Baumer

Passion for Sensors

Manual

Cable transducers GCAxx with CANopen® interface

Inclination sensor integrated (option)

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Subject to modification in technic and design
Errors and omissions excepted

Contents

1 Document history

This document is subject to changes. In order to have the most current version please download on www.baumer.com

Document index	Date	Firmware version	CANopen Revision Number Obj. 1018	Author	Changes
0000 (Rev11)	-	From V01-23	0000.0000h	zazg	- Updated references to eds files Version replacing all previous documents
0001	24.09.2020	From V01-23	0000.0000h	mis / gua	- Introduce firmware version and CANopen revision number in this table - Adapted manual filename name and EDS file name - Errata / language / format corrections - Set the parameters in the object list with the “SAVE” attribute, paragraph 11.
0002	09.02.2021	From V01-23	0000.0000h	zazg	- Changed the linear position and angular position information.
0003	22.03.2021	From V01-23	0000.0000h	mis / gua	- Updated the product assignment, paragraph 3 - Updated Node IDs with default address for CANopen redundant version, paragraph 10 - Updated OBJ 0x3001 description, paragraph 11.2 (Manufacturer specific profile area) - Insert note for products with CANopen redundant, paragraph 11.2 (Manufacturer specific profile area) - Insert note for products with CANopen redundant and inclination sensor integrated, paragraph 11.3 (Standardized device profile area)
0004	29.10.2021	From V01-23	0000.0000h	zazg	- Updated in the manual obj. 1018.02 in the object dictionary
0005	19.04.2024	From V4.7	0000.0000h	bson	- Updated company name - Updated references to eds files - Changed Device Type and Product Code - Updated functional principle diagram - Added chapter 7.4.1 PDO mapping procedure and chapter 4.5 Redundant or full redundant design - Updated Emergency messages - Added objects referring to redundant version - Added objects 0x2116 related to 16-bit speed, 0x2111 related to 16-bit length, 0x2117 and 0x6503 related to alarms, 0x6E11 and 0x7511 related to device temperatures, 0x1029 related to error behavior and 0x2101-03 and 0x2101-04 related to custom presets - Removed chapter on terminal assignments

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At any time we should be pleased receiving your comments and proposals for further improvement of the present manual.

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2 Safety and operating instructions

Intended purpose of the equipment

- The cable transducer is a precision measuring device that is used to determine linear and angular positions It provides measuring values as electronic output signals for the subsequently connected device. The sensor must not be used for any other purpose.
- Unless this product is specially labeled, it may not be used for operation in potentially explosive environments.
- Make sure by appropriate safety measures, that in case of error or failure of the sensor, no danger to persons or damage to the system or operating facilities occurs.

Personnel qualification

- Installation and assembly of this product may be performed only by a person qualified in electronics and precision mechanics.
- Consider also the operation manual of the machine manufacturer.

Maintenance

- The sensor is maintenance-free and must not be opened up nor mechanically or electronically modified. Opening up the sensor can lead to injury.

Safety remarks

- Prior to commissioning the equipment, check all electrical connections.
- If installation, electrical connection or any other work performed at the sensor or at the equipment is not correctly executed, this can result in a malfunction or failure of the sensor.
- Steps must be taken to exclude any risk of personal injury, damage to the plant or to the operating equipment as a result of sensor failure or malfunction by providing suitable safety precautions.
- Sensor must not be operated outside the specified limited values (see detailed product documentation).

Failure to comply with the safety remarks can result in malfunctions, personal injury or damage to property.

Transport, storage and disposal

- Only ever transport or store sensors in their original packaging.
- Never drop sensors or expose them to major vibrations.
- The sensor contains electronic components. At its disposal, local environmental guidelines must be followed.

Assembly

- Avoid impacts or shocks on the housing.
- Avoid any twist or torsion on the housing.
- Do not open the sensor or make any mechanical changes to it.

The sensor housing or electronic components can be damaged. In this case, safe and reliable operation cannot be guaranteed.

Electrical commissioning

- Do not modify the sensor electrically and remove power supply while connecting it electrically.
- The electrical connection must not be attached or removed under power supply.
- Ensure that the entire plant is installed in line with EMC requirements. The installation environment and wiring affect the electromagnetic compatibility of the sensor.
- Install the sensor and supply cables separately or at a long distance from cables with high interference emissions (frequency converters, contactors etc.)
- Where working with consumers which have high interference emissions, make available a separate power supply for the sensor.
- Unused outputs must not be connected.

Failure to observe these instructions can result in malfunctions, material damage or personal injury.

Supplementary information

- This manual is intended as a supplement to already existing documentation (catalogues, data sheets and assembly instructions).
- The manual must be read without fail before initial commissioning of the equipment.

3 Product assignment

3.1 Cable transducer

Product	Product Code	Device Name	EDS File
GCA3-5			
Cable transducer GCA3-5-PM	0x0521	GCA3-5	GCA3-5_0x0521_V00.02.eds
Cable transducer GCA3-5-PM redundant (2-sensing design)	0x0520	GCA3-5	GCA3-5_0x0520_V00.02.eds
Cable transducer GCA3-5-PM with integrated inclinometer	0x0523	GCA3-5	GCA3-5_0x0523_V00.02.eds
Cable transducer GCA3-5-PM redundant (2-sensing design with integrated inclinometer)	0x0522	GCA3-5	GCA3-5_0x0522_V00.02.eds
GCA8-12-20			
Cable transducer GCA8-12-20-PP	0x0521	GCA8-12-20	GCA8-12-20_0x0521_V00.02.eds
Cable transducer GCA8-12-20-PP redundant (2-sensing design)	0x0520	GCA8-12-20	GCA8-12-20_0x0520_V00.02.eds
Cable transducer GCA8-12-20-PP with integrated inclinometer	0x0523	GCA8-12-20	GCA8-12-20_0x0523_V00.02.eds
Cable transducer GCA8-12-20-PP redundant (2-sensing design with integrated inclinometer)	0x0522	GCA8-12-20	GCA8-12-20_0x0522_V00.02.eds

4 System Overview

4.1 General

The cable transducer is a linear measuring system with a CANopen interface. It supports scaling and presetting.
In consideration of encoder device profile CiA 406, it behaves like an absolute linear encoder - class C2 (exception diagnostic part). It has also implemented the inclinometer device profile CiA 410 from users organization “CAN in Automation” (CiA).

