Manual

Inclination sensor with CANopen® interface

Firmware Version 1.00 and up

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

1. Introduction

1.1. Scope of delivery

Please check the delivery upon completeness prior to commissioning.
Depending on sensor configuration and part number delivery is including:

- Sensor
- Describing file and manual (also available as download in the Internet)

1.2. Product assignment

Product	Product code	Device name	EDS file	Product family
GNAMG.x225xxx	0x32	GNAM	GNAMG_30.eds	Inclination sensor
GNAMG.x215xxx	0x33	GNAM	GNAMG_15.eds	Inclination sensor
GNAMG.x235xxx	0x34	GNAM	GNAMG_60.eds	Inclination sensor
GNAMG.x155xxx	0x35	GNAM	GNAMG_360.eds	Inclination sensor

2. Safety and operating instructions

Supplementary information

- This manual is intended as a supplement to already existing documentation (i.e. catalogues, product information and mounting instructions).
- The manual must be read without fail before initial commissioning of the equipment.

Intended purpose of the equipment

- The inclination sensor is a sensing device. It is only used to determine angular positions and to prepare and provide measured values as electric output signals for the downstream device. The inclination sensor must not be used for any other purpose.

Commissioning

- The inclination sensor may only be installed and mounted by suitably qualified experts.
- Observe the operating instructions of the machine manufacturer.

Safety remarks

- Prior to commissioning of the equipment check all electrical connections.
- If installation, electrical connections or any other work performed at the inclination sensor or at t
- he equipment is not duly and correctly executed this can result in a mulfunction or failure of the inclination sensor.
- Steps must be taken to eliminate any risk of personal injury, damage to corporate or operating equipment as a result of inclination sensor failure or malfunction by providing suitable safety precautions.
- The inclination sensor must not be operated outside the limit values specified in the product information.

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

Transport and storage

- Only ever transport or store the inclination sensor in its original packaging.
- Never drop the inclination sensor nor expose it to major shocks.

Mounting

- Avoid impacts or shocks on the housing.
- The bus cover must fully and evenly rest on the base plate. Any tolerances in mounting the bus cover to the base plate may affect the absolute slope angle.

Electrical commissioning

- Do not modify the inclination sensor electrically.
- Do not carry out any wiring work when the inclination sensor is live.
- Never plug or unplug the electrical connection when the encoder is live.
- Ensure that the entire equipment is installed in line with EMC requirements. Ambient conditions and wiring affect the electromagnetic compatibility of the inclination sensor. Install inclination sensor and supply cables separately or far away from lines with high interference emissions (frequency converters, contactors etc.)
- Provide a separate power supply for the inclination sensor where working with consumers that have high interference emissions.
- Completely shield the inclination sensor housing and connecting cables.
- Connect the encoder to protective earth (PE) using shielded cables. The braided shield must be connected to the cable gland or plug. Ideally, aim at a bilateral connection to protective earth (PE), the housing via the mechanical assembly, the cable shield via the downstream devices. In case of earth loop problems, earth on one side only as a minimum requirement.

Failure to observe these instructions can result in malfunctions, personal injury or damage to property!

3. CAN-bus and CANopen communication

CAN bus (CAN: Controller Area Network) was developed by Bosch and Intel for high-speed, economic data transmission in automotive applications. Today CAN bus has been commercialised for use in industrial automation.
CAN bus is a fieldbus system (standards administered by CAN in Automation, CiA) for communication between appliances, actors and sensors of different brands.

3.1.1. CAN-bus properties

- Data rate of 1 Mbaud with network length capabilities of max. 40m
- Bilateral terminated network
- Bus medium: twisted pair wire
- Realtime capability: Max. defined waiting time for high priority messages.
- In theory up to 127 users in one bus line, physically however only 32 (due to driver).
- Seized netwide data consistency. Faulty messages are made known as faulty to all nodes in the network.
- Message-oriented communication
  The message comes with an identifier. All nodes in the network check by the identifier whether the message is relevant for them or not.
- Broadcasting, Multicasting
  All nodes get every message at the same time, thus enabling synchronisation.
- Multi-Master capability
  Every fieldbus user is able to transmit or recieve data independently, irrespectible of a priority by master. Every user can start his message if the bus is not busy. If several messages are transmitted at the same time, the user with the highest priority will succeed.
- Message priorities
  Message priority is determined by the identifier. Thus, the bus is quickly transmitting important messages.
- Risk of remaining errors
  Reliability precautions in the network reduce the risk of faulty, inevident data transmissions to less than 10^{-11}. A 100% reliability in transmission can be taken for granted.
- Function guarding
  Stations with malfunction or breakdown are located. The CAN protocol provides function guarding of the nodes in the network. Defective nodes are restricted in their function or even logged off from the network.
- Data transmission with minimized error recovery time
  Thanks to several error diagnostics faulty messages will be recognized with maximum reliability. Upon recognizing an error the message will be automatically repeated.

CAN bus is networking several bus users by bus cable. Every network user is in a position to transmit and receive messages. There is a serial data transmission between the individual network users.

Network users for CAN bus euipment might be:
- automation equipment, for example PLCs
- PCs
- input/output modules
- drive controls
- analysing equipment, for example CAN monitor
- operating and input equipment as HMI (human machine interface)
- sensors and actuators

3.2. CANopen

The CANopen profile was developed under technical supervision of the Steinbeis Transfer Centre for Automation and is based on layer 7 of CAL specification (CAN Application Layer). Compared to CAL, CANopen comprises onyl the functions relevant for this application. CANopen is a user-optimized CAL excerpt and thanks to a simplified system structure and the use of simplified appliances CANopen is optimized for rapid data exchange in realtime systems.

Applicable standards of the corresponding profiles are administered by the organisation CAN in Automation (CiA).

Some CANopen benefits:

- easy access to all device and communication parameters
- synchronisation of several appliances
- automated network configuration
- cyclic and event-triggered process data traffic

CANopen provides four communication objects (COB) with different properties:

- process-data objects for realtime data (PDO)
- service-data-objects for parameter and profile transmission (SDO)
- network management (NMT, Heartbeat)
- pre-defined objects (for synchronisation, emergency message)

All device and communication parameters are sectioned in an object directory. One object comprises object name, data type, number of subindexes, parameter structure and address. According to CiA the object directory is subdivided in three sections: communication profile, device profile and manufacturer-specific profile (see object directory).

3.3. CANopen communication

3.3.1. Communication profile

Communication between network users and master (PC / control) is effected by object directories and objects. Adressing the objects is by help of a 16bit index. The individual communication objects are standardized by CANopen communication profile DS 301. They are subdivided into several groups:

- Process DataOobjects PDO for process data transmission in realtime
- Service Data Objects SDO for write and read access to the object directory
- objects for synchronisation and error warnings of CAN users:
    - SYNC-object (synchronisation object) for synchronisation of network users
    - EMCY-object (emergency object) for error warnings of a single device or its periphery
- Network Management NMT (network management) for initialization and network control
- Layer Setting Services LSS for configuration by serial number, revision number etc within the existing network

3.3.2. CANopen message structure

First part of the message is the COB-ID (identifier).
Structure of the 11-Bit COB-ID :

<table>
<tr><th colspan="4">Function Code</th><th colspan="7">Node-ID</th></tr>
<tr><td colspan="4">4 Bit Function code</td><td colspan="7">7 Bit Node-ID</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

The function code is defining the kind of message and priority. The lower the COB-ID, the higher the priority of the message.

Broadcast messages:

Function code	COB-ID
NMT	0
SYNC	80h

Peer to Peer messages:

Function code	COB-ID
Emergency	80h + Node-ID
PDO1 (tx)1)	180h + Node-ID
PDO2 (tx)1)	280h + Node-ID
SDO (tx)1)	580h + Node-ID
SDO (rx)1)	600h + Node-ID
Heartbeat	700h + Node-ID
LSS (tx) 1)	7E4h
LSS (rx) 1)	7E5h

1): (tx) and (rx) from the inclination sensor’s point of view

The Node-ID is optionally set anywhere between 1 and 127 via the CANopen bus (if rotary switch = 0).
Default setting of the inclination sensor is Node ID 1.
Changing the Node-ID is effected by using service data object 2101h or by LSS.

