworth Filter
Universal filter	Specific applications
Short response time	Higher attenuation
Short delay time	The attenuation starts just above the set cut-off frequency.
No overshoot	Overshoot

Table 5 Filter characteristics

5.1.2 Critical Damped Filter

The Critical Damped Filter is suitable for most requirements due to its short response time. If the output signal is overlaid with noise or interference, the optimal setting is determined by gradually lowering the cut-off frequency f_G to the limit of the response time t_R.

For this type of filter, the response time is:

$$t_R = \frac{1}{f_G}$$

The lowest adjustable cut-off frequency is 0.1 Hz and should be tested if the response time t_R is not relevant to the application. A cut-off frequency of 2000 mHz is preset at the factory.

5.1.3 Butterworth Filter

Due to its characteristics, the Butterworth filter tends to overshoot during jumps in the input signal. The filter should be used where there are no or only minor mechanical shocks and vibrations. This is especially important if the sensor works in a control loop. The filter can be used well to reduce low-frequency interference, which is caused by vibrations, for example. This is achieved by the greater separation of passing frequency and cut-off frequency.

5.1.4 Kalman Filter

5.1.4.1 General Information

The Kalman filter combines the sensor data from the accelerometer and gyroscope to achieve the following goals.

- Fast filter response: The output of the Kalman filter responds immediately with a negligible delay to a change in sensor orientation.
- Good attenuation of the influence of the acceleration components in addition to the gravitational force on the calculated angles.

The following diagram shows the behavior of the Kalman filter and the low-pass filter of a sensor rotated from -45° to 45°. You can see that the Kalman filter reacts immediately, while the low-pass filter has a delay of about 0.2 seconds. The diagram shows the behavior when the Kalman pre-filter is deactivated. Activating the pre-filters leads to a delay that increases as the filter frequency decreases. See chapter 5.1.4.2 for more details on the Kalman pre-filters.

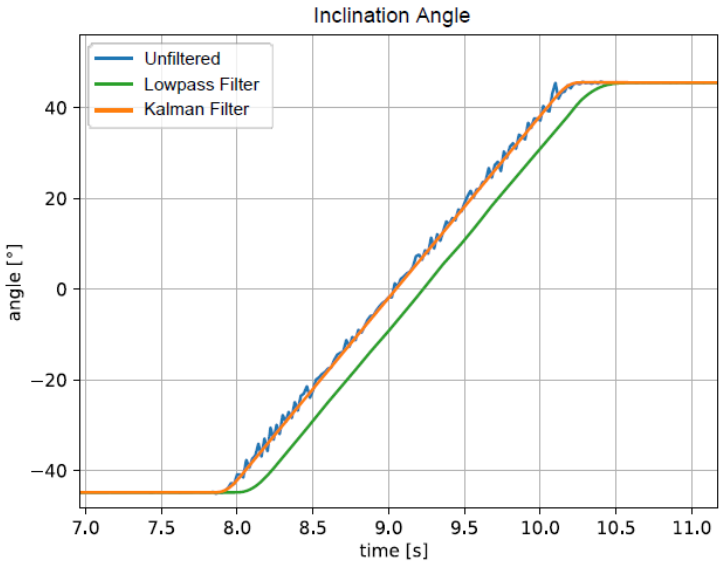

Fig. 9: Filter Type Latency

The following diagram shows the response of the Kalman filter and the low-pass filter to vibrations acting on the sensor.

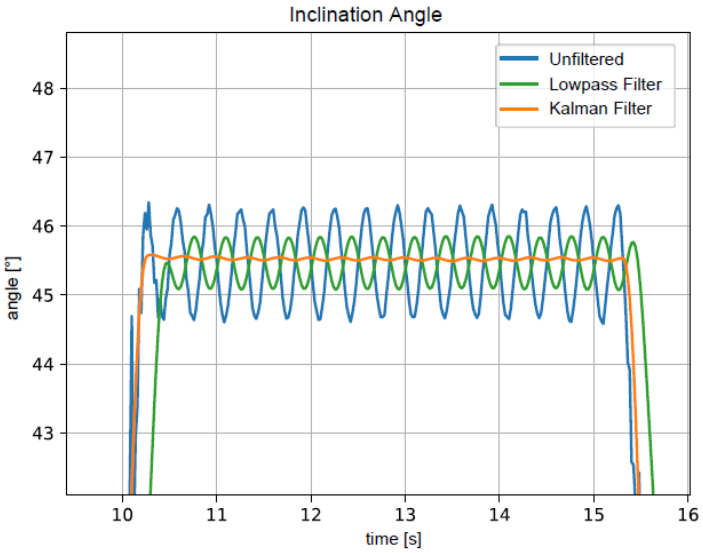

Fig. 10: Filter Type Vibration Suppression

The following filter configurations were used:

- Low-pass Filter: Critical damped, fc = 3.0 Hz
- Kalman Filter Parameter: R = 10.0, Q = 0.001
- Kalman pre-filters are deactivated

Depending on the frequency of the interference, activating the low-pass filter can lead to better results. Especially when the signal-to-noise ratio is low, a low-pass filter may be the better choice if the signal delay is acceptable. Alternatively, the sensor provides pre-filters that filter the acceleration and rotation rate values before they are processed in the Kalman filter (see chapter 5.1.4.2).

5.1.4.2 Pre-filter

As a compromise between fast response time and good attenuation of interference, the sensor provides pre-filters. These pre-filters are applied to the acceleration and rotation rate values before they are processed in the Kalman filter. These filters are low-pass filters of the second-order Bessel filter type.

They can be used in environments with large amplitude oscillations close to or above 1 g and medium to low frequencies. In these situations, the Kalman filter values may tend to drift, which can be prevented by activating the pre-filters.

The frequency of the pre-filters can be configured separately for the acceleration and rotation rate values. The valid range is between 1.0 Hz and 51.0 Hz in steps of 0.2 Hz. The pre-filters can also be completely deactivated. See chapter 7.2, object 3112h.

The filtering of the pre-filter only applies to the values transferred to the Kalman filter. It has no influence on the acceleration, rotation rate or angle values, which can be read out directly via the corresponding communication objects.

5.1.4.3 Configuration

For the configuration of the Kalman filter, the parameters R (measurement noise) and Q (system state transition noise) are used. These two floating-point values are defined by the mantissa M and the exponent E. Mantissa and exponent are each two signed integer8 numbers. The value of the parameters is calculated as follows:

$$x = M \times 10^{E}$$

Examples:

The value 0.001 (1×10^{-3}) is set as follows:

1. Byte	2. Byte
E	M
FDh (-3d)	1h (1d)

The value 10 (1×10^{1}) is set as follows:

1. Byte	2. Byte
E	M
1h (1d)	1h (1d)

Usually, it is sufficient to adjust the parameter Q and leave the parameter R at its default value of 10.0. Changes in the filter behavior due to modifications of the parameter Q can also be achieved to the same extent by changing the parameter R. When parameter R is set to its default value of 10.0, useful values for parameter Q are usually in the range of 0.01 to 0.0001 (exceptions in special applications cannot be ruled out). As a rule, it is sufficient to change the exponent E of parameter Q to adapt the behavior of the Kalman filter to the application. Smaller values of Q cause the gyroscope to have a stronger influence on the angular value, but this also increases the static error due to the gyro offset error. At the same time, disturbing acceleration components caused by vibrations and shocks are suppressed to a greater extent.

The dynamics of the filter (signal delay) are not affected by the Q and R parameters.

5.2 Selecting the correct filter

Deciding which filter to use for a particular application depends on the requirements of the application.

The following table provides support in selecting a filter.

Request	Preferred filter
High static accuracy	Low-Pass Filter
High noise reduction	Butterworth
Use in control loops	Critical damped or Kalman Filter
Vibration suppression	Kalman Filter
Fast filter response	Kalman Filter

Table 6: Select filter

If the Kalman filter is permanently exposed to high amplitude oscillations, e. g. near or above 1.0 g, the values may drift over time. In such situations, please check whether the Kalman filter is the right choice. Consider activating the Kalman pre-filter or using the low-pass filter instead. Alternatively, the mounting point of the sensor can also be mechanically decoupled from these vibrations.

5.3 STATUS-Flags

The sensor provides a list of STATUS flags that represent various information about the measured values. All STATUS flags are listed in the following table.