4.2 Supported profiles

Following CANopen profiles are supported:

- CiA 301 / Version 4.2.0 (Communication profile)
- CiA 305 / Version 3.0.0 (LSS Layer Setting Services)
- CiA 406 / Version 4.0.2 (Encoder device profile)
- CiA 410 / Version 2.0.0 (Inclinometer device profile)

4.3 Supported CANopen services

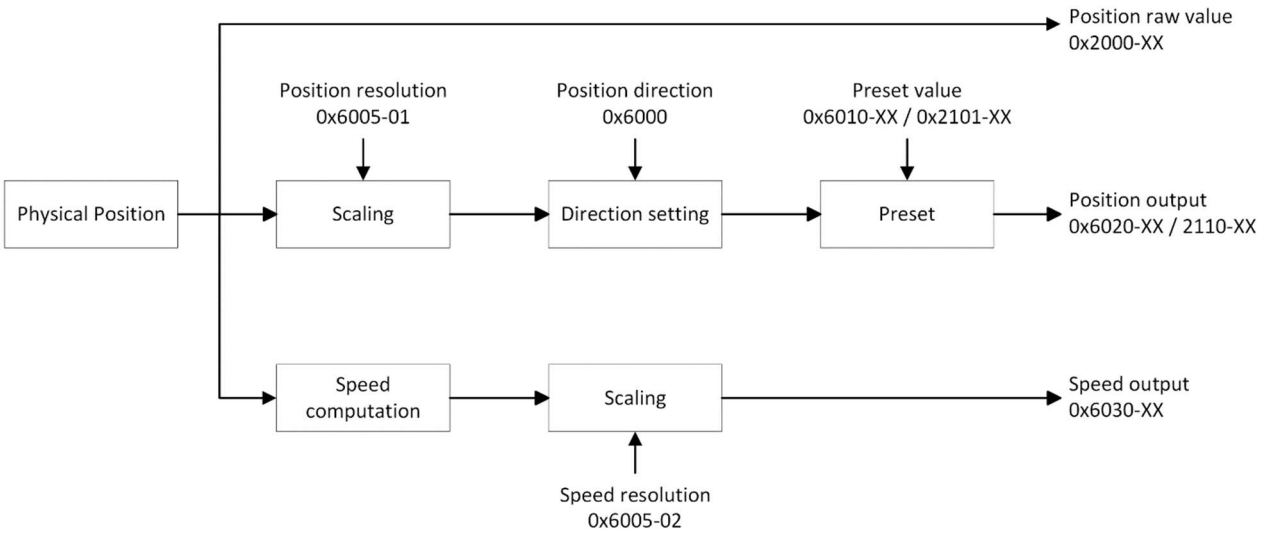
Following CANopen services are supported:

- 1 Network Management (according to CiA 301)
- 1 SDO Server (according to CiA 301)
- 2 TPDOs (according to CiA 301/CiA 406/ CiA 410)
- 1 Emergency Producer (according to CiA 301/CiA 406/ CiA 410)
- 1 Heartbeat Producer (according to CiA 301)
- 1 LSS Client (according to CiA 305)

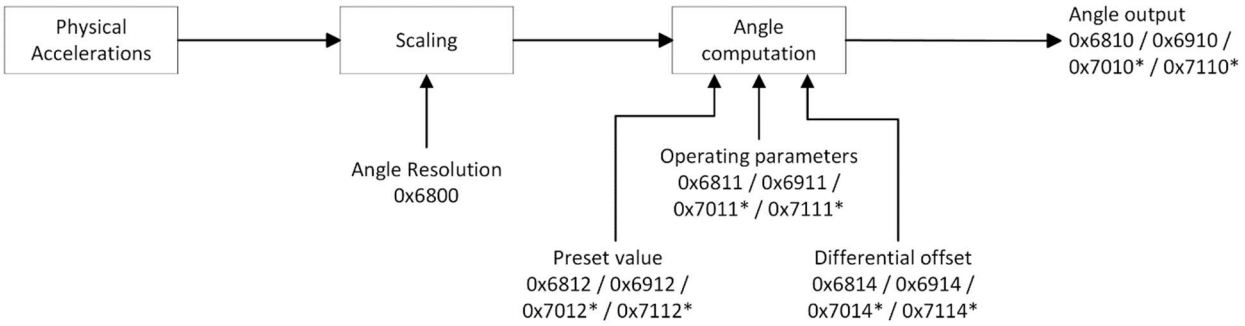
4.4 Function principle

4.4.1 Overview

Length measurement:



Angle measurement:
(Only for sensors that integrate the inclination sensor)



* For redundant version only (2-sensing)

4.4.2 Scaling

The object 6005 indicates the measuring step settings for position and speed.
The value of position step setting (sub-index 01h) is given in multiples of 0,001 µm.
The value of speed step setting (sub-index 02h) is be given in multiples of 0,01 mm/s.

Example 1: A position step setting of 1'000'000 nm/step means that the position output unit is 1mm.

4.5 Redundant or full redundant design

In a sensor with full redundant design (2-channel), there are two separate nodes with two different node IDs connected with the same connector to the network. This means that each node has its own objects that can be read by addressing the correct node ID.

In a sensor with redundant design (2-sensing), there are two primary sensors that are read by a single node with a single node ID connected to the network. The values of each primary sensor read by the node are written to separate objects.

5 NMT Service

5.1 Supported commands

Following NMT commands are supported:

NMT Command	Code	Description
Start	0x01	Switch to the "Operational" state
Preoperational	0x80	Switch to the "Stop" state
Stop	0x02	Switch to the "Pre-Operational" state
Reset	0x81	Reset node
Communication Reset	0x82	Reset communication

NMT Frame:

COB-ID	DLC	Byte 0	Byte 1
		NMT Command	Node-ID
0x000	2	0xXX	0xYY

Examples:

NMT Command: Preoperational
Node-ID: all nodes (broadcast)

COB-ID	DLC	Byte 0	Byte 1
		NMT Command	Node-ID
0x000	2	0x80	0x00

NMT Command: Reset
Node-ID: 5

COB-ID	DLC	Byte 0	Byte 1
		NMT Command	Node-ID
0x000	2	0x81	0x05

5.2 Boot up message

Send NMT message to initialize the sensor

COB-ID	Len	D0	D1
0x000	2	0x01	ID

Note: ID can be 0 for broadcast initialization

After a power-on or NMT reset, the device will send a Boot up message.