A CAN telegram consists of the COB-ID and a data packet of max. 8 bytes:

COB-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Xxx	x	xx	xx	xx	xx	xx	xx	xx	xx

More detailed information on the telegram structure in later chapters.

3.3.3. Service data communication

Service data objects are conform to CiA standards. A certain object is accessed by index and subindex. There are data requests or, if required, data are written into the object.

General information on SDOs
SDO telegram structure:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3

A SDO-**COB-ID** is composed as follows:
Master -> inclination sensor : 600h + Node-ID
Inclination sensor -> master : 580h + Node-ID

DLC (Data length code) defines the length of a telegram with following structure:
1 byte command + 2 bytes object + 1 byte subindex + number of data bytes (0..4).

The **command byte** specifies whether data are write or read only and how many data bytes are involved:

SDO command	Meaning	Data length	
22h	Download Request	max. 4 Byte	transmit parameter to inclination sensor
23h	Download Request	4 Byte	
2Bh	Download Request	2 Byte	
2Fh	Download Request	1 Byte	
60h	Download Response	-	confirm download to master
40h	Upload Request	-	request parameter upload from inclination sensor
42h	Upload Response	max. 4 Byte	parameter to master, max. 4 bytes
43h	Upload Response	4 Byte	
4Bh	Upload Response	2 Byte	
4Fh	Upload Response	1 Byte	
80h	Abort Message	-	Inclination sensor gives error code to master

Abort Message means an error in CAN communication. SDO command byte is 80h. Object and subindex are those of the requested objects. The error code is in bytes 5..8.

ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
580h + Node-ID	8	80h	Object L	Object H	Subindex	ErrByte 0	ErrByte 1	ErrByte 2	ErrByte 3

Byte 8..5 composes the SDO abort message (Byte 8 = MSB).
The following messages are supported:

05040001h : command byte not supported
06010000h : incorrect access to an object
06010001h : Read access to write only
06010002h : Write access to read only
06020000h : Object not supported
06090011h : Subindex not supported
06090030h : Value is not within the defined limits
06090031h : Value too high
08000000h : General error
08000020h : Incorrect memory signature ("save")
08000021h : No data saving possible

SDO examples

Parameter request master to slave
Read resolution → object 6000h

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	40h	00h	60h	0	x	x	x	x

Response of slave to parameter **request**

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
580h+Node-ID	8	4Bh	00h	60h	0	a	b	C	d

Write parameter by master into slave
Angular position Y-axis set slope long by help of object 6112h preset

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	22h	12h	61h	0	a	b	c	d

Response of slave **to write** parameter

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
580h+Node-ID	8	60h	12h	61h	0	0	0	0	0

3.3.4. Process data communication

Process data objects serve for process data exchange in realtime. PDO transmision is synchronous or cyclic (asynchronous). The inclination sensor supports PDO1 providing the actual angular position of the two axis of the inclination sensor and defined in the objects 1800h, 1A00h, 6110h and 6120h .

Synchronous
For synchronous process data transmission the parameter set in object 1800h must be between 1 and F0h (=240). If for example the parameter is 3, the PDO will be transmitted on every third sync telegram (in case the parameter is 1, transmission will be on every sync telegram).

In synchronous operation the PDOs are requested by master via sync telegram:

byte 0	byte 1
COB-ID = 80	0

Cyclic (asynchronous)
For cyclic PDO transmission, the parameter written in object 1800h subindex 2 must be FEh or FFh. In addition, the same object subindex 5 must provide the cycle time in milliseconds. The written time is rounded to 1 ms. If the parameter is 0ms, the PDO’s won’t be transmitted at all. The function is disabled.

Overview
The following table is giving an overview on several kinds of PDO transmission.
Examples:

1800h		Brief explanation
Sub2	Sub5	
FEh	3ms	Cyclic transmission every 3 ms
FEh	0ms	PDO transmission off
3	xxx	PDO transmission on every third sync telegram
1	xxx	PDO transmission on every sync telegram

PDO (slope angle)
PDO1 telegram structure:

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
181h	8	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx

ID : 180h + Node-ID
Length : 8 DataByte
Byte 0.. 3 : Slope angle in degrees axis Slope Long Y
Byte 4.. 7 : Slope angle in degrees axis Slope Lateral X

Emergency service
Internal device errors or bus problems will result in an emergency message:

COB-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
80h+Node-ID	8	Error Code 00h	01h	Error-Register 1001h	Xx	Xx	Xx	Xx	Xx

Byte 0..1: Error Codes

Error Code (hex)	Meaning
0000	Error Reset or No Error
1000	Generic Error
5530	EEProm error
6010	Software reset (Watchdog)
7510	Internal communication error
8130	Life Guard error or Hearbeat

Byte 2: Error-Register

Bit	Meaning
0	Generic Error
4	Communication error
7	manufacturer specific

3.3.5. Network management services

The network management is subdivided into two groups:
NMT services for **device guarding** are for boot-up, start and stop of bus users. NMT services are also available as **connection guard**.

Significance of the NMT commands

The commands are transmitted as unconfirmed objects with the following structure:

Byte 0	Byte 1	Byte 2
COB-ID = 0	command byte	Node ID

COB-ID for NMT commands is always zero. The Node-ID is transmitted in byte 2 of the NMT command.

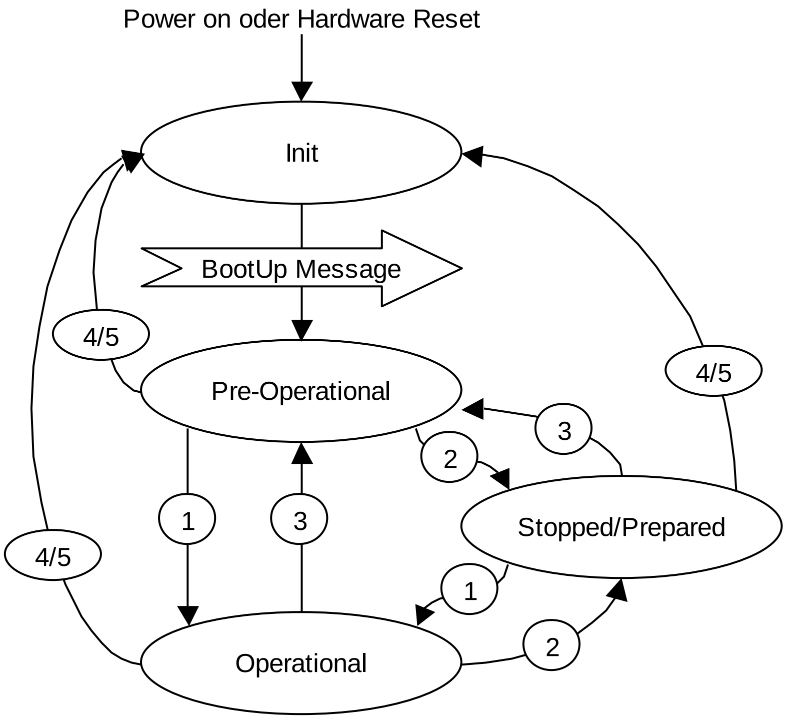
Command byte

Command byte	Meaning	State Event Mapping
01h	Start Remote Node	1
02h	Stop Remote Node	2
80h	Enter Pre-Operational Mode	3
81h, 82h	Reset Remote Node	4, 5

The **Node number** is the Node-ID of the requested user. Node-ID = 0 means addressing all users.

NMT State Event

After boot-up the inclination sensor is in pre-operational mode which is the state for read and write SDO parameters. For PDO parameter requests, the inclination sensor must be set to operational mode first.



The various NMT states

Init
After boot-up the inclination sensor will give a BootUp message at the CAN bus. Then the inclination sensor will automatically go to PreOperational mode.

The COB-ID of the BootUp message is composed by 700h and the Node-ID.

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

Pre-Operational Mode
Read and write of SDO's is in Pre-Operational mode.

Operational Mode
In Operational mode the inclination sensor is transmitting the requested PDO's. In addition, this mode is for read and write SDOs.

Stopped oder Prepared Mode
NMT communication is only possible in Stopped Mode. Read and write SDO parameters is disabled. LSS is also only available in Stopped Mode.