Bit	Name	Description	Category
0	SAT_XL	At least one axis of the acceleration sensor is in saturation.	WARN
1	SAT_GY	At least one gyroscope sensor axis is in saturation.	WARN
2	-	Not used	-
3	-	Not used	-
4	I90_X_OOR	±90° inclination angle of the X axis is out of range.	WARN
5	I90_Y_OOR	±90° inclination angle of the Y axis is out of range.	WARN
6	R360_X_NA	360° rotation angle of X axis is not available.	WARN
7	R360_Y_NA	360° rotation angle of Y axis is not available.	WARN
8	R360_Z_NA	360° rotation angle of Z axis is not available.	WARN
9	-	Not used	-
10	UCGF_INV	User Config Invalid: User settings are invalid. If the power supply is interrupted while saving the user settings, an error may occur. The sensor can be reset to the factory setting.	ERR
11	-	Not used	-
12	IFC	Invalid filter configuration; the low pass filter configuration for the acceleration values is invalid.	ERR
13	-	Not used	-

Table 7: Description of the STATUS flags

These flags can be read with the status parameter (Details see chapter 5.4).

Note on I90_X_OOR and I90_Y_OOR:

The ±90° inclination angles can theoretically map inclinations in the range of -90° to 90°. If the sensor is moved beyond the ±90° point, the value of the angle becomes smaller again for algorithmic reasons. In addition, offset and gain errors of the acceleration sensors prevent values up to exactly ±90° from being determined. For this reason, these flags are set when the associated inclination angle approaches or exceeds the upper limit of ±90°. The exact threshold values can be found in the specification sheet or the sensor manual.

Note on R360_X/Y/Z_NA:

To determine the 360° rotation angle, the axis of rotation must be horizontal. In extreme cases – with a vertical axis of rotation – the calculation of a rotation angle is not possible algorithmically, since the acceleration sensor values used for the calculation then no longer change during a rotation. The deviation from the horizontal position is tolerated to a certain extent. However, if the axis is too far away from the ideal horizontal position, the corresponding flag R360_X/Y/Z_NA is set. The exact threshold values can be found in the specification sheet or the sensor manual.

5.4 Combined warning and error flags (status bytes)

Telegrams that transmit measured values contain abbreviated status flags that represent the individual bits of this STATUS parameter. For example, the measured value in the CM_INCL_XY telegram is marked as untrustworthy when the acceleration sensor is in saturation. The messages of the CAN protocols that transmit sensor data therefore contain a STATUS byte. This STATUS byte contains bits that represent warnings and errors.

The error bit is set if at least one of the following STATUS flags is set:

STATUS Flag
UCFG_INV (User Config Invalid)
IFC (Invalid Filter Configuration)
PC_TSENS (Temperature Sensor Problem)

The STATUS flags associated with the warning bit depend on the data type and sensor configuration. The following table shows which STATUS flags must at least be set for the warning bit to be set (the warning bit is a logical OR association of these STATUS flags):

Name	Type	SAT_XL	PC_XL	SAT_GY	PC_GY	I90_X_OOR	I90_Y_OOR	R360_X_NA	R360_Y_NA	R360_Z_NA
WARN_XL	Acceleration	X	X							
WARN_GY	Angular speed			X	X					
WARN_IX	Inclination angle X	X	X	X[1)]	X[1)]	X				
WARN_IY	Inclination angle Y	X	X	X[1)]	X[1)]		X			
WARN_EU	Euler angles	X	X	X[1)]	X[1)]					
WARN_RX	360° Rotation angle X	X	X	X[1)]	X[1)]			X		

Name	Type	SAT_XL	PC_XL	SAT_GY	PC_GY	I90_X_OOR	I90_Y_OOR	R360_X_NA	R360_Y_NA	R360_Z_NA
WARN_RY	360° Rotation angle Y	X	X	X[1)]	X[1)]				X	
WARN_RZ	360° Rotation angle Z	X	X	X[1)]	X[1)]					X

Table 8: Logical OR combination of warning flags [1)] Only if Sensor Fusion is enabled

Each measured value supplied by the sensor (e. g., acceleration) is assigned a STATUS byte that contains status information about the respective measured value. The following sections describe the structure of these STATUS bytes.

Acceleration STATUS

Bit	Name	Function
0	-	Not used
1	WARN_XL	The measured values are unreliable (see chapter 5.4).
2	ERR	There is a hardware problem that prevents the determination of correct measured values.
3 … 7	-	Not used

Table 9: Structure of the acceleration STATUS byte

Gyro STATUS

Bit	Name	Function
0	-	Not used
1	WARN_GY	The measured values are unreliable (see chapter 5.4).
2	ERR	There is a hardware problem that prevents the determination of correct measured values.
3 … 7	-	Not used

Table 10: Structure of the gyro STATUS byte

Inclination STATUS

Bit	Name	Function
0	-	Not used
1	WARN_IX	X axis: The measured values are unreliable (see chapter 5.4).
2	WARN_IY	Y axis: The measured values are unreliable (see chapter 5.4).
3	ERR	There is a hardware problem that prevents the determination of correct measured values.
4 … 7	-	Not used

Table 11: Structure of inclination STATUS byte

Euler STATUS

Bit	Name	Function
0	-	Not used
1	WARN_EU	The measured values are unreliable (see chapter 5.4).
2	ERR	There is a hardware problem that prevents the determination of correct measured values.
3 ... 7	-	Not used

Table 12: Structure of the Euler STATUS Byte

Rotation X/Y/Z STATUS

Bit	Name	Function
0	-	Not used
1	WARN_RX/_RY/_RZ	The measured values are unreliable (see chapter 5.4).
2	ERR	There is a hardware problem that prevents the determination of correct measured values.
3 ... 7	-	Not used

Table 13: Structure of rotation angle STATUS byte

Temperature STATUS

Bit	Name	Function
0	-	Not used
1	-	Not used
2	ERR	There is a hardware problem that prevents the determination of correct measured values.
3 ... 7	-	Not used

Table 14: Structure of temperature STATUS byte

5.5 Rotation of the coordinate system

The coordinate system can be rotated if the installation situation requires this, for example because the sensor can only be mounted vertically. The sensor can be configured for one of six possible installation situations.

Code	Name	Description
0	ZDN	Z axis points down
1	ZUP	Z axis points up
2	YDN	Y axis points down
3	YUP	Y axis points up
4	XDN	Z axis points down
5	XUP	Z axis points up

Table 15: Coordinate system rotation options

The sensor rotates the coordinate system internally as if it were mounted in a standard mounting situation. These situations can be characterized by the downward pointing axis. The rotation that puts the sensor in the non-standard mounting situation is shown in the following figures. The arrows indicate the coordinate orientation of the monitoring system (e. g., of the vehicle).

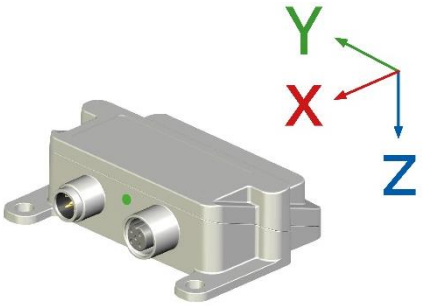

Fig. 11: Code 0, Standard

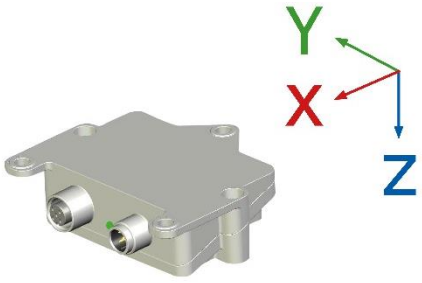

Fig. 12: Code 1, rotates 180° along the X axis

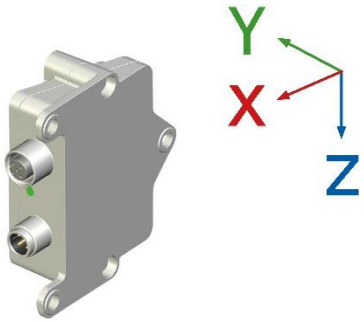

Fig. 13: Code 2, rotates 90° along the X axis

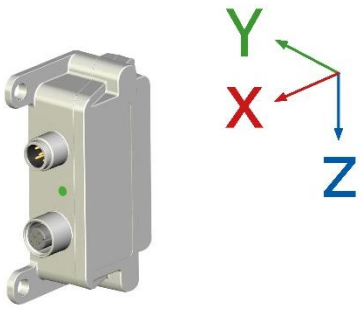

Fig. 14: Code 3, rotates -90° along the X axis

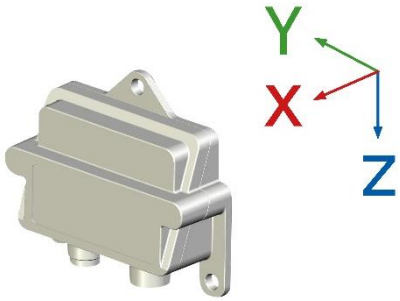

Fig. 15: Code 4, rotates -90° along the Y axis

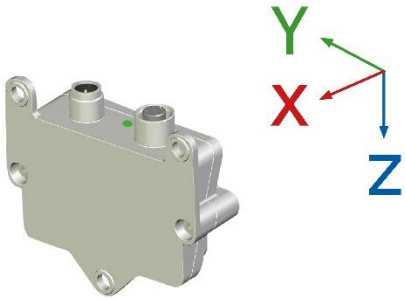

Fig. 16: Code 5, rotates 90° along the Y axis

The sensor mounting situation can 3200h: Auto Zero be configured using the sub-index 01h object.