COB ID	Byte 0
700h + node ID	00

6 SDO service / service data

6.1 General

The sensor supports 1 SDO server (Expedited read/write, segmented read).

6.2 Save/load parameters

The sensor supports saving parameters to a non-volatile memory.

6.2.1 Save

Object 1010h-1, save all parameters

Writing “save” to 1010h-1 saves the corresponding objects to the non-volatile memory.
The device must not reset or turned off before the object 1010h-1 has responded (see par. 6.2.3).
After a reset or power-on, the parameters are loaded from the non-volatile memory.

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0x600 + Node-ID	8	0x23	0x10	0x10	0x01	0x73	0x61	0x76	0x65
						s	*a*	*v*	*e*

6.2.2 Load

Object 1011h-1, load all parameters

Writing “load” to 1011h-1 restores the corresponding objects.
The device must not reset or turned off before the object 1011h-1 has responded (see par. 6.2.3).
The parameters are restored after a reset or power-on.

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0x600 + Node-ID	8	0x23	0x11	0x10	0x01	0x6C	0x6F	0x61	0x64
						l	*o*	*a*	*d*

6.2.3 Safe non-volatile operation

To ensure safe non-volatile operation, the user must ensure no power interruption immediately after sending of the save command to object 1010h-x (otherwise, the factory values are restored at the next power up).
The time between access object 1010h-1 or 1011h-1 and a reset or power-off has to be at least 600 ms.

6.2.4 Side effect

Save/Load operations interrupt the updating of position.

6.3 Examples writing parameters

6.3.1 How to change the node ID

Object 3001h, node-id settings.

Send the SDO message

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x2F	0x01	0x30	0x00	ID	0x00	0x00	0x00

ID: values below 1 or above 127 are not accepted and the existing setting remains valid.

After setting the new entries a SAVE command (see par. “6.2 Save/load parameters”) followed by a reset or power-on is necessary to adopt the new value.

6.3.2 How to change the baud rate

Object 3000h, baud rate settings.

Send the SDO message

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x2F	0x00	0x30	0x00	BR	0x00	0x00	0x00

BR: values above 7 are not accepted and the existing setting remains valid.
After setting the new entries a SAVE command (see par. “6.2 Save/load parameters”) followed by a reset or power-on is necessary to adopt the new value.

6.3.3 How to change the length direction

There are 2 ways for changing direction.

6.3.3.1 First method (CiA 406)

Object 6000h, operating parameters.

Send the SDO message.

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x2B	0x00	0x60	0x00	PAR	0x00	0x00	0x00

Where PAR is the parameter setting as follows

PAR	MEANING
0x00	Positive direction (length increase pulling the cable), length expressed in unit of 0.1 mm
0x01	Negative direction (length decrease pulling the cable), length expressed in unit of 0.1 mm
0x04	Positive direction (length increase pulling the cable), resolution depends on object 0x6005
0x05	Negative direction (length decrease pulling the cable), resolution depends on object 0x6005

6.3.3.2 Second method

Object 2102h-1, length direction.

Send the SDO message

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x2F	0x02	0x21	0x01	DIR	0x00	0x00	0x00

Where DIR is the direction: 0 = positive (0 to FS), 1 = negative (0 to –FS)
If it is necessary to set negative direction (FS to 0), the object 2119.0 must be set to 0.

6.3.4 How to change the length resolution

Object 6005h-1, Length position setting.

Set the parameters as explained in previous paragraph, then send the SDO message.

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x23	0x05	0x60	0x01	R0	R1	R2	R3

Where R0...R3 represents the unit of measure of the output length, expressed in nm (Nanometer).
For example, to obtain a resolution of 1 mm:
R0 = 0x40, R1 = 0x42, R2 = 0x0F, R3 = 0x00
It means R = 0x000F4240 (1’000’000 decimal) = 1’000’000nm = 1 mm.

I.e: if it’s necessary to have the measure expressed in 10 mm, the value to write must be 10’000’000 nm, to obtain instead a resolution of 0.1 mm, the value to write will be 100’000 nm

Note: it's necessary to be sure that in the object 6000h the value present is 4 or 5.

6.3.5 How to set the Preset

Object 6010h-1, preset value encoder (Channel 1).

Send the SDO message to set the desired value:

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x23	0x10	0x60	0x01	R0	R1	R2	R3

Where R0...R3 represent the desired output length, expressed in according with the resolution.
For example, if the resolution is 1 mm and the desired value in that position is 300 mm:
R0 = 0x2C, R1 = 0x01, R2 = 0x00, R3 = 0x00
It means R = 0x0000012C (300 decimal).
if the resolution is 0.1 mm and the desired value in that position is 300 mm:
R0 = 0xB8, R1 = 0x0B, R2 = 0x00, R3 = 0x00
It means R = 0x00000BB8 (3000 decimal).

For the Zero it's only necessary to set R = 0x00000000 (0 decimal)

6.3.6 How to change the angle resolution

This object shall indicate the resolution of the inclinometer of Slope long16 (object 6810h) based on 0.001°.

This resolution is also valid for the 32-bit value object (6910h). In case of low resolution, the value is 10d. In case of high resolution the value is 1d. The following table describes all possible resolutions:

Resolution (6800h/7000h)	
Value	**Description**
01h (1d)	0.001°
Ah (10d)	0.01°
64h (100d)	0.1°
3E8h (1000d)	1°

6.3.7 Operating parameters

Object 6811h/6911h, operating parameters.

The above mentioned operating parameter influences the output inclination in the following manner:
Bit Mask:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved						s	i
Default	-						1	0

i = Inversion (0 = Do not enable inversion; 1 = Enable inversion)
s = Scaling (0 = Do not enable scaling; 1 = Enable scaling)

Scaling means that the following equation is applied:

Inclination = A + B + C

Where

A is a physically measured angle;
B is a differential slope offset;
C is a slope offset.

The operating parameters are applied for the according slope (i.e. 6811h operating parameter influences 6810h slope).

The 16-bit and 32-bit values are hardwired internally (i.e. changing the operating parameter at 6811h changes the operating parameter at 6911h).