Changing the operational state

Start Remote Node (1)
The start command will set the inclination sensor to operational mode.

COB-ID	Command byte	Node-ID
0	1h	0..127

Stop Remote Node (2)
The stop command will set the inclination sensor to stopped mode or prepared mode.

COB-ID	Command byte	Node-ID
0	2h	0..127

Enter Pre-Operational Mode (3)
Change to Pre-Operational Mode.

COB-ID	Command byte	Node-ID
0	80h	0..127

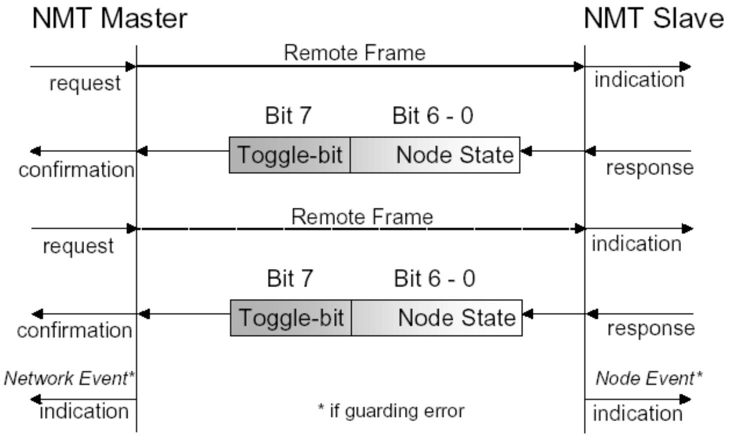
Reset Remote Node (4) or Reset Communication (5)
The reset command will re-init the inclination sensor.
Reset Remote Node (4):

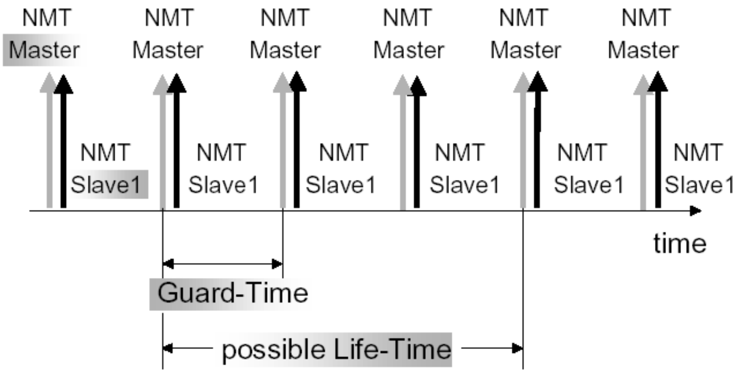
COB-ID	Command byte	Node-ID
0	81h	0..127

Reset communication (5):

COB-ID	Command byte	Node-ID
0	82h	0..127

Node und Life Guarding





For user guarding either the heartbeat protocol (default) or the nodeguarding protocol (object 2110h Bit 5 = 1) can be applied.
The NMT master is able to form a data bank with the corresponding NMT states of every single user. This protocol is for guarding whether a user has left the bus.In addition, every user can monitor whether the control is still active.
The NMT master starts the guarding service by a Remote Frame to the requested user. Every Remote Frame will reset the Life-Time at the user. Further the user responds his NMT state. This way, the NMT master is able to check whether the user is in the correct NMT state and can react correspondingly in case of error.
Upon Life-Time expiry a „Node Event“ will be triggered. The behaviour in case of error is defined in object 1029h-1h “Communication Error”.

Example of a nodeguarding protocol:

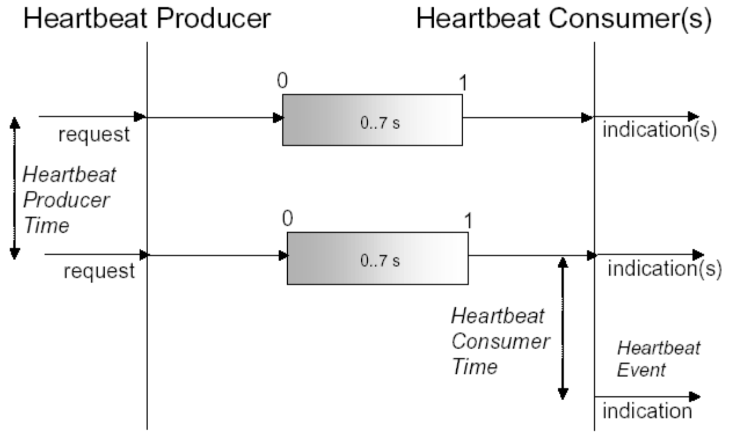
COB-ID	Data/ Remote	Byte 0
701h	r	00h (0d)
701h	d	FFh (255d)
701h	r	00h (0d)
701h	d	7Fh (127d)

Possible user NMT-states:

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

In this example the lower 7 bits equal 7Fh, i.e. the inclination sensor is in pre-operational mode.

Heartbeat protocol



Optionally the new Heartbeat protocol can be utilized. Heartbeat is enabled if in object 2110h bit 5 is on “0”. We recommend for new applications the modern guarding protocol heartbeat.
A "Heartbeat-Producer" produces a cyclic heartbeat indication. One or more “Heartbeat-Consumers" can receive this heartbeat indication.
If there is no cyclic transmission of the heartbeat message, this will result in a „Heartbeat Event“. The behaviour in case of error is defined in object 1029h-1h "Communication Error".

Example of a Heartbeat protocol

COB-ID	Data/Remote	Byte 0
701h	d	7Fh (127d)

Heartbeat messages are composed of COB-ID and one byte. This byte is transmitting the NMT state.

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

i.e. the inclination sensor is in pre-operational mode (7Fh = 127).

Important : Only one of the above nodeguarding options can be active.

Default: Heartbeat
Optional: NodeGuarding (see object 2110)

3.3.6. Layer Setting Services

In spring 2000 CiA presented a new protocol to ensure a uniform presence. Proceedings are defined under *Layer Setting Services and Protocol, CiA Draft Standard Proposal 305* (LSS).
The inclination sensor comes with the standard Node-ID 1 and standard baud rate 50 kBaud. Several inclination sensors with the same Node-ID can be networked to the bus system. LSS is utilized to address the individual inclination sensor.
Every inclination sensor comes with a unique serial number that it must be addressed to. Consequently, any number of inclination sensor with the same Node-ID can be networked to the bus for init via LSS. Both Node-ID and baud rate can be configured. LSS is only available in **stopped mode.**

Message structure

COB-ID:
Master → Slave : 2021 = 7E5h
Master ← Slave : 2020 = 7E4h
The COB-ID is followed by a LSS command specifier and a data packet of max. 7 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 → Operational mode
1 → Configuration mode

Switch Mode Selective
The following sequence is for addressing a determined inclination sensor in the bus system

7E5h →	40h	VendorId	Reserved

7E5h →	41h	ProductCode	reserved

7E5h →	42h	RevisionNumber	reserved

7E5h →	43h	SerialNumber	reserved

7E4h ←	44h	Mode	reserved

VendorId : ECh
ProductCode : Internal product code of the respective inclination sensor
RevisionNumber : Current revision number of the inclination sensor
SerialNumber : Unique, successive serial number
Mode : The inclination sensor will respond in the new mode (0=Operational mode; 1=Configuration mode)

Setting the Node-ID

7E5h →	11h	Node-ID	reserved

7E4h ←	11h	ErrCode	Spec Error	reserved

Node-ID : The new Node-ID of the inclination sensor
ErrorCode : 0=OK; 1=Node-ID beyond the range; 2..254=reserved; 255→specificError
SpecificError : If ErrorCode=255 → application-specific error code.

Setting the BitTiming

7E5h →	13h	tableSel	tableInd	reserved

7E4h ←	13h	ErrCode	SpecError	reserved

TableSel : Selects BitTiming table 0 : Standard CiA Bit Timing table
1..127 : Reserved for CiA
128..255 : Manufacturer-specific tables
TableInd : BitTiming entry in table selected (see table below).
ErrorCode : 0=OK; 1=BitTiming beyond the range; 2..254=reserved; 255→SpecificError
SpecificError : If ErrorCode=255 → application-specific error code.