6 Communication via CANopen

The basis for the IMS365 inclination sensor is the CANopen communication profile CiA 301 and the device profile for inclination sensors CiA 410. The details necessary to better understand how it works are contained in this documentation. If more detailed information is required, we recommend the corresponding technical literature on CAN or CANopen and the user information of the controller used and the CANopen master.

6.1 Network Management (NMT) Services

The master configures, manages and monitors network nodes via the NMT service. The device is always in one of the four communication states "INITIALISATION", "PRE-OPERATIONAL", "OPERATIONAL" or "STOPPED".

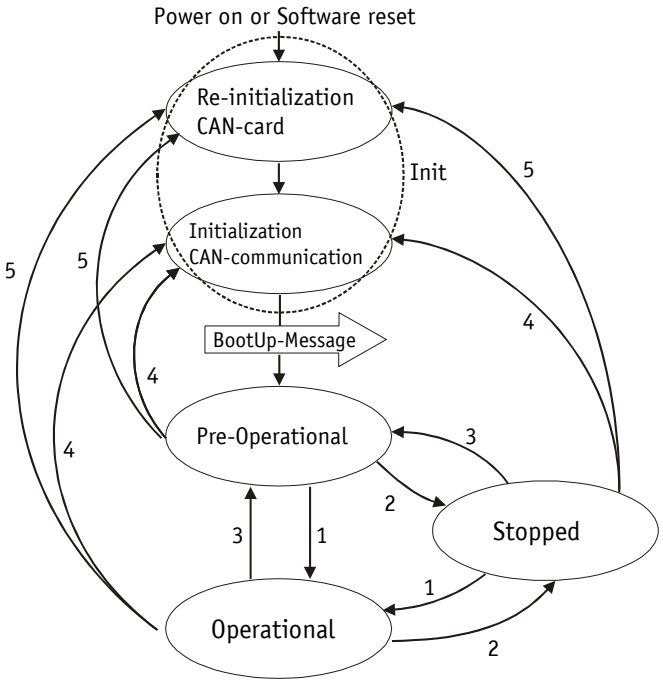

Fig. 17: NMT status diagram

6.1.1 NMT communication states

NMT Status 'INITIALIZATION'

In this state, the device does not participate in the bus operation. All hardware and software components are initialized. This state is attained after switching on the device or after receipt of the command code 81h ("Reset node") of the own or global addresses. After receiving the command code 82h ("Reset Communication"), the initialization phase of the device also begins. However, only the hardware and software components associated with CAN communication are reinitialized. The device automatically signals the completion of initialization by sending a boot message. Once the boot message is successfully sent, the device enters the PRE-OPERATIONAL state.

NMT Status PRE-OPERATIONAL

Parameterization data (SDO) can be exchanged in the pre-operational mode. However, no process data (PDO's) is transferred.

NMT Status OPERATIONAL

The exchange of process data is activated. However, the parameters COB ID and transmit PDO Mapping can no longer be changed in this state.

NMT Status STOPPED

Communication is stopped except for Heartbeat and Node Guarding. Only NMT communication is enabled.

6.1.2 Change of NMT status

Telegrams with the following structures are used for switching between the communications statuses:

Change of state		Step in Fig. 17	COB-ID	Com-mand	Node ID
from	to				
PRE-OPERATIONAL / STOPPED	OPERATIONAL	1	0h	01h	x
OPERATIONAL/ PRE-OPERATIONAL	STOPPED	2	0h	02h	x
OPERATIONAL / STOPPED	PRE-OPERATIONAL	3	0h	80h	x
OPERATIONAL / PRE-OPERATIONAL / STOPPED	INITIALIZATION (Reset Node)	5	0h	81h	x
OPERATIONAL / PRE-OPERATIONAL / STOPPED	INITIALIZATION (Reset Communication)	4	0h	82h	x

Table 16: Change of NMT status

If 0h is transmitted as Node ID, then the message is intended for all bus subscribers.

6.1.3 Boot-Up

The COB ID of the boot-up message is made up of 700h and the Node ID. The "Initialization" NMT status is output as data content.

COB-ID	Byte 0
700h + Node-ID	00h

Table 17: Boot-Up message

6.1.4 SYNC object

CANopen enables simultaneous polling of all inputs and simultaneous setting of all outputs. The synchronization message (SYNC), a CAN message with high priority serves this purpose. The identifier of the SYNC object can be set via object 1005h (see object 1005h: COB-ID SYNC).

6.2 Process data exchange

6.2.1 Process data objects (PDO)

Process data objects (PDO) serve for fast exchange of process data. A maximum of 8 bytes of user data can be transferred in a PDO. These can be dynamically mapped and are transmitted in three possible operating modes.

The IMS365 supports the Transmit PDO services TPDO1, TPDO2, TPDO3 and TPDO4.

6.2.2 Transmit-PDO (from IMS365 to master)

PDO transfer from the IMS365 to the bus master (TPDO) can be initiated as a result of various events:

- Asynchronous transmission, controlled by the internal device timer
- Synchronous transmission, in response to a SYNC message
- Event-driven transfer

The operating modes for PDO transmission are set with the standardized TPDO communication parameters in the objects 1800h to 1803h. Within these TPDO communication parameters, the transmission type, blocking time and event time can be adjusted.

The TPDO can be enabled or disabled by setting the valid flag (bit 31) in the PDO COB ID. Only when the TPDO is disabled can the mapping of the PDO data be configured. The TPDO communication parameters of all 4 TPDOs can be stored in persistent memory.

6.2.3 TPDO Mapping

The data of the TPDO is defined with the standardized TPDO mapping parameters in the objects 1A00h to 1A03h. This allows the parameters that are transmitted with the individual TPDO to be set for specific applications.

Index	Sub-index	Parameter	Max. number of bits	Input value
3000h	01h	Status-Byte ST0	8	30000108h
	02h	Status-Byte ST1	8	30000208h
	03h	Acceleration Status	8	30000308h
	04h	Gyro Status	8	30000408h
	05h	Inclination Status	8	30000508h
	06h	Euler Status	8	30000608h
	07h	Rotation Z Status	8	30000708h
	08h	Temperatur Status	8	30000808h
	09h	Rotation X Status	8	30000908h
	0Ah	Rotation Y Status	8	30000A08h
3010h	00h	Acceleration Value X Axis	16	30100010h
3011h	00h	Acceleration Value Y Axis	16	30110010h
3012h	00h	Acceleration Value Z Axis	16	30120010h

Index	Sub-index	Parameter	Max. number of bits	Input value
3020h	00h	Gyroscope Value X Axis	16	30200010h
3021h	00h	Gyroscope Value Y Axis	16	30210010h
3022h	00h	Gyroscope Value Z Axis	16	30220010h
3030h	00h	Inclination Value X Axis	16	30300010h
3031h	00h	Inclination Value Y Axis	16	30310010h
3032h	00h	Inclination value X Axis	16	30320010h
3033h	00h	Inclination value Y Axis	16	30330010h
3040h	00h	Roll Euler Angle Value	16	30400010h
3041h	00h	Pitch Euler Angle Value	16	30410010h
3042h	00h	KF Roll Euler Angle value	16	30420010h
3043h	00h	KF Pitch Euler Angle value	16	30430010h
3050h	00h	Rotation Value X Axis	16	30500010h
3051h	00h	Rotation Value Y Axis	16	30510010h
3052h	00h	Rotation Value Z Axis	16	30520010h
3053h	00h	KF Rotation value X Axis	16	30530010h
3054h	00h	KF Rotation value Y Axis	16	30540010h
3055h	00h	KF Rotation value Z Axis	16	30550010h
3060h	00h	Temperature Value	16	30600010h
6010h	00h	Slope long16	16	60100010h
6020h	00h	Slope lateral16	16	60200010h

Table 18: TPDO Mapping

Before the mapping parameters can be set, the TPDO must be deactivated and the first entry of the object (sub-index 0) must be set to 0. After the mapping parameters have been changed, the first entry of the object must be set to the number of mapped objects (maximum 8) and the TPDO must be re-enabled.