6.3.8 Offset parameters and calculation

This object shall indicate the application offset of the longitudinal axis. The value shall be given in angular degrees with the resolution given in object 6000h. The following formula applied:

Slope offset = A –B –C

Where

A is a slope preset value at t_{acc};
B is a slope physical measured at t_{acc};
C is a differential slope offset and t_{acc} = time when accessing object a preset object

The 16-bit and 32-bit values are hardwired internally (i.e. changing the differential offset at 6814h changes the differential offset at 6914h)

i.e.: Send the SDO message to set the angle zero:

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x600 + ID	8	0x2B	0x12	0x68	0x00	0x00	0x00	0x00	0x00

6.3.9 Digital low pass filter configuration for angle and length

Object 2603h, Angle filter strength.
Object 2103h, Length filter strength.

Angle filter:

The digital Angle filter's cut-off frequency can be adjusted through the object 2603h.

The IIR coefficient is expressed in tenths of hertz. E.g.: Fc = 3 Hz -> 30d (0x1E).
The value can be selected in a range from 0 to 300 (30Hz), where the value 0 disables the filter.

The default coefficient is 30 (3.0Hz).

Length filter:

The Length Filter can be adjusted through the object 2103h.
The IIR coefficient is expressed in %.
The value can be selected in a range from 0 to 100

The default coefficient is 20.

7 PDO service / process data

7.1 General

By default only TPDO1 and TPDO2 in case of inclination sensor integrated are enabled. PDOs are only transmitted in operational mode.

7.2 PDO transmission types

The following transmission types are supported (object 180x-2):

- Synchronous transmission (1-240)
- Asynchronous transmission (255)
- Manufacturer transmission (254)

Both PDOs support all transmission types.

Transmission type 255 and 254: The PDO is transmitted timer driven. The time interval between 2 PDOs can be adapted in the object 180xh-5

Transmission type 1-240: The PDO is transmitted after the n-th sync frame.

Transmission type 1: The PDO is transmitted after one sync frame.

Transmission type 2: The PDO is transmitted after two sync frames.

etc.

7.3 COB-ID

The COB-ID for both PDOs is changeable (in Object 180xh-1)
The format of the TPDO is:

TPDO1

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x180 + ID	8	P0	P1	P2	P3	0	0	0	0

where P is the actual position value in 0.1 mm or other scale (depending on the resolution settings).

Interpretation example
Considering a resolution of 0.1 mm:
P0 = 0x10, P1 = 0x27, P2 = P3 = 0
It means P = 0x00002710 (10’000 decimal) = 1’000 mm

TPDO2 (enabled in case of inclination sensor integrated)

COB-ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
0x280 + ID	8	R0a	R1a	0	0	0	0	0	0

where R is the actual rotation value in degrees or tenths of degrees (depending on the resolution settings).

Interpretation example
Considering a resolution of 0.1°:
P0 = 0x84, P1 = 0x03
It means P = 0x00000384 (900 decimal) = 90°.

7.4 PDO mapping

The sensor supports dynamic mapping.

7.4.1 PDO mapping procedure

PDO mapping entries can only be changed using the defined mapping procedure:

1. Set PDO invalid by switching Bit 31 in the related COB-ID entry

Object 180X.1h(1) bit 31 =1

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0xn80+Node-ID	8	0x23	0x0X(1)	0x18	0x01	0x00	0x00	0x00	0x80

2. Set PDO mapping invalid by writting 00h to sub-index 00h of the related mapping entries.

Object 1A0X.0h(1)

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0xn80+Node-ID	8	0x2F	0x0X(1)	0x1A	0x00	0x00	0x00	0x00	0x00

3. Adjust the desired PDO mapping.

Object 1A0X.0h(1)

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0xn80+Node-ID	8	0x23	0x0X(1)	0x1A	OBJ_NBR(2)	SIZE(4)	SUB	OBJLSB	OBJMSB

4. Set sub-index 00h of the related mapping index to number of mapped objects.

Object 1A0X.0h(1)

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0xn80+Node-ID	8	0x2F	0x0X(1)	0x1A	0x00	TOT_NBR(3)	0x00	0x00	0x00

5. Switch PDO valid by means of Bit 31 in the related COB-ID entry

Object 180X.1h(1) bit 31 =0

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Command	Object LSB	Object MSB	Subindex	Data 0	Data 1	Data 2	Data 3
0xn80+Node-ID	8	0x23	0x0X(1)	0x18	0x01	0x80 + Node-ID	n	0x00	0x40

(1) Where X is:
- 0 for PDO1
- 1 for PDO2
- 2 for PDO3
- 3 for PDO4

(2) Where OBJ_NBR increase starting from 1 to maximum 8 every obj associated mapped

(3) Where TOT_NBR is the Total number of mapped object

(4) Where SIZE is:
- 8h for 1 byte obj.
- 10h for 2 byte obj.
- 20h for 4 byte obj.

7.4.2 Mappable objects

The mappable objects are listed in chapter 11 Object directory and identified with the “m” (mappable) symbol in the Access column.
Follow the procedure defined in chapter 7.4.115 PDO mapping procedure to change the mapping entries.

7.4.3 Default mapping of absolute encoder redundant with cable-pull

The mappings for both PDOs are the same. The position will be transmitted in byte 0...3.

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
184h	8	xx	xx	xx	xx	00	00	00	00

Byte 0…3: Length (Object 6020h-1)

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
284h	8	xx	xx	xx	xx	00	00	00	00

Byte 0...3: Angle (Object 6910h-0)

7.5 Timing

The minimal cycle time for TPDOs is 50 msec

7.6 Exceptions of accurate calculation of process data

The following operations could interrupt the accurate calculation of process data such as position, speed, warnings and alarms:

- Non-volatile operations
- Changing the scaling parameters

8 EMCY service / emergency

8.1 General

If there is an error on the device, the device commits an emergency message and sets the corresponding bits in the error register (Object 1001h).
Error codes are accessible by the error field (object 1003h-x). A history of maximal 8 error codes is stored in the error field.

8.2 COB-ID

The COB-ID for the emergency message can be modified in object 1014h.
Default Value: 80h + node ID
Changes will be applied immediately.

The COB-ID is stored internally as a difference to the default COB-ID. Example:
Node ID: 4 COB-ID Emergency: 84h (Default value)
COB-ID Emergency: 87h (Changed by user)
Node ID: 9 COB-ID Emergency: 89h (Adapted automatic)

8.3 Emergency message

The emergency message is transmitted if an error is indicated in the error register.