Standard CiA Table

Baud rate	Table Index
1000 kBaud	0
800 kBaud	1
500 kBaud	2
250 kBaud	3
125 kBaud	4
100 kBaud	5
50 kBaud	6
20 kBaud	7
10 kBaud	8

Saving the configuration protocol

By this protocol the configured parameters are saved in EEPROM.

7E5h →	17h	reserved

7E4h ←	17h	ErrCode	SpecError	Reserved

ErrorCode : 0=OK;1=saving not supported;2=acess error;3..254=reserved;255→specificError
SpecificError : If ErrorCode=255 → application-specific error code.

Activate BitTiming Parameters

The new BitTiming parameters are activated by command specifier 15h.

7E5h →	15h	Switch Delay	Reserved

Switch Delay : Delay in ms of slave reset.
After the delay the inclination sensor will register with the new baud rate.

VendorId request

Requesting the VendorId of a selected inclination sensor

7E5h →	5Ah	Reserved

7E4h ←	5Ah	32 Bit Vendor ID	Reserved

VendorID : = ECh

Product code request
Requesting the product code of a selected inclination sensor

7E5h →	5Bh	reserved

7E4h ←	5Bh	ProductCode	reserved

Product code : Manufacturer-defined product code

Revision number request
Requesting the revision number of a selected inclination sensor

7E5h →	5Ch	reserved

7E4h ←	5Ch	32 Bit Revision number	reserved

Revision number : current revision

Serial number request
Requesting the serial number of a selected inclination sensor

7E5h →	5Dh	reserved

7E4h ←	5Dh	32 Bit Serial number	reserved

Serial number : unique successive serial number of the inclination sensor

Range Selection
Inclination sensors can also be selected within a defined range. To do so, the following objects are transmitted one after the other:

7E5h →	46h	VendorId	reserved

7E5h →	47h	ProductCode	reserved

7E5h →	48h	RevisionNumber LOW	reserved
7E5h →	49h	RevisionNumber HIGH	reserved

7E5h →	4Ah	SerialNumber LOW	reserved
7E5h →	4Bh	SerialNumber HIGH	reserved

Every inclination sensor with the respective parameters will respond by the following message:

7E4h ←	4Fh	reserved

3.4. Inclination sensor profile

3.4.1. Inclination sensor object overview

According to CiA (CAN in Automation) the objects are subdivided into three groups:

- **Standard objects**:
  1000h, 1001h, 1018h
- **Manufacturer-specific objects**:
  2000h - 5FFFh
- **Device-specific objects**:
  All remaining objects from 1000h - 1FFFh, 6000h - FFFFh

The table below is giving a summary of all SDO objects supported by the inclination sensor.

Object	Object number in Hex
Name	---
Format	U/I = Unsigned/Integer, number = number bit, ARR = Array, REC = Record
Access	ro = ReadOnly, wo = WriteOnly, rw = ReadWrite
Default	Default upon first init or restore default
Save	yes → saved in EEPROM
Meaning	supplementary description

Object Sub-Index	Name	Format	Access	Default	Save	Meaning
1000h	Device Type	U32	ro	0004019Ah		0x019A = 410 = device profile inclination sensor 0x0004 = Two axis with resolution max. 32-bit
1001h	Error Register	U8	ro	0h		Bit0 = Generic error Bit4 = Communication error (overrun, …) Bit7 = Manufacturer -specific
1003h	PreDefined ErrorField	ARR				Comprises the last 8 errors or warnings
00h	Maximum Subindex	U8	rw	0h	ja	Number of messages saved (0..8)
01h	Latest entry	U32	ro			Latest error or warning 1000h Generic Error 5530h EEPROM Error 6010h Software Reset (Watchdog) 7510h Internal Communication Error 8130h Life Guard Error or Heartbeat Error
..	..	..	..	..		..
08h	Oldest entry	U32	ro			Error or warning, see Sub-Index 01h
1005h	Sync COB-ID	U32	rw	80h	ja	COB-ID of Sync Oject
1008h	DeviceName	U32	ro	"GNAM"		Device name GNAMG inclination sensor
1009h	Hardware Version	U32	ro	werkseitig		Product Hardware Version in ASCII
100Ah	Software Version	U32	ro	werkseitig		Product Software Version in ASCII
100Ch	Guard Time	U16	rw	0h	ja	Timer Nodeguarding
100Dh	Life Time factor	U8	rw	0h	ja	Guard Time Multiplier
1010h	Store Parameters	ARR				
00h	Maximum Subindex	U8	ro	4h		
01h	Save all parameters	U32	rw			=“save“ (0x73617665) to save
02h	Communication parameters	U32	rw			=“save“ (0x73617665) to save
03h	Application parameters	U32	rw			=“save“ (0x73617665) to save
04h	Manufacturer-specific parameters	U32	rw			=“save“ (0x73617665) to save
1011h	Restore Default Parameters	ARR				
00h	Größter Subindex	U8	ro	4h		
01h	Alle Parameter	U32	rw			=“load“ (0x6C6F6164) to load

Object Sub-Index	Name	Format	Access	Default	Save	Meaning
02h	Communication Parameters	U32	rw			=“load“ (0x6C6F6164) to load
03h	Application Parameters	U32	rw			=“load“ (0x6C6F6164) to load
04h	Manufacturer Specific Parameters	U32	rw			=“load“ (0x6C6F6164) to load
1014h	Emergency COB-ID	U32	rw	80h + Node-ID	yes	COB-ID of the emergency object
1016h	Consumer heartbeat time	ARR			yes	
00h	Maximum Subindex	U8	ro	1h		
01h	Consumer heartbeat time	U32	rw	10000h	yes	Bit0..15 Consumer Heartbeat time in ms Bit16..23 Node-ID
1017h	Producer Heartbeat Time	U16	rw	0h	yes	Producer Heartbeat time in ms
1018h	Identity Object	REC	ro			
00h	Maximum Subindex	U8	ro	4h		
01h	VendorID	U32	ro	ECh		Vendor ID specified by CiA
02h	Product Code	U32	ro	32h		Product Code: 0x32 = GNAMG.x225xxx 0x33 = GNAMG.x215xxx 0x34 = GNAMG.x235xxx
03h	Revision Number	U32	ro	Works-defined	yes	Product revision number
04h	Serial Number	U32	ro	Works-defined	yes	Unique successive serial number
1029h	Error behaviour	ARR				Error behaviour
00h	Maximum Subindex	U8	ro	1h		
01h	Communication error	U8	rw	1h	yes	0h = go to pre-operational mode 1h = no change of mode 2h = go to stop mode 3h = Node reset
1800h	Transmit PDO1 Parameter	REC				
00h	Maximum subindex	U8	ro	5h		
01h	COB-ID	U32	rw	180h+id	ja	PDO ID = 180h + Node-ID
02h	PDO Type	U8	rw	FEh	ja	FEh=User defined, cyclic
05h	EventTimer	U16	rw	203h	ja	Cycle time in ms
1A00h	Transmit PDO1 Mapping	ARR				
00h	Maximum Subindex	U8	ro	2h		
01h	Content of PDO1	I32	ro	61100020h		Slope angle Slope Long , Y-axis
02h	Content of PDO1	I32		61200020h		Slope angle Slope Lateral, X-axis
2100h	Baud rate	U8	rw	2h	ja	Setting the baud rate must be followed by saving operation in EEPROM and re-init. 0=10 kBit/s 1=20 kBit/s 2=50 kBit/s 3=100 kBit/s 4=125 kBit/s 5=250 kBit/s 6=500 kBit/s 7=800 kBit/s 8=1000 kBit/s
2101h	Node-ID	U8	rw	1h	yes	Node ID available from 1..127 Setting the baud rate must be followed by a saving operation in EEPROM and re-init.
2110h	Manufacturer_ Options	U32	rw	8h	yes	Bit3 = 0 no BusOFF reset 1 if BusOFF there is a bus reset Bit5 = 0 Heartbeat protocol active 1 Nodeguarding protocol active
2201h	Statistics	REC				
00h	Maximum subindex	U8	ro	3h		