The TPDO mapping parameters of all 4 TPDOs can be stored in persistent memory (see 1010h: Store Parameter).

Example:

The TPDO2 is supposed to output the value of the gyroscope X, Y, Z.

Step	Description
1	Disable TPDO2 Object: 1801h 01h Data: 80000281h
2	Set the number of mapped objects to 0 Object: 1A01h 00h Data: 00000000h
3	Set a mapped object Object: 1A01h 01h Data: 30200010h Object: 1A01h 02h Data: 30210010h Object: 1A01h 03h Data: 30220010h
4	Set number of mapped objects (here in example 3) Object: 1A01h 00h Data: 00000003h
5	Enable TPDO2 Object: 1801h 00h Data: 40000281h

Step	Description
6	Set TPDO2 cycle time to a value >0 (if asynchronous transmission is set) Object 1801h 05h Data: 00000064h

6.3 Node monitoring

6.3.1 Emergency-Dienst (EMCY)

In the case of an error, the status of the bus subscriber is transferred via prioritized emergency messages (emergency telegrams). These messages have a data length of 8 bytes and contain error information.

The emergency message is transferred as soon as a sensor or communication error has occurred or when such errors have been corrected. The cause of the error is deposited in the error buffer (see object 1003h: Pre-defined Error Field). An emergency object is sent only once per error event. Removal of the cause of the error is signaled by sending an emergency message with the error code 0000h (no error). If multiple errors have occurred and one cause of error is removed, the error code 0000h is output as well; the persisting error status is indicated in the error register, however.

Identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
11/ 29 Bit	Emergency Error Code		Error Register (object 1001h)	Manufacturer-specific error field (not used)				

6.3.2 Emergency Error Code

Error Description	Error Code
Cause of the error removed	0000h
CAN Overflow	8110h
CAN in Error Passive Mode	8120h
Communication restored after Bus Off	8140h
Invalid filter configuration	FF11h
Temperature values are not plausible	FF12h

Table 19: Emergency Error Code

The identifier of the Emergency object is set to 80h +Node-ID, but can be changed with the object 1014h: COB-ID Emergency message. The transmission of an emergency message is only possible in the NMT status "OPERATIONAL" or "PRE-OPERATIONAL". The transmission of the emergency messages can be disabled by setting the COB ID valid bit 31 to 1.

6.3.3 Heartbeat

The master monitors the state of the slave device via the heartbeat protocol. The device automatically sends its NMT status cyclically. The IMS365 is a heartbeat producer, it does not receive or process heartbeat protocols itself. The cycle time of the heartbeat message is set via object 1017h. The heartbeat protocol is disabled when the cycle time is 0 ms.

The heartbeat message consists of the COB ID and an additional byte. In this byte, the current NMT state is deposited.

COB-ID	Byte 0
700h + Node-ID	NMT state

NMT state:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

The identifier of the heartbeat protocol is permanently set to 700h + Node ID and cannot be changed. Heartbeat messages are sent in the NMT status "OPERATIONAL", "PRE-OPERATIONAL" or "STOPPED".

6.4 Layer Setting Service (LSS)

Layer Setting Service (LSS) is a special method described in CiA 305 that is used to retrieve and configure various parameters (Node ID, baud rate, and Identity Object 1018h).

Each device must have a unique NSSO number, which is made up of the entries in object 1018h.

- Vendor-ID: 0000 0195h
- Product code: 0001 869Fh (1-axis variant)
0002 869Fh (2-axis variant)
- Revision number: 0002 0005h
- Serial number: xxxx xxxxh (respective serial number of the device)

In order to enable the use of full LSS functionality, all devices on the bus must support the LSS method. An LSS master must exist and all nodes must start with the same baud rate. After starting, the device is in the LSS waiting state. To enable the configuration, one or all devices must be placed in the LSS configuration state. If the LSS master expects a response to its command, only one LSS slave needs to be switched to LSS configuration mode.

Two LSS services are available:

- LSS (rx) (LSS Master ⇒ IMS365): 7E5h
- LSS (tx) (IMS365 ⇒ LSS Master): 7E4h

These NSSO identifiers cannot be changed!

A message always consists of 8 bytes. Byte 0 contains the command (Command – Specifier cs), followed by max. 7 data bytes unused data bytes are reserved and must be filled with 00h.

Services	LSS waiting	LSS configuration
Switch state global	yes	yes
Switch state selective	yes	no
Activate bit timing parameters	no	yes, if all devices on the bus support LSS
Configure bit timing parameters	no	yes
Configure node-ID	no	yes
Store configuration	no	yes
Request LSS address	no	yes
Request LSS address	no	yes

7 Directory of object

The object directory is a list of the accessible functions and parameters of a device. It is the interface between the application program and the device. Each row in the directory's list represents a communication object that is accessible through a specific 16-bit index and an 8-bit sub-index.

7.1 Overview of objects

The following table offers an overview of the objects of the device.

Name	Description	See page
1000h: Device Type	Device profile and encoder type.	27
1001h: Error Register	Current error state of the device.	28
1003h: Pre-defined Error Field	The object stores the 8 error states that have occurred last.	28
1005h: COB-ID SYNC	Setting of the COB ID of the SYNC object.	29
1008h: Manufacturer Device Name	Device name in ASCII notation.	29
1009h: Manufacturer Hardware Version	Indicates the hardware version of the device.	29
100Ah: Manufacturer Software Version	Indicates the software version of the device.	30
1010h: Store Parameter	Object for non-volatile storage of the settings.	30
1011h: Restore Parameter	Object for restoring the user and factory settings.	31
1014h: COB-ID Emergency message	COB ID of the Emergency object.	33
1017h: Producer Heartbeat Time	Cycle time of the heartbeat.	33
1018h: Identity Object	Contains the manufacturer number.	34
1800h: 1. Transmit PDO Parameter	Settings for the 1st TPDO.	35
1801h: 2. Transmit PDO Parameter	Settings for the 2nd TPDO.	36

Name	Description	See page
1802h: 3. Transmit PDO Parameter	Settings for the 3rd TPDO.	38
1803h: 4. Transmit PDO Parameter	Settings for the 4th TPDO.	39
1A00h: 1. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO1.	41
1A01h: 2. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO2.	43
1A02h: 3. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO3.	45
1A03h: 4. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO4.	47
2000h: Logistic Data	Contains information about the sensor and its manufacture, e. g. serial number, article number, device ID.	49
2001h: Baud rate	Baud rate settings.	50
2002h: Node ID	Node ID settings.	50
2010h: Controller Settings	Request for controller-specific commands, e. g. reset controller.	51
20FFh: Version of Layout	Contains the layout version of the standard SDO currently in use.	51
3000h: Status	Contains status information of the sensor.	51
3010h: Acceleration X axis	Contains raw acceleration value of the X axis.	57
3011h: Acceleration Y axis	Contains raw acceleration value of the Y axis.	57
3012h: Acceleration Z axis	Contains raw acceleration value of the Z axis.	57
3020h: Gyro Values X Axis	Contains the gyroscope value of the X axis.	58
3021h: Gyro Value Y axis	Contains the gyroscope value of the Y axis.	58
3022h: Gyro Values Z axis	Contains the gyroscope value of the Z axis.	58
3030h: Inclination Values X axis	Contains the inclination value of the X axis.	59
3031h: Inclination Values Y axis	Contains the inclination value of the Y axis.	59
3032h: KF Inclination value X axis	Contains the inclination value of the X-axis calculated using the Kalman filter.	59
3033h: KF Inclination value Y axis	Contains the inclination value of the Y-axis calculated using the Kalman filter.	60
3040h: Roll Euler angle value	Contains the Roll Euler angle value.	59
3041h: Pitch Euler Angle Value	Contains the pitch Euler angle value.	60
3042h: KF Roll Euler angle value	Contains the value of the Euler roll angle calculated using the Kalman filter.	61
3043h: KF Pitch Euler angle value	Contains the value of the Euler pitch angle calculated by the Kalman filter.	61
3050h Rotation Value X axis	Contains the rotation value of the X axis.	61
3051h: Rotation value Y axis	Contains the rotation value of the Y axis.	62
3052h: Rotation value Z axis	Contains the rotation value of the Z axis.	62