COB-ID	DLC	Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
80h+node ID	8	Error code		Error register (object 1001h)	-	-	-	-	-

8.4 Error register

Error register (object 1001h)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Manufacturer error	-	-	Communication error				Generic error

8.4.1 Communication error

Communication errors are indicated if the internal CAN message buffers are overflowed or there are malformed CAN frames on the bus. After a communication error the device changes to pre-operational mode.

8.4.2 Generic error

A generic error is indicated for all other errors.
An encoder specific alarm or warning will also cause a generic error.
After a generic error the device changes to pre-operational mode.

8.5 Error codes / EMCY messages

The following error codes are generated by the device:

Error Code	Meaning
0x0000000000000000	Error reset or no error
0x0010010000000000	Generic error
0x1081110000000000	CAN RX overflow
0x1082110000000000	PDO not processed due to length error
0x00FF810100000000	Wire break
0x00FF810200000000	Length sensor break
0x00FF810300000000	Inclinometer break

8.6 Sensor Diagnostics

In case of sensor failure, the object 0x6503 provides information about the failure. It is a bit field of 16 bits where each bit indicates the fault detected. If an fault occurs, the value provided by the sensor is no longer valid (the output value remains fixed at the last valid value) and the according bit indicates the error. When the fault ceases and the sensor is able to provide an accurate position value, the error is cleared.

Bit	Description	Meaning
0	Position error	Position error occurred (wire break or over stroke or communication error)
1	-	Not used
2	-	Reserved
3	-	Reserved
4	-	Reserved
5	-	Reserved
6	-	Reserved
7	-	Reserved
8	-	Reserved
9	-	Reserved
10	-	Reserved
11	-	Reserved
12	Wire break error	Set when wire break or over stroke error occurred
13	Length sensor error	Set when communication with the length sensor fails
14	Accelerometer sensor error	Set when communication with the accelerometer sensor fails
15	-	Not used

8.7 Error behavior

The object 1029 indicates which state the sensor should be set to if it is in the NMT state Operational and a communication error or severe internal errors are detected. In particular, the behavior is defined by:

- 0x1029-01: in case of communication error
- 0x1029-02: in case of internal error related to length measurement
- 0x1029-03: in case of internal error related to angle measurement (only for products with integrated inclinometer)

The following table indicates the values that can be set in the sub-index of the object.

Value	Description
0x00	Change to NMT state Pre-operational (only if currently in NMT state Operational)
0x01	No change of the NMT state
0x02	Change to NMT state Stopped

9 Heartbeat service

9.1 General

The sensor supports a heartbeat producer according CiA 305.
Example for a heartbeat protocol:

COB-ID	Data/Remote	Byte 0
704h	D	7Fh(127d)

The heartbeat messages consist of the COB ID and one byte. In this byte, the NMT status is supplied.

0: BootUp-Event
4: Stopped
5: Operational
127: Pre-operational

In other words, the sensor is in the pre-operational mode (7Fh = 127).

9.2 COB-ID

The COB-ID for the heartbeat message is 700h + node ID.

9.3 Timing

The minimal cycle time for heartbeat messages is 10 msec.

10 LSS Layer setting services

In spring 2000, CiA drafted a new protocol intended to ensure standardized procedures, as described under Layer Setting Services and Protocol, CiA Draft Standard Proposal 305 (LSS).

The sensor is supplied by default with single node-ID (default factory setting node-ID 4) for version CANopen, and with double node-ID (default factory setting node-ID 4 and node-ID 5) for version CANopen full redundant. Default factory setting for both versions is 250 kBaud.

Using LSS, several sensors with the same node ID can be connected to the bus system. To allow individual sensors to be addressed, LSS is used.

Each sensor has its own unique serial number and is addressed using this serial number. In other words, an optional number of sensors with the same node ID can be connected to one bus system, and then initialized via LSS. Both the node ID and also the baud rate can be reset. LSS can be executed only in **Stopped Mode**.

10.1 LSS addressing

The baud rate and node ID can be configured by LSS (according to CiA 305). Another possibility to change the baud rate and node ID is to access to the objects 0x3000 and 0x3001 (see object directory).
The LSS service is only available in NMT Stopped Mode.

10.2 Supported LSS commands

- Switch state global
- Switch state selective
- Configure node ID protocol
- Configure bit timing parameters
- Store configuration
- Inquire identity serial number
- Inquire identity node ID

Message structure

COB ID:

Consumer -> Producer: 2021 = 7E5h
Consumer <- Producer: 2020 = 7E4h
After the COB ID, an LSS command specifier is transmitted.
This is followed by up to seven attached data bytes.

COB ID	cs	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

Switch mode global

7E5h ->	04h	Mode	reserved

Mode : 0 -> Operation mode
1 -> Configuration mode

Selective switch mode
The following procedure can be used to address a certain sensor in the bus system.

7E5h ->	40h	Vendor ID	reserved

7E5h ->	41h	Product code	reserved

7E5h ->	42h	Revision number	reserved

7E5h ->	43h	Serial number	reserved

7E5h ->	44h	Mode	reserved

Vendor ID : 0x005F – GCA series products
Product code : Internal product code for the respective sensor
Revision number : Current revision number of the sensor
Serial number : Unique, consecutive serial number
Mode : The sensor's response is the new mode (0=operating mode; 1=configuration mode)

Setting the node ID

7E5h->	11h	Node ID	reserved

7E4h<-	11h	ErrCode	Spec error	reserved

Node ID : The inclination sensor's new node ID
Error code : 0=OK; 1=Node ID outside range; 2...254=reserved; 255->Specific error
Specific error : If Error code=255->application-specific error code.

Setting the bit timing

7E5h ->	13h	tableSel	tableInd	reserved

7E4h<-	13h	ErrCode	Spec error	reserved

TableSel : Selects the bit timing table 0 : Standard CiA bit timing table
1...127 : Reserved for CiA
128…255: Manufacturer-specific tables
TableInd : Bit timing entry in selected table (see table below).
Error code : 0=OK; 1=Bit timing outside range; 2...254=reserved; 255->Specific error
Specific error : If Error code=255 ->Application-specific error code.

Saving the configuration protocol

This protocol saves the configuration parameters in the EEPROM.

7E5h ->	17h	reserved

7E4h<-	17h	ErrCode	Spec error	reserved

Error code : 0=OK; 1=Saving not supported; 2=Access error; 3...254=reserved; 255->Specific error
Specific error : If error code=255 -> Application-specific error code.