Object Sub-Index	Name	Format	Access	Default	Save	Meaning
01h	Total of position errors	U32	ro		yes	
02h	Time in seconds	U32	ro		yes	Time elapsed since last reset
03h	Total of TimerReset Watchdog	U32	ro		yes	TimerWatchDog
2300h	Customer EEPROM range	ARR			yes	Any optional data can be saved in this object
00h	Maximum Subindex	U8	ro	7h	yes	
01h	Data0	U16	rw	0h	yes	
02h	Data1	U16	rw	0h	yes	
03h	Data2	U16	rw	0h	yes	
04h	Data3	U16	rw	0h	yes	
05h	Data4	U16	rw	0h	yes	
06h	Data5	U16	rw	0h	yes	
07h	Data6	U16	rw	0h	yes	
6000h	Resolution	U16	rw	1h	yes	0001h = 0.001° 000Ah = 0.01° 0064h = 0.1° 03E8h = 1.0°
6110h	Slope angle Y-axis Slope Long	I32	ro			Value range Depending on device type (measuring range) and parameter in 6000h (resolution): (+measuring range)/resolution ... to ... (-measuring range)/resolution
6111h	Parameter Y-axis Slope long operating parameter	U08	rw (ro bei 360°)	0h	yes	Bit 0 = 1 inversion on 0 inversion off Bit 1 = 1 scaling on 0 scaling off
6112h	Preset value Y-axis Slope long preset value	I32	rw (ro bei 360°)	0h	yes	Value range according parameter in object 6000h
6113h	Offset Y-axis Slope long offset	I32	ro	0h	yes	Calculated offset when writing on object 6112h
6114h	Differential Offset Y-axis Differential slope long offset	I32	rw (ro bei 360°)	0h	yes	Supplementary offset, independent from object 6112h and 6113h
6120h	Slope angle X-axis Slope Lateral	I32	ro		yes	Value range Depending on device type (measuring range) and parameter in 6000h (resolution): (+measuring range)/resolution ... to ... (-measuring range)/resolution
6121h	Parameters X-axis Slope lateral operating parameter	U08	rw	0h	yes	Bit 0 = 1 inversion on 0 inversion off Bit 1 = 1 scaling on 0 scaling off
6122h	Preset value X-axis Slope lateral preset value	I32	rw	0h	yes	Value range according parameter in object 6000h
6123h	Offset X-axis Slope lateral offset	I32	ro	0h	yes	Calculated offset when writing on object 6122h
6124h	Differential Offset X-axis Differential slope lateral offset	I32	rw (ro bei 360°)	0h	yes	Supplementary offset, independent from object 6112h and 6123h

3.4.2. Detailed object list

Object 1000 Device type

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	0004019Ah
EEPROM	No
Meaning	Information ond device profile and device type
Parameters	0x019A = 410 = device profile inclination sensor 0x0004 = Two axis with resolution max. 32-bit

Object 1001 Error register

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	0h
EEPROM	No
Meaning	Current error code

Parameters	Bit0 = Generic error
	Bit4 = Communication error (overrun, …)
	Bit7 = Manufacturer- specific

Object 1003 Pre-defined error field

CiA (CAN in Automation) defines here about 200 different error codes. This documentation only describes the sensor-relevant error codes.
This object saves the latest 8 errors or warnings that occurred.

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	0
EEPROM	No
Meaning	Read: Number of errors or warnings Write 0: error reset
Parameters	0..8

SubIndex	1..8
Data type	Unsigned 32
Access	ReadOnly
Default	0
EEPROM	No
Meaning	Errors or warnings occured, subindex 1 being the last, subindex 2 the second-to-last,…… entry
Parameters	Not yet defined

Object 1005 COB-ID SYNC Message

SubIndex	0
Data type	Unsigned 32
Access	ReadWrite
Default	80h
EEPROM	Yes
Meaning	Defines COB-ID of the synchronisation object (SYNC)
Parameters	Bit 31 not defined Bit 30 1=Sensor generates SYNC messages, 0=no SYNC message generated Bit 29 1=29 Bit SYNC COB-ID (CAN 2.0B), 0=28 Bit SYNC COB-ID (CAN 2.0A) Bit 28..11 Bit 28..11 of 29 Bit SYNC COB-ID Bit 10..0 Bit 10..0 of SYNC COB-ID

Object 1008 Manufacturer Device Name

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	Depending on the utilized basic encoder
EEPROM	No
Meaning	Device name in ASCII
Parameters	Data 0..3: "GNAM"

Object 1009 Manufacturer Hardware Version

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Meaning	Hardware version in ASCII
Parameters	Data 0..3 Example: 31h 2Eh 30h 30h = "1.00“

Object 100A Manufacturer Software Version

SubIndex	0
Data t type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Meaning	Software version in ASCII
Parameters	Data 0..3 Example: 31h 2Eh 30h 30h = "1.00“

Object 100C Guard Time

SubIndex	0
Data type	Unsigned 16
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Timer for nodeguarding in ms
Parameters	0...65535

Object 100D Life Time Factor

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	This factor multiplied by the guard time equals the life time
Parameters	0...256

Object 1010 Save parameter

By Object 1010h the relevant objects are saved non-volatile in EEPROM. To prevent any inadvertent saving operation the message „save“ must be written.

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	23h	10h	10h	01	73h 's'	61h 'a'	76h 'v'	65h 'e'

Object 1011 Restore parameter

Object 1011h restores the RAM parameters by the default parameters (see object 1010h.
The default parameters are at the same time loaded in EEPROM.
To prevent any inadvertent restore operation the message „load“ must be written.

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	23h	11h	10h	01	6Ch 'l'	6Fh 'o'	61h 'a'	64h 'd'

Object 1014 COB-ID emergency message

SubIndex	0
Data type	Unsigned 32
Access	ReadWrite
Default	80h+Node-ID
EEPROM	Yes
Meaning	Defines COB-ID of the emergency object
Parameters	80h + Node-ID

Object 1016 Consumer heartbeat time

SubIndex	0
Data type	Unsigned 8
Access	Read only
Default	1
EEPROM	No
Meaning	Maximum supported subIndex
Parameters	1

SubIndex	1
Data type	Unsigned 32
Access	Read write
Default	10000h
EEPROM	Yes
Meaning	Consumer heartbeat time
Parameters	Bit 0..15 Consumer heartbeat time in ms Bit 16..23 Node ID

Object 1017 Producer heartbeat time

SubIndex	0
Data type	Unsigned 16
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Defines the repetition time of the guarding service heartbeat
Parameters	0 = Disabled 1..65535 = repetition time in ms

Object 1018 Identity Object

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	4
EEPROM	No
Meaning	Maximum supported subindex
Parameters	4

SubIndex	1
Data type	Unsigned 32
Access	ReadOnly
Default	ECh
EEPROM	Yes
Meaning	CiA -defined VendorID of Baumer Germany
Parameters	ECh (in the Internet under www.can-cia.de)
SubIndex	2
Data type	Unsigned 32
Access	ReadOnly
Default	32h
EEPROM	Yes
Meaning	Product Code
Parameters	0x32 = GNAMG.x225xxx 0x33 = GNAMG.x215xxx 0x34 = GNAMG.x235xxx

<table>
<tr><td>SubIndex</td><td>3</td></tr>
<tr><td>Data type</td><td>Unsigned 32</td></tr>
<tr><td>Access</td><td>ReadOnly</td></tr>
<tr><td>Default</td><td></td></tr>
<tr><td>EEPROM</td><td>No</td></tr>
<tr><td>Meaning</td><td>Sensor revision number</td></tr>
<tr><td>Parameters</td><td>Actual software version = xxyy (xx=version, yy=running number)
<table>
<tr><td>Data 0 = running number LOW</td><td>Data 1 = running number HIGH</td><td>Data 2 = version LOW</td><td>Data 3 = version HIGH</td></tr>
</table>
See product label</td></tr>
</table>

SubIndex	4
Data type	Unsigned 32
Access	ReadOnly
Default	0
EEPROM	Yes
Meaning	Unique successive serial number of the sensor
Parameters	Defined ex works during final test

Object 1029 Error behavior

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	1
EEPROM	No
Meaning	Maximum supported subindex
Parameters	1 = maximum supported subIndex

SubIndex	1
Data type	Unsigned 8
Access	ReadWrite
Default	1
EEPROM	Yes
Meaning	Behaviour after communication error
Parameters	0h = switch to pre-operational mode 1h = no change of mode 2h = switch to stop mode 3h = Node Id reset

Object 1800 PDO1 parameters

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	5
EEPROM	No
Meaning	Maximum supported subindex
Parameter	5

SubIndex	1
Data type	Unsigned 32
Access	ReadWrite
Default	180h + Node-ID
EEPROM	Yes
Meaning	COB-ID des PDO
Parameters	180h + Node-ID
SubIndex	2
Data type	Unsigned 8
Access	ReadWrite
Default	FEh
EEPROM	Yes
Meaning	PDO Type
Parameters	1..n..F0h = synchronous PDO (PDO transmission on every n-th SYNC-telgram) FEh,FFh = asynchronous PDO (cyclic PDO transmission in reliance on EventTimer)

SubIndex	5
Data type	Unsigned 16
Access	ReadWrite
Default	203h
EEPROM	Yes
Meaning	Event Timer for PDO (process data object)
Parameters	0 = cyclic transmission disabled 1..n..65535 =repetition time of cyclic transmission is n ms.