Name	Description	See page
3053h: KF Rotation value X axis	Contains the rotation value of the X-axis calculated by the Kalman filter.	62
3054h: KF Rotation value Y axis	Contains the rotation value of the Y-axis calculated by the Kalman filter.	63
3055h: KF Rotation value Z axis	Contains the rotation value of the Z-axis calculated by the Kalman filter.	63
3060h: Temperature value	Contains the temperature value.	62
3100h: CAN settings	Contains the settings of the CAN interface.	64
3110h: Filter Configuration	Contains the settings of the filter.	65
3111h: Low Pass Filter Frequency	Object for adjusting the cut-off frequency of the digital low-pass filter.	66
3112h: Kalman Filter Parameters	Object for setting up the Kalman filter.	66
3120h: Sensor Configuration	Object for selecting the measuring range.	67
3130h: Inclination offset value X axis (Inclination X axis)	Object to set the zero position of the X or Z axis inclination value.	70
3131h: Inclination offset value Y axis (Inclination Y axis)	Object to set the zero position of the Y axis inclination value.	70
3132h: Rotation offset value X axis	Object to set the zero position of the X axis rotation value.	71
3133h: Rotation offset value Y axis	Object to set the zero position of the Y axis rotation value.	71
3134h: Rotation offset value Z axis	Object to set the zero position of the Z axis rotation value.	72
3135h: KF Inclination offset value X axis	Object for defining the inclination value of the X-axis, calculated by the Kalman filter, for the zero point adjustment of the longitudinal inclination.	72
3136h: KF Inclination offset value Y axis	Object for defining the inclination value of the Y-axis, calculated by the Kalman filter, for the zero point adjustment of the longitudinal inclination.	72
3137h: KF Rotation offset value X axis	Object for defining the value for the zero point adjustment of the rotation of the X-axis, calculated by the Kalman filter.	73
3138h: KF Rotation offset value Y axis	Object for defining the value for the zero point adjustment of the rotation of the Y-axis, calculated by the Kalman filter.	73
3139h: KF Rotation offset value Z axis	Object for defining the value for the zero point adjustment of the rotation of the Z-axis, calculated by the Kalman filter.	73
3200h: Auto Zero	Executes a specific command, such as Auto Zero or Auto Rotation.	74
6000h: Resolution	Specifies the resolution of the longitudinal and lateral slope values.	75
6010h: Slope Longitudinal (Inclination X Axis)	16-bit inclination value of the longitudinal axis (Z axis only accessible for 1-axis version).	75

Name	Description	See page
6011h: Slope Long Operating Parameter (Inclination X Axis)	Specifies the interpretation of the 16-bit longitudinal inclination (Z axis only accessible with 1-axis version).	76
6020h: Slope Lateral (Inclination Y Axis)	16-bit slope value of the lateral axis (only accessible with the 2-axis version).	76
6021h: Slope Lateral16 Operating Parameter (Inclination Y Axis)	Specifies the interpretation of the 16-bit lateral inclination (only available on the 2-axis version).	76
6511h: Device Temperature6511h:	Provides the temperature of the inclinometer.	77

Table 20: Overview of objects

7.2 Object Description

7.2.1 1000h: Device Type

Object 1000h indicates the device profile number.

Sub-index	00h			
Description	Information about the device profile and encoder type			
Access	ro			
Data type	UNSIGNED 32			
Default	1-axis: 0701019Ah 2-axis: 0702019Ah			
EEPROM	no			
Data content	Device profile -number		Encoder type	
	Byte 0	Byte 1	Byte 2	Byte 3
	9Ah	01h	01h / 02h	07h

019Ah (= 410d): CANopen Device Profile for Inclinometers

Type:
0701h: 1-Axis
0702h: 2-Axis

7.2.2 1001h: Error Register

Object 1001h indicates the error state of the device.

Sub-index	00h	
Description	pending error status	
Access	ro	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	no	
Data content	Bit	Meaning
	0	set bit indicates the occurrence of any error condition
	4	set bit indicates communication error on the CAN bus (passive or bus-off)
	7	Manufacturer-specific (sensor error)
	1 ... 3, 5, 6	not used

Faults and errors are signaled at the time of their occurrence by an emergency message.

7.2.3 1003h: Pre-defined Error Field

In object 1003h, the 8 latest error states are archived (see chapter 6.3.2).

- The entry under sub-index 0 indicates the number of errors saved.
- The latest error status is always stored in sub-index 01h. Previous error messages "slip onwards" in their position by one sub-index.
- The whole error list is deleted by writing the value 0 in sub-index 00h.
- The entries in the error list have the format described in chapter 6.3.2.

Sub-index	00h
Description	Number of the error messages stored
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Sub-index	01h ... 10h
Description	Error messages that occurred
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	no

7.2.4 1005h: COB-ID SYNC

The COB ID of the SYNC object is set via object 1005h.

Sub-index	00h
Description	Defines the COB ID of the synchronization object (SYNC)
Access	const
PDO mapping	no
Data type	UNSIGNED 32
Default	80h
EEPROM	no

7.2.5 1008h: Manufacturer Device Name

Object 1008h indicates the device name. Since this consists of 7 bytes of data, a normal transfer is required to read the SDO.

Sub-index	00h					
Description	Device Name in ASCII Notation					
Access	ro					
PDO mapping	no					
Data type	Visible String					
Default	IMS365					
EEPROM	no					
Data content	Read:					
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
	49h ("I")	4Dh ("M")	53h ("S")	33h ("3")	36h ("6")	30h ("5")

7.2.6 1009h: Manufacturer Hardware Version

Object 1009h indicates the hardware version.

Sub-index	00h
Description	Hardware version in ASCII notation
Access	ro
PDO mapping	no
Data type	Visible_String
Default	-
EEPROM	no
Data content	The hardware version is encoded in one byte and represents the revision number.

7.2.7 100Ah: Manufacturer Software Version

Sub-index	00h
Description	Software version in ASCII notation
Access	ro
PDO mapping	no
Data type	Visible_String
Default	-
EEPROM	no
Data content	The software version is encoded in three bytes and is divided into Major Version (MA), Minor Version (MI) and Release Number (REL) of the software (example: 1.2r7).

7.2.8 1010h: Store Parameter

Parameters are transferred into the EEPROM with this object in order to ensure that they are protected from loss of voltage. Different parameter groups are stored depending on the selection of the sub-index to be accessed. The string "Save" must be sent as data content.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	no

Sub-index	01h			
Description	Saving User Parameters			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	73h ("s")	61h ("a")	76h ("v")	65h ("e")
	Read:			
	Bit 31 ... 2	0: reserved		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

7.2.9 1011h: Restore Parameter

Object 1011h restores the user and factory settings of the device depending on the selection. The string "Load" must be sent as data content and the device reset thereafter. If the restored parameters are intended to be permanently available, they must be stored via object 1010h: Store Parameter.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Sub-index	01h			
Description	Reset all user parameters to data in the EPROM			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters		

Sub-index	02h			
Description	Only reset communication parameters to data in the EPROM (1000h ... 1FFFh, CiA 301)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters		

Sub-index	03h			
Description	Only reset application parameters to data in the EPROM (6000h ... 9FFFh, CiA 406)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters		

Sub-index	04h			
Description	Only reset manufacturer-specific parameters to data in the EPROM (2000h ... 5FFFh)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters		

Sub-index	05h			
Description	Reset all parameters to factory settings			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters		

7.2.10 1014h: COB-ID Emergency message

The COB ID of the Emergency object is set with the object 1014h.

Sub-index	00h
Description	Defines the COB ID of the Emergency object (EMCY)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	80h + Node-ID
EEPROM	no

7.2.11 1017h: Producer Heartbeat Time

The 1017h object is used to set the "Heartbeat Time" cycle time for the heartbeat protocol. The cycle time is indicated in milliseconds.

Sub-index	00h
Description	Defines the cycle time of the heartbeat monitoring service
Access	rw
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	yes
Data content	0d, 10d ... 65535d (0h, Ah ... FFFFh); the numerical value corresponds to a multiple of 1 ms. Value 0h disables the service.

7.2.12 1018h: Identity Object

Object 1018h is used to specify the general identification information (e. g. Vendor ID).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	4h
EEPROM	no

Sub-index	01h
Description	The manufacturer identification number (vendor ID) for the company SIKO GmbH allocated by the CiA.
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	195h
EEPROM	no

Sub-index	02h
Description	Product Code (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	99999h
EEPROM	no

Sub-index	03h
Description	Revision Number (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Sub-index	04h
Description	Serial Number
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	variable
EEPROM	yes

7.2.13 1800h: 1. Transmit PDO Parameter

The communication parameters for TPDO1 are set via the object 1800h.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Sub-index	01h
Description	COB-ID of TPDO1
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	40000180h + Node-ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	1h (1d) ... F0h (240d)	PDO is sent after 1d ... 240d SYNC messages received.
	FEh (254d) FFh (255d)	PDO has asynchronous properties (PDO is sent depending on the "Event Timer").