Activate bit timing parameters

The new bit timing parameters are activated with the command specifier 15h.

7E5h ->	15h	Switch delay	reserved

Switch Delay : Reset delay in the Producer in msec.
: After the delay, the sensor logs on with the new baud rate.

Request vendor ID

Requesting the vendor ID of a selected sensor

7E5h ->	5Ah	reserved

7E4h <-	5Ah	32 bit vendor ID	reserved

Vendor ID : = 0x005F – GCA series products

Request product code

Request product code of a selected sensor

7E5h ->	5Bh	reserved	
7E4h <-	5Bh	Product code	reserved

Product code : Manufacturer-dependent product code

Request revision number

Request revision number of a selected sensor

7E5h ->	5Ch	reserved	
7E4h <-	5Ch	32 bit revision number	reserved

Revision number : Current revision

Request serial number

Request serial number of a selected sensor

7E5h ->	5Dh	reserved	
7E4h <-	5Dh	32 bit serial number	reserved

Serial number: Unique consecutive serial number of the sensor

Range request

Sensors can also be searched for within a certain range. For this purpose, the following objects are sent in sequence:

7E5h ->	46h	Vendor ID	reserved
7E5h ->	47h	Product code	reserved
7E5h ->	48h	Revision number LOW	reserved
7E5h ->	49h	Revision number HIGH	reserved
7E5h ->	4Ah	Serial number LOW	reserved
7E5h ->	4Bh	Serial number HIGH	reserved

Each sensor with the relevant parameters logs on with the following message:

7E4h <-	4Fh	reserved	

11 Object directory

The following tables provide a summary of all SDO objects supported by the sensor.

Object Object number
Name Object name
Format U/I = Unsigned/Integer, No. = no of bits, ARR = Array, REC = Record, STR = String
Access ro = read only, wo = write only, rw = read write, m = supports mapping
Default Default parameter value on first init
Save X = can be stored in the EEPROM / non-volatile memory

11.1 Communication profile area

Object	Sub-index	Name	Format	Access	Default value	Save	Description
0x1000	0	Device type	U32	ro	0x07080196		CiA406
0x1001	0	Error register	U8	ro	0x00		Bit-coded to profile CiA 406 0x00: no error 0x01: generic error 0x10: communication error 0x20: device profile error 0x80: manufacturer specific error
0x1003	0	Predefined error list	U8	ro	0x00		Errors in the list (up to 8)
	1…8	History errors	U32	ro	0x00000000		Errors occurred according to the error codes list, the last error is in the sub-index
0x1005	0	COB ID Sync object	U32	rw	0x00000080	X	Sensor generates no sync message (bit 30 =0) 11-bits identifier system (bit 29=0)
0x1008	0	Device name	STR	ro	-		Device designation (see paragraph 3)
0x1009	0	HW version	STR	ro	1.0		Hardware version
0x100A	0	FW version	STR	ro	-		Software version (ASCII characters, i.e. version 1.28 = 31 56 32 38) (! Attention, as specified in the segmented mode: Send 60 00 00 00 00 00 00 00 after the command 40 0A 10 00 00 00 00 00 to see this string)
0x1010	0	Numbers of save-options	U8	ro	0x01		
	1	Save all parameters	U32	rw	0x00000001	X	The parameters are saved only writing the key string “save” (0x73-0x61-0x76-0x65)
0x1011	0	Numbers of restore-options	U8	ro	0x01		
	1	Restore all parameters	U32	rw	0x00000001	X	If the key string “load” (0x6C-0x6F-0x61-0x64) is entered here, the parameters are assigned to default values / factory settings and are valid after the next reset.
0x1014	0	COB ID Emergency	U32	rw	0x00000080 +ID	X	bit 30 = 1 The sensor generates EMCY message
0x1017	0	Producer heartbeat time	U16	rw	0x0000	X	Time interval [msec] where sensor generates a producer heartbeat
0x1018	0	Numbers of identity-options	U8	ro	0x04		
	1	Vendor ID	U32	ro	0x005F		GCA series products
	2	Product code	U32	ro	-		As described in paragraph 3.1
	3	Revision number	U32	ro	0x00000000		
	4	Serial number	U32	ro	-		Depending by the SN of the product
0x1029	0	Error behavior supported	U8	ro	0x02 / 0x03		0x02 for products without integrated inclinometer 0x03 for products with integrated inclinometer
	1	Communication error	U8	rw	0x01	X	See paragraph 8.7
	2	Encoder internal error	U8	rw	0x00	X	See paragraph 8.7
	3	Inclinometer internal error	U8	rw	0x00	X	See paragraph 8.7
0x1200	0	Server SDOs	U8	ro	0x02		

Object	Sub-index	Name	Format	Access	Default value	Save	Description
	1	COB ID Rx SDO	U32	ro	0x600 + ID		bit 31=0 –> valid SDO
	2	COB ID Tx SDO	U32	ro	0x580 +ID		bit 31=0 –> valid SDO
0x1800	0	TPDO1	U8	ro	0x05		Number of the entries TPDO1
	1	COB ID TPDO1	U32	rw	0x180 + Node ID	X	Bit 31 = 0 -> TPDO activated Bit 31 = 1 -> TPDO not activated (not transmitted)
	2	Transmission type	U8	rw	0xFE	X	Transmission type (synchronous/asynchronous)
	3	Inhibit time	U16	rw	0x0000	X	Minimum interval time between consecutive TPDOs
	5	Event time TPDO1	U16	rw	0x0064	X	Used if 1800.02 is 0xFE or 0xFF
0x1801	0	TPDO2	U8	ro	0x05		Number of the entries TPDO2
	1	COB ID TPDO2	U32	rw	0x280+Node ID	X	Bit 31 = 0 -> TPDO activated Bit 31 = 1 -> TPDO not activated (not transmitted)
	2	Transmission type	U8	rw	0xFE	X	Transmission type (synchronous/asynchronous)
	3	Inhibit time	U16	rw	0x0000	X	Minimum interval time between consecutive TPDOs
	5	Event time TPDO2	U16	rw	0x0064	X	Used if 1801.02 is 0xFE or 0xFF
0x1A00	0	TPDO1 mapping	U8	rw	0x02		Number of objects integrated in TPDO1
	1	index in obj directory	U32	rw	0x60200120		Cable length
	2	index in obj directory	U32	rw	0x21970020		
0x1A01	0	TPDO2 mapping	U8	rw	0x02		Number of objects integrated in TPDO2
	1	index in obj directory	U32	rw	0x69100020		Angle
	2	index in obj directory	U32	rw	0x21970020		
0x1F80	0	NMT Startup	U32	rw	0x00000000	X	Configuration of the start-up behavior of a device that is able to perform the NMT