Object 1A00 PDO1 Mapping

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	0
EEPROM	No
Meaning	Maximum supported subindex
Parameter	2

SubIndex	1
Data type	Integer 32
Access	ReadOnly
Default	61100020h slope angle Slope Long , Y-axis
EEPROM	No
Meaning	Inhalt PDO1
Parameters	61100020h slope angle Slope Long , Y-axis

SubIndex	2
Data type	Integer 32
Access	ReadOnly
Default	61200020h slope angle Slope Lateral , X-axis
EEPROM	No
Meaning	Contents PDO1
Parameters	61200020h slope angle Slope Lateral , X-axis

Object 2100 Baud rate

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	2 = 50 kBaud
EEPROM	Yes
Meaning	Read or set a new sensor baud rate → After the setting operation the parameters must be stored in EEPROM by object 1010h, followed by a sensor re-init.
Parameters	0 10 kBaud 1 20 kBaud 2 50 kBaud 3 100 kBaud 4 125 kBaud 5 250 kBaud 6 500 kBaud 7 800 kBaud 8 1000 kBaud

Object 2101 Node-ID

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	1
EEPROM	Yes
Meaning	Read or set a new sensor Node-ID. → After the setting operation the parameters must be stored in EEPROM by object 1010h, followed by a sensor re-init.
Parameters	1..127

Object 2110 Manufacturer_Options

SubIndex	0
Data type	Unsigned 32
Access	ReadWrite
Default	8h
EEPROM	Yes
Meaning	Parameters to guarantee compatibility to former sensors respectively to proceed customer-specific configurations **Object is not supported by EDS file.** **Any parameterization should be by the manufacturer only. Any customer-specific parameterization should be strictly conform to the table below.**

Parameters	Bit3 = 0 no reset if BusOFF
	1 bus reset if BusOFF
	Bit5 = 0 Heartbeat protocol active
	1 Nodeguarding protocol active

Object 2201 Statistics

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	3h
EEPROM	No
Meaning	Maximum supported subindex
Parameters	3

SubIndex	1
Data type	Unsigned 32
Access	ReadOnly
Default	0h
EEPROM	Yes
Meaning	Presently not assigned
Parameters	-

SubIndex	2
Data type	Unsigned 32
Access	ReadOnly
Default	0h
EEPROM	Yes
Meaning	Operating time in seconds total (object 6508h time elapsed since last reset)
Parameters	0... 4294967295

SubIndex	3
Data type	Unsigned 32
Access	ReadOnly
Default	0h
EEPROM	Yes
Meaning	WatchDog TimerReset counter
Parameters	0... 4294967295

Object 2300 Customer EEPROM section

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	8h
EEPROM	No
Meaning	Any optional data can be saved in this object
Parameter	8

SubIndex	1...8
Data type	Unsigned 16
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	One 16 bit parameter per each subindex (load in EEPROM by object 1010h)
Parameter	0

Object list according to DS 410

Object 6000 Resolution

SubIndex	0
Data type	Unsigned 16
Access	ReadWrite
Default	0001h = 0.001°
EEPROM	Yes
Meaning	Resolution
Parameters	0001h = 0.001° 000Ah = 0.01° 0064h = 0.1° 03E8h = 1.0°

Object 6110 Slope angle Y- axis (Slope long) (not at 360° sensor)

SubIndex	0
Data type	Integer 32
Access	ReadOnly
Default	
EEPROM	No
Meaning	Slope angle
Parameters	Value range Depending on the device type (measuring range) and parameter in 6000h (resolution): (+measuring range)/resolution ... to ... (-measuring range)/resolution Example: measuring range = ±30° Resolution = 0,001 Value range: +30000...-30000

Object 6111 Operating parameter Y-axis (Slope long operating parameter) (not with 360° sensor)

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Inversion: Inversion enable means reverse polarity of the Y-axis. Scaling: Scaling enable means calculating the slope of the Y-axis as follows: *Slope Y –axis* = physically measured slope + d*ifferential offset Y- axis* + *offset Y-axis* When scaling is disabled: *Slope Y –axis* = physically measured angle
Parameters	Bit 0 = 1 inversion on 0 inversion off Bit 1 = 1 scaling on 0 scaling off

Object 6112 Preset value Y-axis (Slope long preset value) (not with 360° Sensor)

SubIndex	0
Data type	Integer 32
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Sets the actual slope value Y-axis to the desired value
Parameters	Value range depending on parameters in object 6000h

Objekt 6113 Offset Y-axis (Slope long offset) (not with 360° sensor)

SubIndex	0
Data type	Integer 32
Access	ReadOnly
Default	0h
EEPROM	Yes
Meaning	Calculated offset when writing on object 6112h *Offset Y-axis* = *Preset value Y-axis* at t_{acc} - physically measured slope value Y- axis at t_{acc} - d*ifferential offset Y- axis*
Parameters	Value range depending on parameters in object 6000h

Objekt 6114 Differential Offset Y-axis (Differential slope long offset) (not with 360° sensor)

SubIndex	0
Data type	Integer 32
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Supplementary offset, independent from objects 6112h and 6113h The entered value is directly added to the current slope of the Y- axis
Parameters	Value range depending on parameters in object 6000h

Object 6120 Slope angle X- axis (Slope lateral)

SubIndex	0
Data type	Integer 32
Access	ReadOnly
Default	
EEPROM	No
Meaning	Slope angle
Parameters	Value range Depending on the device type (measuring range) and parameter in 6000h (resolution): (+measuring range)/resolution ... to ... (-measuring range)/resolution Example: Measuring range = ±30° Resolution = 0,001 Value range: +30000...-30000

Object 6121 Operating parameters X-axis (Slope lateral operating parameter)

SubIndex	0
Data type	Unsigned 8
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Inversion: Inversion enabled means reverse polarity of the X-axis. Scaling: Scaling enabled means calculation of slope of the X-axis as follows: *Slope X –axis* = physically measured slope + d*ifferential offset X- axis* + o*ffset X-axis* If scaling is disabled: *Slope X –axis* = physically measured angle
Parameters	Bit 0 = 1 inversion on 0 inversion off Bit 1 = 1 scaling on 0 scaling off

Object 6122 Preset value X-axis (Slope lateral preset value)

SubIndex	0
Data type	Integer 32
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Sets the actual slope of the X-axis to the required value
Parameters	Value range depending on parameters in object 6000h

Object 6123 Offset X-Achse (Slope lateral offset)

SubIndex	0
Data type	Integer 32
Access	ReadOnly
Default	0h
EEPROM	Yes
Meaning	Calculated offset when writing on object 6122h *Offset X-axis* = *Preset value X-axis at* i t_{acc} - physically measured slope Y-axis at t_{acc} - d*ifferential offset Y- axis*
Parameters	Value range depending on parameters in object 6000h

Object 6124 Differential Offset X-Achse (Differential slope lateral offset)

SubIndex	0
Data type	Integer 32
Access	ReadWrite
Default	0h
EEPROM	Yes
Meaning	Supplementary offset, independent from objects 6122h and 6123h The entered value is directly added on the current slope of the X-axis
Parameters	Value range depending on parameters in object 6000h

4. Diagnostics and useful information

4.1. Error diagnostics in fieldbus communication

- In case the inclination sensor does not react via the CANbus, check all cable connections first.