Sub-index	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes

Sub-index	04h (is not used, access attempt generates error message)
Description	reserved
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	0
EEPROM	no

Sub-index	05h
Description	Event timer for TPDO2
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes
Data content	Writing the value 0h will disable the service. If the value is changed while the timer is running, the change will not be applied until the next timer operation.

7.2.14 1801h: 2. Transmit PDO Parameter

The communication parameters for TPDO2 are set via the object 1801h.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Sub-index	01h
Description	COB-ID of TPDO2
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	80000280h + Node-ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	1h (1d) ... F0h (240d)	PDO is sent after 1d ... 240d SYNC messages received.
	FEh (254d) FFh (255d)	PDO has asynchronous properties (PDO is sent depending on the "Event Timer").

Sub-index	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes

Sub-index	04h (is not used, access attempt generates error message)
Description	reserved
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	0
EEPROM	no

Sub-index	05h
Description	Event timer for TPDO2
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes
Data content	Writing the value 0h will disable the service. If the value is changed while the timer is running, the change will not be applied until the next timer operation.

7.2.15 1802h: 3. Transmit PDO Parameter

The communication parameters for TPDO3 are set via the object 1802h.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Sub-index	01h
Description	COB-ID of TPDO3
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	80000380h + Node-ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	1h (1d) ... F0h (240d)	PDO is sent after 1d ... 240d SYNC messages received.
	FEh (254d) FFh (255d)	PDO has asynchronous properties (PDO is sent depending on the "Event Timer").

Sub-index	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes

Sub-index	04h (is not used, access attempt generates error message)
Description	reserved
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	0
EEPROM	no

Sub-index	05h
Description	Event timer for TPDO3
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes
Data content	Writing the value 0h will disable the service. If the value is changed while the timer is running, the change will not be applied until the next timer operation.

7.2.16 1803h: 4. Transmit PDO Parameter

The communication parameters for TPDO4 are set via the object 1803h.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Sub-index	01h
Description	COB-ID of TPDO4
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	80000480h + Node-ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	1h (1d) ... F0h (240d)	PDO is sent after 1d ... 240d SYNC messages received.
	FEh (254d) FFh (255d)	PDO has asynchronous properties (PDO is sent depending on the "Event Timer").

Sub-index	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	yes

Sub-index	04h (is not used, access attempt generates error message)
Description	reserved
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	0
EEPROM	no

Sub-index	05h
Description	Event timer for TPDO4
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
EEPROM	no
Data content	Writing the value 0h will disable the service. If the value is changed while the timer is running, the change will not be applied until the next timer operation.

7.2.17 1A00h: 1. Transmit PDO Mapping Parameter

Object 1A00h determines the objects that will be mapped on the first transmit PDO (TPDO1).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	yes

Sub-index	01h
Description	Mapping Entry 1
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	60100010h (Slope long16 object 6010h, sub-index 00h, 16bit)
EEPROM	yes

Sub-index	02h
Description	Mapping Entry 2
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	60200010h (Slope lateral16 object 6020h, sub-index 00h, 16bit) – only with 2 axes sensor
EEPROM	yes

Sub-index	03h
Description	Mapping Entry 3
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	30000508h
EEPROM	yes

Sub-index	04h
Description	Mapping Entry 4
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	05h
Description	Mapping Entry 5
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	06h
Description	Mapping Entry 6
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	07h
Description	Mapping Entry 7
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	08h
Description	Mapping Entry 8
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

7.2.18 1A01h: 2. Transmit PDO Mapping Parameter

Object 1A01h determines the objects that will be mapped on the second transmit PDO (TPDO2).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

Sub-index	01h
Description	Mapping Entry 1
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	02h
Description	Mapping Entry 2
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	03h
Description	Mapping Entry 3
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	04h
Description	Mapping Entry 4
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	05h
Description	Mapping Entry 5
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	06h
Description	Mapping Entry 6
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	07h
Description	Mapping Entry 7
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	08h
Description	Mapping Entry 8
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

7.2.19 1A02h: 3. Transmit PDO Mapping Parameter

Object 1A02h determines the objects that will be mapped on the third transmit PDO (TPDO3).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

Sub-index	01h
Description	Mapping Entry 1
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	02h
Description	Mapping Entry 2
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	03h
Description	Mapping Entry 3
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	04h
Description	Mapping Entry 4
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	05h
Description	Mapping Entry 5
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	06h
Description	Mapping Entry 6
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	07h
Description	Mapping Entry 7
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	08h
Description	Mapping Entry 8
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

7.2.20 1A03h: 4. Transmit PDO Mapping Parameter

Object 1A03h determines the objects that will be mapped on the fourth transmit PDO (TPDO4).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

Sub-index	01h
Description	Mapping Entry 1
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	02h
Description	Mapping Entry 2
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	03h
Description	Mapping Entry 3
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	04h
Description	Mapping Entry 4
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	05h
Description	Mapping Entry 5
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	06h
Description	Mapping Entry 6
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	07h
Description	Mapping Entry 7
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

Sub-index	08h
Description	Mapping Entry 8
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0
EEPROM	yes

7.2.21 2000h: Logistic Data

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	no

Sub-index	01h
Description	Includes the serial number of the sensor
Access	ro
PDO mapping	no
Data type	Visible String
Default	-
EEPROM	no

Sub-index	02h
Description	Includes the version number of the sensor (the version number is also on the nameplate after the product name (IMS365-_ _ _ _))
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	-
EEPROM	no

Sub-index	03h						
Description	Includes the device ID of the sensor						
Access	ro						
PDO mapping	no						
Data type	Visible String						
Default	IMS365						
EEPROM	no						
Data Content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
	49h ("I")	4Dh ("M")	53h ("S")	33h ("3")	36h ("6")	35h ("5")	

7.2.22 2001h: Baud rate

The object 2001h sets the baud rate of communication.

Sub-index	00h
Description	Baud rate of the CAN bus
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	3D090h (250 kbit/s)
EEPROM	yes
Data content	1E848h: 125 kbit/s 3D090h: 250 kbit/s (default) 7A120h: 500 kbit/s C3500h: 800 kbit/s F4240h: 1000 kbit/s

7.2.23 2002h: Node ID

Object 2002h sets the node ID.

Sub-index	00h
Description	Node-ID
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	01h ... 7Eh

7.2.24 2010h: Controller Settings

Object 2003h requests controller-specific commands.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	no

Sub-index	01h
Description	Set Controller
Access	wo
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no
Data content	01h: Reset the controller

7.2.25 20FFh: Version of Layout

Object 20FFh contains the layout version of the standard SDOs currently in use.

Sub-index	00h
Description	Version of the layout
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	1h
EEPROM	no

7.2.26 3000h: Status

Object 3000h contains status information of the sensor.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	Ah
EEPROM	no

Sub-index	01h		
Description	Status Byte ST0		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	SAT_XL	1: Acceleration sensor is in saturation
	1	SAT_GY	1: Gyro sensor is in saturation
	2	-	not used
	3	-	not used
	4	I90_X_OOR	1: ±90°inclination angle is not available for X axis
	5	I90_Y_OOR	1: ±90°inclination angle is not available for Y axis
	6	R360_X_NA	1: 360° rotation angle is not available for X axis
	7	R360_Y_NA	1: 360° rotation angle is not available for Y axis

Sub-index	02h		
Description	Status Byte ST1		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	R360_Z_NA	1: 360° rotation angle is not available for Z axis.
	1	-	not used
	2	UCFG_INV	1: The configured user settings are invalid. The ex-work settings should be loaded.
	3	-	not used
	4	IFC	1: The low pass filter configuration for the acceleration values is invalid.
	5 ... 7	-	not used

Sub-index	03h		
Description	Acceleration Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_XL	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	04h		
Description	Gyro Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_GY	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	05h		
Description	Inclination Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_IX	1: External influences in the form of accelerations caused by shocks, vibrations or other movements or the current position currently prevent the determination of reliable measured values for the X axis.
	2	WARN_IY	1: External influences in the form of accelerations caused by shocks, vibrations or other movements or the current position currently prevent the determination of reliable measured values for the Y axis.
	3	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	4 ... 7	-	not used

Sub-index	06h		
Description	Euler Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_EU	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	07h		
Description	Rotation Z Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_RZ	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	08h		
Description	Temperature Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	-	not used
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	09h		
Description	Rotation X Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN RX	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7	-	not used

Sub-index	0Ah		
Description	Rotation Y Status		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	0h		
EEPROM	no		
Data content	Bit	Name	Description
	0	-	not used
	1	WARN_RY	1: External influences in the form of accelerations caused by shocks, vibrations or other movements currently prevent the determination of reliable measured values.
	2	ERR	1: There is a hardware problem that prevents the measurement of correct measured values.
	3 ... 7		not used

7.2.27 3010h: Acceleration X axis

Object 3010h contains raw values of the acceleration X axis.