11.2 Manufacturer specific profile area

Object	Sub-index	Name	Format	Access	Default value	Save	Description
0x2000	0	Length raw channel value	U8	ro	2		Number of the entries
	1	Length raw value Channel 1	I32	ro, m			length in 0.1 mm (internal raw value)
	2	Length raw value Channel 2*	I32	ro, m			length in 0.1 mm (internal raw value)
0x2101	0	Length preset values	U8	ro	4		Number of the entries
	1	Length preset value Channel 1	I32	rw	0	X	Same as object 6010.01 (it is possible to set a value only equal to zero)
	2	Length preset value Channel 2*	I32	rw	0	X	Same as object 6010.01 (it is possible to set a value only equal to zero)
	3	Custom preset value Channel 1	I32	rw	0	X	
	4	Custom preset value Channel 2*	I32	rw	0	X	
0x2102	0	Length direction	U8	ro	4	X	Number of the entries
	1	Length direction Channel 1	U8	rw		X	direction (0=increasing when pull; 1= decreasing when pull)
	2	Length direction Channel 2*	U8	rw		X	direction (0=increasing when pull; 1= decreasing when pull)
	3	Length preset value Channel 1	I32	rw	0x00000000	X	Preset the value (it's possible to set a value different from Zero, accordingly to the resolution)
	4	Length preset value Channel 2*	I32	rw	0x00000000	X	Preset the value (it's possible to set a value different from Zero, accordingly to the resolution)
0x2103	0	Length filter strength	U8	rw	0x14 for hall effect based sensors 0x50 for potentiometer based sensors	X	IIR coefficient expressed in % (lower values->more filtering)

Object	Sub-index	Name	Format	Access	Default value	Save	Description
0x2105	0	Speed filter strength	U8	rw	0x8	X	IIR coefficient expressed in % (lower values->more filtering)
0x2110	0	Length value	U8	ro	4		Number of the entries
	1	Length value Channel 1	I32	ro, m			length in 0.1 mm or other scale (depending on resolution)
	2	Length value Channel 2*	I32	ro, m			length in 0.1 mm or other scale (depending on resolution)
	3	Length value Invers Channel 1	I32	ro, m			opposite value (FS-value)
	4	Length value Invers Channel 2*	I32	ro, m			opposite value (FS-value)
0x2111	0	Length value16-bit	U8	ro	4		Number of the entries
	1	Length value 16-bit Channel 1	U16	ro, m			16-bit version of object 0x2110
	2	Length value 16-bit Channel 2*	U16	ro, m			16-bit version of object 0x2110
0x2116	0	Biggest subindex	U8	ro	0x02	No	Number of entries
	1	Speed value 16-bit Channel 1	I16	ro, m		No	Speed value
	2	Speed value 16-bit Channel 2*	I16	ro, m		No	Speed value
0x2117	0	Reserved	U16	ro, m			For internal use (sensor diagnostic flags)
0x2119	0	Inversion Length Behavior	U8	ro	1 for hall effect based sensors 0 for potentiometer based sensors		If it's equals to 1 means: Length goes from 0 to –FS (if either 2102.01 is equal to 1) If it's equals to 0 means: Length goes from FS to 0 (if either 2102.01 is equal to 1)
0x2120	0	Angle value	U8	ro	2		Number of the entries
	1	Angle value Invers Channel 1	I32	ro, m			Angle opposite value (FS-value)
	2	Angle value Invers Channel 2*	I32	ro, m			Angle opposite value (FS-value)
0x2194	0	Type of rotation	U8	ro	1		Number of the entries
	1	Rotation axis	U8	rw	1	X	Orientation of inclinometer measuring axis 1= vertical installation of cable transducer with horizontal axis of inclinometer measuring axis (cannot be changed)
0x2195	0	Fw version	U16	ro, m	-		Obj. 0x100A in 16 bit
0x2196	0	String customer	U32	rw, m	0x00000000		4 byte of empty space for customer specific content (e.g. customer name)
0x2197	0	Dummy double word	U32	ro, m	0x00000000		4 byte of empty space to compose PDO with dynamic mapping
0x2198	0	Dummy word	U16	ro, m	0x0000		2 byte of empty space to compose PDO with dynamic mapping
0x2199	0	Dummy byte	U8	ro, m	0x00		1 byte of empty space to compose PDO with dynamic mapping
0x2603	0	Angle filter strength	U16	rw	0x1E		IIR coefficient expressed in Hz (lower values->more filtering)
0x3000	0	Baud rate	U8	rw	0x03	X	0=1000 kbits/s 1=800 kbits/s 2=500 kbits/s 3=250 kbits/s 4=125 kbits/s 5=100 kbits/s 6=50 kbits/s 7=20 kbits/s 8=10 kbits/s The baud rate is activated after a reset or power-on (if parameter is saved to non-volatile memory)
0x3001	0	Node ID	U8	rw	0x04	X	Node number 1…127 (0x01...0x7F)

Object	Sub-index	Name	Format	Access	Default value	Save	Description
					(0x05)		Products with CANopen are equipped with one node-ID: Channel A: Node-ID 4 (default factory setting 04h) Products with CANopen full redundant (2-channel) are equipped with two node-IDs (each channel has its own node-ID)*: Channel A: Node-ID 4 (default factory setting 04h) Channel B: Node-ID 5 (default factory setting 05h)

*Note: For products with CANopen full redundant (2-channel), the measuring function objects 0x6xxxh (standardized device profile area) exist in parallel for each channel / node-ID, and can be accessed simultaneously in parallel.