  If the cable connections are ok, test fielbus operation next. To do so you need a CAN monitor to record CANopen communication and to map the telegrams .

- Now the inclination sensor should give a BootUp message upon power off and on again.

  If there is no BootUp message, check whether the baud rates of inclination sensor, CAN monitor and bus system are in alignment.

- If you have problems in establishing a connection to a user check Node- ID and baud rate.

  The baud rate must be all the same. The Node- ID (identifier, address) must be within 1 and 127. Every bus user must be assigned a unique Node-ID, i.e. by no means the same Node ID must be assigned several times.

  Node-ID and baud rate may also conveniently be assigned by LSS services.

4.2. Error diagnostics via fieldbus

The inclination sensor provides several objects and messages to indicate state or error state:

- object 1001h: This object serves as error register for the device error state.
- object 1003h: This object saves the last 8 error codes and warnings.
- object emergency (80h + Node-ID): High-priority error message of a user including error code and error register.
- SDO Abort Message: If SDO communication does not run properly the SDO response will come with an abort code.

Object 1001h Error register
This register is indicating an existing device error together with its kind.

See separate object meaning

Object 1003h Predefined error field
In this object the last 8 error codes occurred out of the objects 6503h and 6505h are saved, the latest error as entry in subindex 1, the most ancient error as entry in subindex 8.

Object Emergency
Error message of a user.

SDO Abort Message

If SDO communication does not run properly, the SDO response will come with an abort code:

05040001h : Command byte not supported
06010000h : Incorrect object access
06010001h : Read access on write only
06010002h : Write access on read only
06020000h : Object not supported
06090011h : Subindex not supported
06090030h : Value outside the limit
06090031h : Value too high
08000000h : General error
08000020h : Incorrect saving signature ("save")
08000021h : No data saving possible

4.3. Useful information on the sensor

Setting a new Node-ID

1. Setting a new Node-ID is by using Baumer Germany-specific object 2100h.
2. After having set the new Node-ID latter must be stored in EEPROM by object 1010h.
3. Upon next init the sensor will log in with the new Node-ID.

Setting a new baud rate

1. Setting a new baud rate is by using Baumer Germany-specific object 2101h.
2. After having set the new baud rate latter must be stored in EEPROM by object 1010h.
3. Upon next init the sensor will log in utilizing the new baud rate.
4. ! DO NOT FORGET TO ALIGN THE NEW BAUD RATE WITH MASTER!

Shield

The inclination sensor’s base plate should always be grounded. By principle the inclination sensor should be connected by shielded cable.
Ideally, aim at a bilateral cable shield if possible. Take care that no compensating currents are drained off the inclination sensor.

5. Applications

5.1. Write and read SDO objects

To write or read an object (SDO) always two telegrams are transmitted

Write object
First the value to write is transmitted by master, then the inclination sensor will confirm.

Value (ba) transmitted:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	2Bh	00h	23h	3h	a	b	x	x

Confirmation:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
580h+Node-ID	8	60h	00h	23h	3h	0	0	0	0

Read object
First the required object is requested by master, second the inclination sensor will respond by transmitting the requested value.

Master request:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	40h	10h	61h	0h	x	x	x	x

Response (dcba) of the inclination sensor to master request:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
580h+Node-ID	8	43h	10h	61h	0h	a	b	c	d

Commissioning
When connected the bus the inclination sensor will give a BootUp message. Now it must be configured and adapted to its ambiance.

Changing Node-ID and baud rate by LSS
Node-ID and baud rate can be changed without having to address the inclination sensor by them. LSS services enable sensor configuration and addressing by product code, revsion number, Vendor ID and serial number.

Changing the Node-ID
The Node-ID can be changed in object 2101h from 1 to 127. Next step should be a saving operation using object 1010h. Upon next init the sensor will log in with the new Node-ID.

Changing the baud rate
Object 2100h is for changing the baud rate. Not the real baud rate is written in the object but an index:

	Baud rate
0	10 kBaud
1	20 kBaud
2	50 kBaud
3	100 kBaud
4	125 kBaud
5	250 kBaud
6	500 kBaud
7	800 kBaud
8	1000 kBaud

Now the baud rate must be saved by object 1010-1. Upon next init the inclination sensor will log in with the new baud rate. Prior to next sensor init the baud rate of the master should be aligned.

5.2. Configuration

Changing the resolution
See object 6000h

Setting a new slope value
See objects 6112h and 6122h

Changing polarity and scaling
See objects 6111h and 6121h

Parameter saving in EEPROM
Object 1010h saves the objects below non-volatile in EEPROM. To prevent any inadvertent saving operation the message „save“ must be written in subindex 1.

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+Node-ID	8	23h	10h	10h	01h	73 's’	61 'a’	76 'v’	65 'e’

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
580h+Node-ID	8	60h	10h	10h	01h	0	0	0	0

5.3. Operation

NMT states
After init the inclination sensor is in **Pre-Operational Mode** which is the state for reading and writing SDOs.

To start PDO communication **NMT-Start** must be transmitted to switch the inclination sensor to **Operational Mode**. Now the required PDO's are transmitted. Now there is also read and write access to SDOs.

Upon stopping the inclination sensor by **NMT-Stop** it will got to **Stopped Mode**. This state is only for NMT communication including Heartbeat.

NMT-Reset means re-init of the inclination sensor that now will be in **Pre-Operational Mode** again .

The NMT state is indicated by LED (refer to chapter Status LED)

Setting the Heartbeat Time
For guarding the communication capability a „Producer Hearbeat Time“ must be defined in object 1017h. The service will be utilized upon confirmation of the parameter. Example: Every 100 ms the inclination sensor shall transmit a heartbeat (100 = 64h):

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1
600h+Node-ID	8	2Bh	17h	10h	0h	64h	0h

Confirmation:

COB-ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1
580h+Node-ID	8	60h	17h	10h	0h	0	0

COB-ID	Data/ Remote	Byte 0
701h	d	7Fh

Hearbeat messages comprise COB-ID and one byte, latter is transmitting the NMT state.

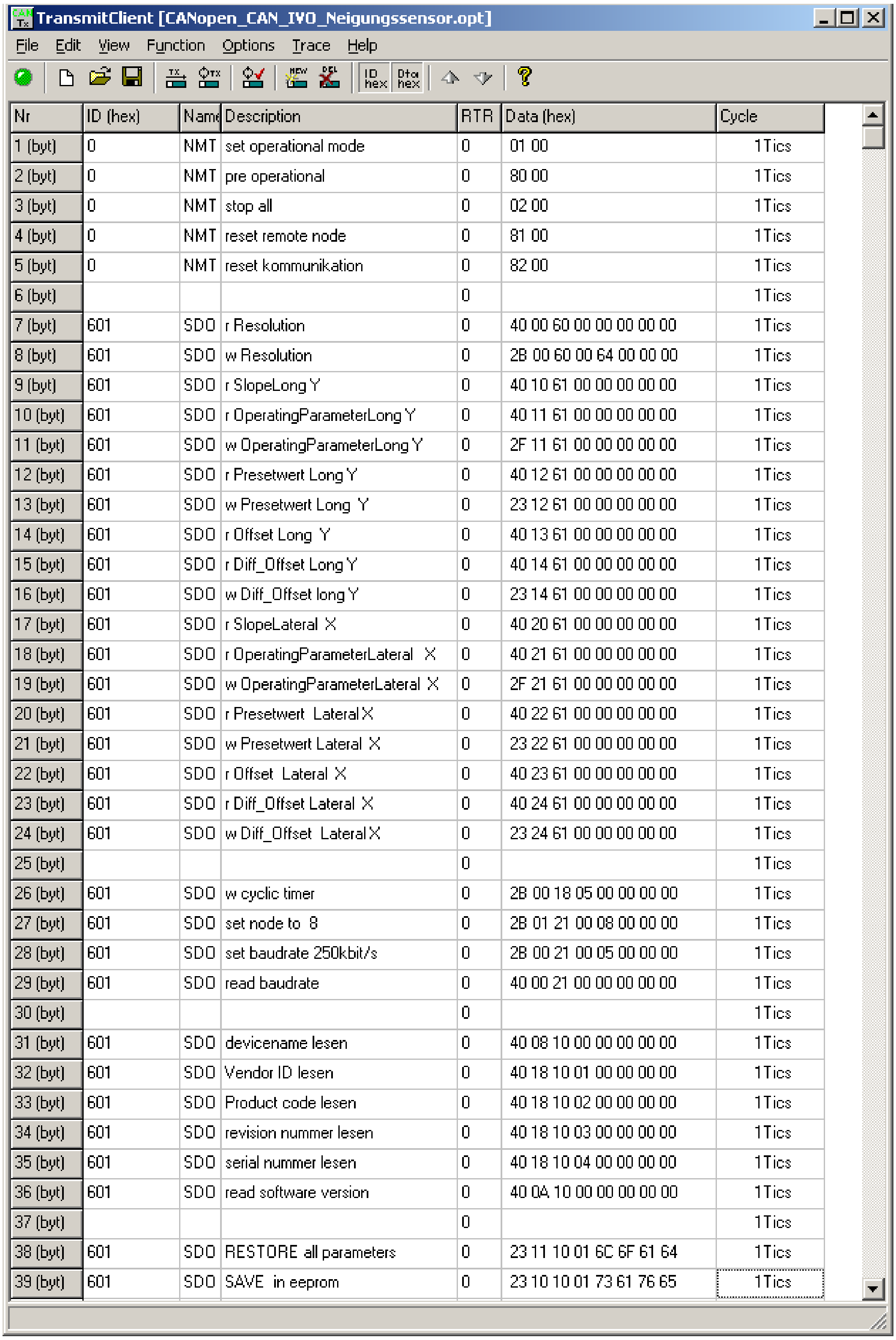
0:	BootUp-Event
4:	Stopped
5:	Operational
127:	Pre-Operational