Sub-index	00h
Description	Raw value of X axis (resolution is 0.25 mg; 1 g = 9.81 m/s²)
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.28 3011h: Acceleration Y axis

Object 3011h contains raw values of the acceleration Y axis.

Sub-index	00h
Description	Raw value of Y axis (resolution is 0.25 mg; 1 g = 9.81 m/s²)
Access	ro
PDO mapping	yes
Data type	Integer 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.29 3012h: Acceleration Z axis

Object 3012h contains raw values of the acceleration Z axis.

Sub-index	00h
Description	Gross value Z axis (resolution is 25 mg; 1 g = 9.81 m/s²)
Access	ro
PDO mapping	yes
Data type	Integer 32
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.30 3020h: Gyro Values X Axis

Object 3020h contains the raw value of the gyroscope X axis.

Sub-index	00h
Description	Raw value of X axis (resolution depends on the set FSR (3120h, 04h))
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.31 3021h: Gyro Value Y axis

Object 3021h contains the raw value of the gyroscope Y axis.

Sub-index	00h
Description	Raw value of Y axis (resolution depends on the set FSR (3120h, 04h))
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.32 3022h: Gyro Values Z axis

Object 3022h contains the raw value of the gyroscope Z axis.

Sub-index	00h
Description	Raw value of Z axis (resolution depends on the set FSR (3120h, 04h))
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.33 3030h: Inclination Values X axis

Sub-index	00h
Description	Raw value X-axis (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.34 3031h: Inclination Values Y axis

Sub-index	00h
Description	Raw value Y-axis (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.35 3032h: KF Inclination value X axis

Object 3032h contains the inclination value of the X-axis calculated using the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Inclination value of the X-axis calculated using the Kalman filter
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	-
EEPROM	yes

7.2.36 3033h: KF Inclination value Y axis

Object 3033h contains the inclination value of the Y-axis calculated using the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Inclination value of the Y-axis calculated using the Kalman filter
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.37 3040h: Roll Euler angle value

Sub-index	00h
Description	Roll Euler angle (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.38 3041h: Pitch Euler Angle Value

Sub-index	00h
Description	Pitch Euler angle (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... 32767

7.2.39 3042h: KF Roll Euler angle value

Object 3042h contains the value of the Euler roll angle calculated using the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Value of the Euler roll angle calculated using the Kalman filter
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.40 3043h: KF Pitch Euler angle value

Object 3043h contains the value of the Euler pitch angle calculated by the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Value of the Euler pitch angle calculated using the Kalman filter
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.41 3050h Rotation Value X axis

Sub-index	00h
Description	Rotation value X-axis (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	0h
EEPROM	no
Data content	0 ... 65535

7.2.42 3051h: Rotation value Y axis

Sub-index	00h
Description	Rotation value Y-axis (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	0h
EEPROM	no
Data content	0 ... 65535

7.2.43 3052h: Rotation value Z axis

Sub-index	00h
Description	Rotation value Z-axis (resolution is 0.01°)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	0h
EEPROM	no
Data content	0 ... 65535

7.2.44 3053h: KF Rotation value X axis

Object 3053h contains the rotation value of the X-axis calculated by the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Rotation value of the X-axis calculated by the Kalman filter
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	-
EEPROM	no

7.2.45 3054h: KF Rotation value Y axis

Object 3054h contains the rotation value of the Y-axis calculated by the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Rotation value of the Y-axis calculated by the Kalman filter
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	-
EEPROM	no

7.2.46 3055h: KF Rotation value Z axis

Object 3055h contains the rotation value of the Z-axis calculated by the Kalman filter. The resolution of the value is 0.01°.

Sub-index	00h
Description	Rotation value of the Z-axis calculated by the Kalman filter
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	-
EEPROM	no

7.2.47 3060h: Temperature value

Sub-index	00h
Description	Temperature (resolution is 0.1°C)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.48 3100h: CAN settings

Object 3100h saves the settings for CAN communication.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	no

Sub-index	01h
Description	CAN protocol (parameter changes take effect only after saving the configuration and restarting the sensor)
Access	rw
PDO mapping	yes
Data type	UNSIGNED 8
Default	2h
EEPROM	yes
Data content	1h: SAE J1939 protocol (see SAE J1939 user manual for detailed information) 2h: CANopen protocol

Sub-index	02h
Description	Automatic Bus-Off Recovery
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0h: Disabled (Automatic bus-off recovery is disabled – sensor remains in bus-off; Power-Off-On-Cycle or Reset required) 1h: Enabled (Automatic bus-off recovery is enabled – sensor automatically exits bus-off status)

7.2.49 3110h: Filter Configuration

Within the object 3110h, a type for the low-pass filter can be set or sensor fusion with the Kalman filter can be activated.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	no

Sub-index	01h
Description	Low pass filter type
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes
Data content	00h: Filter disabled 01h: Butterworth filter 8th order 02h: Critical damped filter 8th order

Sub-index	02h
Description	Sensor fusion filter (the parameter is only adjustable if the sensor supports sensor fusion)
Access	rw
PDO mapping	yes
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	00h: Low-pass filter; Angle calculation based on the low-pass filtered acceleration values 01h: Sensor fusion filter (Kalman filter); Angle calculation based on acceleration values and gyroscope values

7.2.50 3111h: Low Pass Filter Frequency

Object 3111h contains the cut-off frequency of the digital low-pass filter.

Sub-index	00h
Description	Low-pass filter frequency in MHz
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	7D0h (2000d)
EEPROM	yes
Data content	Butterworth filter enabled: 100 MHz ... 25000 MHz Critically attenuated filter: 100 MHz ... 8000 MHz

7.2.51 3112h: Kalman Filter Parameters

Object 3112h contains the parameters Q and R of the Kalman filter (sensor fusion).

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	4h
EEPROM	no

Sub-index	01h
Description	Parameter Q Mantissa
Access	rw
PDO mapping	yes
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	1 ... 127

Sub-index	02h
Description	Parameter Q Exponent
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	-10 ... 10

Sub-index	03h
Description	Parameter R Mantissa
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	1 ... 127

Sub-index	04h
Description	Parameter R Exponent
Access	rw
PDO mapping	yes
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	-10 ... 127

Sub-index	05h
Description	Global activation flag for activating or deactivating the pre-filter. The frequency of the pre-filters must be configured separately via subindex 06h and 07h.
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	00h: Pre-filters are deactivated (bypassed) 01h: Pre-filters are activated

Sub-index	06h
Description	Contains the -3dB cut-off frequency of the pre-filter for the acceleration values. The valid frequency range is between 1.0 Hz and 51.0 Hz (corresponding to the value range from 5 to 255). The pre-filter is only activated if the global activation flag (object 3112h, sub 05h for the pre-filter is activated.
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	12h
EEPROM	yes
Data content	00h: Pre-filter of the acceleration values is deactivated 01h ... 04h: Impermissible values. VALUE error is returned 05h ... FFh: -3dB cut-off frequency with a resolution of 0.2 Hz

Sub-index	07h
Description	Contains the -3dB cut-off frequency of the pre-filter for the gyroscope values. The valid frequency range is between 1.0 Hz and 51.0 Hz (corresponding to the value range from 5 to 255). The pre-filter is only activated if the global activation flag (object 3112h, sub 05h for the pre-filter is activated.
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	12h
EEPROM	yes
Data content	00h: Pre-filter of the acceleration values is deactivated 01h ... 04h: Impermissible values. VALUE error is returned 05h ... FFh: -3dB cut-off frequency with a resolution of 0.2 Hz

7.2.52 3120h: Sensor Configuration

Object 3120h contains the configuration of the sensor.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	4h
EEPROM	no

Sub-index	01h
Description	Defines the sensor's range of values
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	Depends on the preselected function
EEPROM	yes
Data content	00h: 1-axis sensor (0 ... 360°) 01h: 2-axis sensor (±90°)

Sub-index	02h
Description	reserved
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	-
EEPROM	-
Data content	-

Sub-index	03h
Description	The object is used to rotate the coordinate system. The object corresponds to the RED field of the CS_ROT parameter (chapter 5.5)
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	00h
EEPROM	yes
Data content	00h: Z axis points down 01h: Z axis points up 02h: Y axis points up 03h: Y axis points down 04h: X axis points down 05h: X axis points up

Sub-index	04h		
Description	The object contains the gyro measurement range. The object corresponds to the GFSR parameter.		
Access	ro		
PDO mapping	yes		
Data type	UNSIGNED 8		
Default	3h		
EEPROM	yes		
Data content	Bit	Measuring range	Resolution
	0	±125 dps	4.375 mdps
	1	±250 dps	8.75 mdps
	2	±500 dps	17.5 mdps
	3	±1000 dps	35 mdps
	4	±2000 dps	70 mdps
	5	±4000 dps	140 mdps

7.2.53 3130h: Inclination offset value X axis (Inclination X axis)

Object 3130h specifies the inclination value for the zero point adjustment of the longitudinal inclination.