11.3 Standardized device profile area

Object	Sub-index	Name	Format	Access	Default value	Save	Description
0x6000	0	Length parameters	U16	rw	0x0000	X	See paragraph 'How to change the length direction'
0x6002	0	Length total range	U32	rw	0x00000000	X	Not used
0x6003	0	Length preset value Channel 1	I32	rw	0x00000000	X	Set the zero length values
0x6004	0	Length value Channel 1	I32	ro, m	-		Length value
0x6005	0	Length position setting	U8	ro	0x02		Number of the entries
	1	Length position setting	U32	rw	0x0000F42 40	X	Express the resolution in nanometers
	2	Speed setting	U32	rw	0x0000F42 40	X	Express the resolution in nanometers
0x6010	0	Length preset values	U8	ro	0x02		Number of the entries
	1	Length preset value Channel 1	I32	rw	0x00000000	X	Preset the value
	2	Length preset value Channel 2*	I32	rw	0x00000000	X	Preset the value
0x6020	0	Length value	U8	ro	0x02		Same as object 2110.00
	1	Length value Channel 1	I32	ro, m	-		Same as object 2110.01
	2	Length value Channel 2*	I32	ro, m	-		Same as object 2110.02
0x6030	0	Speed value	U8	ro	0x02		Number of the entries
	1	Speed value Channel 1	I32	ro, m	-		Speed value
	2	Speed value Channel 2*	I32	ro, m	-		Speed value
0x6503	0	Alarm	U16	ro, m	0x00		See paragraph 8.6
0x6800	0	Resolution Angle**	U16	rw	0x0064	X	This object shall indicate the resolution of Slope long16-bit (object 6810h) and Slope lateral16-bit (object 6820h) objects based on 0,001°. This resolution is also valid for the 32-bit value objects (6910h and 6920h).
0x6810	0	Slope Long 16-bit**	I16	ro, m	-		This object shall provide the 16-bit slope value of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6800h.
0x6811	0	Slope long 16-bit operating parameter**	U8	rw	0x02	X	If scaling is enabled, the Slope long16-bit value shall be calculated accordingly to the following equation: Slope long16-bit = physically measured angle + Differential slope long16-bit offset + Slope long16-bit offset If scaling is disabled, the Slope long16-bit value shall be equal to the physical measured angle.

Object	Sub-index	Name	Format	Access	Default value	Save	Description
0x6812	0	Slope long 16-bit preset value**	I16	rw	0x0000	X	Accessing this object by means of SDO shall set directly the actual longitudinal slope value to a desired longitudinal slope value. The calculated application-offset of the longitudinal slope value is given in Slope long16-bit offset (object 6813h). The Slope long16-bit offset is calculated with respect to object 6814h. The value shall be given in degree (angle) with the resolution given in object 6800h.
0x6813	0	Slope long 16-bit offset**	I16	ro	0x0000		This object shall indicate the application-offset of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6800h. The following equation shall be applied: Slope long16-bit offset = Slope long16-bit preset value at tacc – slope physical measured at tacc – Differential slope long16-bit offset (tacc = time when accessing object 6812h)
0x6814	0	Differential slope long 16-bit offset**	I16	rw	0x0000	X	This object shall shift the Slope long16-bit value (object 6810h) independent of Slope long16-bit preset value (object 6812h) and Slope long16-bit offset (object 6813h). The value shall be given in degree (angle) with the resolution given in object 6800h.
0x6910	0	Slope Long 32-bit**	I32	ro, m			See description of object 6810h
0x6911	0	Slope long 32-bit operating parameter**	U8	rw	0x02	X	See description of object 6811h
0x6912	0	Slope long 32-bit preset value**	I32	rw	0x00000000	X	See description of object 6812h
0x6913	0	Slope long 32-bit offset**	I32	ro	0x00000000		See description of object 6813h
0x6914	0	Differential slope long 32-bit offset**	I32	rw	0x00000000	X	See description of object 6814h
0x6E11	0	Device temperature**	I16	ro, m	0x0000		Internal device temperature of inclination sensor
0x7010	0	Slope Long 16-bit Channel 2***	I16	ro, m	-		This object shall provide the 16-bit slope value of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6800h.
0x7011	0	Slope long 16-bit operating parameter Channel 2***	U8	rw	0x02	X	If scaling is enabled, the Slope long16-bit value shall be calculated accordingly to the following equation: Slope long16-bit = physically measured angle + Differential slope long16-bit offset + Slope long16-bit offset If scaling is disabled, the Slope long16-bit value shall be equal to the physical measured angle.
0x7012	0	Slope long 16-bit preset value Channel 2***	I16	rw	0x0000	X	Accessing this object by means of SDO shall set directly the actual longitudinal slope value to a desired longitudinal slope value. The calculated application-offset of the longitudinal slope value is given in Slope long16-bit offset (object 6813h). The Slope long16-bit offset is calculated with respect to object 7014h. The value shall be given in degree (angle) with the resolution given in object 6800h.
0x7013	0	Slope long 16-bit offset Channel 2***	I16	ro	0x0000		This object shall indicate the application-offset of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6800h. The following equation shall be applied: Slope long16-bit offset = Slope long16-bit preset value at tacc – slope physical measured at tacc – Differential slope long16-bit offset (tacc = time when accessing object 7012h)
0x7014	0	Differential slope long 16-bit offset Channel 2***	I16	rw	0x0000	X	This object shall shift the Slope long16-bit value (object 7010h) independent of Slope long16-bit preset value (object 7012h) and Slope long16-bit offset (object 7013h).

Object	Sub-index	Name	Format	Access	Default value	Save	Description
							The value shall be given in degree (angle) with the resolution given in object 6800h.
0x7110	0	Slope Long 32-bit Channel 2***	I32	ro, m			See description of object 7010h
0x7111	0	Slope long 32-bit operating parameter Channel 2***	U8	rw	0x02	X	See description of object 7011h
0x7112	0	Slope long 32-bit preset value Channel 2***	I32	rw	0x00000000	X	See description of object 7012h
0x7113	0	Slope long 32-bit offset Channel 2***	I32	ro	0x00000000		See description of object 7013h
0x7114	0	Differential slope long 32-bit offset Channel 2***	I32	rw	0x00000000	X	See description of object 7014h
0x7511	0	Device temperature Channel 2***	I16	ro, m	0x0000		Internal device temperature of inclination sensor

*Note: For products with CANopen full redundant (2-channel), the measuring function objects 0x6xxxh (standardized device profile area) exist in parallel for each channel / node-ID, and can be accessed simultaneously in parallel.

**Note: The inclinometer objects 6800h...6914h and 6E11h exist for products with integrated inclinometer only.

***Note: The inclinometer objects 7010h...7114h and 7511h exist only for products with integrated inclinometer and redundant version (2-sensing).