Access to this object via SDO directly sets the zero point of the longitudinal inclination. The calculated application offset triggered by the automatic zero offset of the lateral slope is specified in this object.

If the zero value is not equal to 0, the inclination value long16 (6010h) is shifted by this zero point value.

Sub-index	00h
Description	Inclination offset value X axis (the value must be specified in angular degrees with the resolution specified in the object 6000h)
Access	rw
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes
Data content	-32768 ... 32767

7.2.54 3131h: Inclination offset value Y axis (Inclination Y axis)

Object 3131h specifies the inclination value for the zero point correction of the lateral slope (only available for the 2-axis version).

Access to this object via SDO directly sets the zero point of the lateral slope. The calculated application offset triggered by the automatic zero offset of the lateral slope is specified in this object.

If the zero value is not equal to 0, the slope value long16 (6020h) is shifted by this zero point value.

Sub-index	00h
Description	Inclination offset value Y axis (the value must be specified in angular degrees with the resolution specified in the object 6000h)
Access	rw
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes
Data content	-32768 ... 32767

7.2.55 3132h: Rotation offset value X axis

Object 3132h specifies the value for the zero point adjustment of the rotation of the X axis.

To reduce influences of the mechanical sensor installation, the zero position of the sensor can be set. The specified value is subtracted from the actual measured value.

Zero-point adjustment of the rotation axis of 1-axis sensors is possible with ZERO. This parameter has no significance for 2-axis sensors.

Sub-index	00h
Description	Rotation offset value of X axis (resolution is 0.01°)
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0 ... 65535

7.2.56 3133h: Rotation offset value Y axis

Object 3133h specifies the value for the zero point adjustment of the rotation of the Y axis.

Sub-index	00h
Description	Rotation offset value of Y axis (resolution is 0.01°)
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0 ... 65535

7.2.57 3134h: Rotation offset value Z axis

Object 3133h specifies the value for the zero point adjustment of the rotation of the Z axis.

Sub-index	00h
Description	Rotation offset value of Z axis (resolution is 0.01°)
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0 ... 65535

7.2.58 3135h: KF Inclination offset value X axis

Object 3135h specifies the inclination value, calculated by the Kalman filter, for the zero point adjustment of the longitudinal inclination.

If the zero point value is not equal to 0, the inclination value (3032h) is shifted by this zero point value.

Sub-index	00h
Description	KF Inclination offset value X axis (the value must be specified in angular degrees with the resolution specified in data object 6000h)
Access	rw
PDO mapping	nein
Data type	INTEGER 16
Default	0h
EEPROM	ja
Data content	-32768 ... 32767

7.2.59 3136h: KF Inclination offset value Y axis

Object 3136h specifies the tilt value, calculated by the Kalman filter, for the zero point adjustment of the lateral tilt.

If the zero point value is not equal to 0, the tilt value (3033h) is shifted by this zero point value.

Sub-index	00h
Description	KF Inclination offset value Y axis (the value must be specified in angular degrees with the resolution specified in data object 6000h)
Access	rw
PDO mapping	nein
Data type	INTEGER 16
Default	0h
EEPROM	ja
Data content	-32768 ... 32767

7.2.60 3137h: KF Rotation offset value X axis

Object 3137h specifies the value for the zero point adjustment of the rotation of the X-axis, calculated by the Kalman filter.

The specified value is subtracted from the actual measured value.

Sub-index	00h
Description	KF Rotation offset value X axis (the value must be specified in angular degrees with the resolution specified in data object 6000h)
Access	rw
PDO mapping	nein
Data type	UNSIGNED 16
Default	0h
EEPROM	ja
Data content	0 ... 65535

7.2.61 3138h: KF Rotation offset value Y axis

Object 3138h specifies the value for the zero point adjustment of the rotation of the Y-axis, calculated by the Kalman filter.

The specified value is subtracted from the actual measured value.

Sub-index	00h
Description	KF Rotation offset value Y axis (the value must be specified in angular degrees with the resolution specified in data object 6000h)
Access	rw
PDO mapping	nein
Data type	UNSIGNED 16
Default	0h
EEPROM	ja
Data content	0 ... 65535

7.2.62 3139h: KF Rotation offset value Z axis

Object 3139h specifies the value for the zero point adjustment of the rotation of the Z-axis, calculated by the Kalman filter.

The specified value is subtracted from the actual measured value.

Sub-index	00h
Description	KF Rotation offset value Z axis (the value must be specified in angular degrees with the resolution specified in data object 6000h)
Access	rw
PDO mapping	nein
Data type	UNSIGNED 16
Default	0h
EEPROM	ja
Data content	0 ... 65535

7.2.63 3200h: Auto Zero

Object 3200h sets the zero point of the specified axis(s) to the current position by writing a valid value to this object.

Sub-index	00h
Description	Indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	no

Sub-index	01h
Description	reserved
Access	-
PDO mapping	-
Data type	-
Default	-
EEPROM	-

Sub-index	02h					
Description	Executes the command to set the zero point of the specified axis(es) to the current position by writing a valid value in this object.					
Access	wo					
PDO mapping	no					
Data type	UNSIGNED 8					
Default	0h					
EEPROM	no					
Data content	Bit	0	1	2	3	4
	Axis	INCL_X	INCL_Y	ROT_X	ROT_Y	ROT_Z

Sub-index	03h
Description	Used to automatically adjust the rotation of the sensor coordinate system according to the current installation situation. The sensor attempts to detect the mounting position and automatically selects one of six options. If the sensor axes are not sufficiently aligned with the Earth's gravitational vector, the current alignment cannot be determined automatically. The command then returns an error.
Access	wo
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

7.2.64 6000h: Resolution

Object 6000h indicates the resolution of objects such as Slope Long16 (6010h) and Slope Lateral16 (6020h).

Sub-index	00h
Description	The resolution is set fixed at 0.01°.
Access	const
PDO mapping	no
Data type	UNSIGNED 16
Default	10
EEPROM	no

7.2.65 6010h: Slope Longitudinal (Inclination X Axis)

Object 6010h returns the 16-bit slope value of the longitudinal axis (Z axis only accessible for 1-axis version).

Sub-index	00h
Description	Slope long16 (the value is given in angular degrees with the resolution specified in the object 6000h)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.66 6011h: Slope Long Operating Parameter (Inclination X Axis)

Object 6011h specifies the interpretation of the slope Long16 value (Z axis only accessible for 1-axis version). When scaling is deactivated, the slope Long16 value corresponds to the physically measured angle. Scaling is always deactivated (value 0); the slope Long16 value corresponds to the physically measured angle.

Sub-index	00h
Description	Slope long16 Operating Parameter
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

7.2.67 6020h: Slope Lateral (Inclination Y Axis)

Object 6020h returns the 16-bit tilt value of the lateral axis (only accessible for 2- axis version).

Sub-index	00h
Description	Slope lateral16 (the value is given in angular degrees with the resolution specified in object 6000h)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	-
EEPROM	no

7.2.68 6021h: Slope Lateral16 Operating Parameter (Inclination Y Axis)

Object 6021h specifies the interpretation of the slope Lateral16 value (only accessible for of 2-axis version).

Scaling is always deactivated (value is 0). The slope Lateral16 value corresponds to the physically measured angle.

Sub-index	00h
Description	Slope lateral16 Operating Parameter
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

7.2.69 6511h: Device Temperature

Object 6511h provides the temperature of the inclination sensor. The temperature value is not calibrated. An absolute temperature measurement or the use of the value for further control is not recommended.

Sub-index	00h
Description	Device temperature with a resolution of 1°C
Access	ro
PDO mapping	INTEGER 8
Default	-
EEPROM	no

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