i.e. the inclination sensor is in pre-operational mode (7Fh = 127).

5.4. Commissioning via CAN

Comfortable commissioning of the CANopen inclination sensor via CAN (Layer 2)
Example: Inclination sensor with Node-ID 1, some NMT and SDO commands

Tool applied: CANAnalyser32 by IXXAT

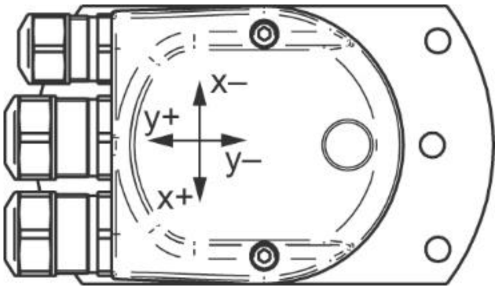


Nr	ID (hex)	Name	Description	RTR	Data (hex)	Cycle
1 (byt)	0	NMT	set operational mode	0	01 00	1Tics
2 (byt)	0	NMT	pre operational	0	80 00	1Tics
3 (byt)	0	NMT	stop all	0	02 00	1Tics
4 (byt)	0	NMT	reset remote node	0	81 00	1Tics
5 (byt)	0	NMT	reset kommunikation	0	82 00	1Tics
6 (byt)				0		1Tics
7 (byt)	601	SDO	r Resolution	0	40 00 60 00 00 00 00 00	1Tics
8 (byt)	601	SDO	w Resolution	0	2B 00 60 00 64 00 00 00	1Tics
9 (byt)	601	SDO	r SlopeLong Y	0	40 10 61 00 00 00 00 00	1Tics
10 (byt)	601	SDO	r OperatingParameterLong Y	0	40 11 61 00 00 00 00 00	1Tics
11 (byt)	601	SDO	w OperatingParameterLong Y	0	2F 11 61 00 00 00 00 00	1Tics
12 (byt)	601	SDO	r Presetwert Long Y	0	40 12 61 00 00 00 00 00	1Tics
13 (byt)	601	SDO	w Presetwert Long Y	0	23 12 61 00 00 00 00 00	1Tics
14 (byt)	601	SDO	r Offset Long Y	0	40 13 61 00 00 00 00 00	1Tics
15 (byt)	601	SDO	r Diff_Offset Long Y	0	40 14 61 00 00 00 00 00	1Tics
16 (byt)	601	SDO	w Diff_Offset long Y	0	23 14 61 00 00 00 00 00	1Tics
17 (byt)	601	SDO	r SlopeLateral X	0	40 20 61 00 00 00 00 00	1Tics
18 (byt)	601	SDO	r OperatingParameterLateral X	0	40 21 61 00 00 00 00 00	1Tics
19 (byt)	601	SDO	w OperatingParameterLateral X	0	2F 21 61 00 00 00 00 00	1Tics
20 (byt)	601	SDO	r Presetwert Lateral X	0	40 22 61 00 00 00 00 00	1Tics
21 (byt)	601	SDO	w Presetwert Lateral X	0	23 22 61 00 00 00 00 00	1Tics
22 (byt)	601	SDO	r Offset Lateral X	0	40 23 61 00 00 00 00 00	1Tics
23 (byt)	601	SDO	r Diff_Offset Lateral X	0	40 24 61 00 00 00 00 00	1Tics
24 (byt)	601	SDO	w Diff_Offset Lateral X	0	23 24 61 00 00 00 00 00	1Tics
25 (byt)				0		1Tics
26 (byt)	601	SDO	w cyclic timer	0	2B 00 18 05 00 00 00 00	1Tics
27 (byt)	601	SDO	set node to 8	0	2B 01 21 00 08 00 00 00	1Tics
28 (byt)	601	SDO	set baudrate 250kbit/s	0	2B 00 21 00 05 00 00 00	1Tics
29 (byt)	601	SDO	read baudrate	0	40 00 21 00 00 00 00 00	1Tics
30 (byt)				0		1Tics
31 (byt)	601	SDO	devicename lesen	0	40 08 10 00 00 00 00 00	1Tics
32 (byt)	601	SDO	Vendor ID lesen	0	40 18 10 01 00 00 00 00	1Tics
33 (byt)	601	SDO	Product code lesen	0	40 18 10 02 00 00 00 00	1Tics
34 (byt)	601	SDO	revision nummer lesen	0	40 18 10 03 00 00 00 00	1Tics
35 (byt)	601	SDO	serial nummer lesen	0	40 18 10 04 00 00 00 00	1Tics
36 (byt)	601	SDO	read software version	0	40 0A 10 00 00 00 00 00	1Tics
37 (byt)				0		1Tics
38 (byt)	601	SDO	RESTORE all parameters	0	23 11 10 01 6C 6F 61 64	1Tics
39 (byt)	601	SDO	SAVE in eeprom	0	23 10 10 01 73 61 76 65	1Tics

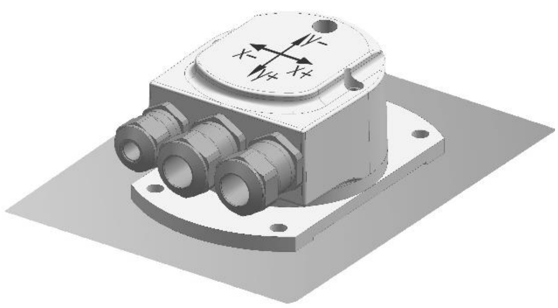
6. Terminal assignment and commisisoning

6.1. Mechanical mounting

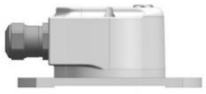
- Release both fastening screws of the bus cover.
- Carefully loosen the bus cover from the base plate and lift off in the axial direction.
- Firmly screw the base plate in place using the fastening holes.
- The bus cover must fully rest against the base plate. Any tolerances in mounting the bus cover to the base plate might affect the absolute slope angle.
- Alignment of coordinates (y- / y+ / x- / x+) see following diagram:



Installation position – sensing range 15°, 30° und 60°



The two-dimensional inclination sensor with a sensing range of 15°, 30° and 60° must be mounted with the base plate in horizontal position, i.e. parallel to the horizontal line.
The inclination sensor may also be installed upside down, i.e. turned by 180°.
The sensor can be inclined both in lateral (X-axis) and longitudinal (Y- axis) direction at the same time. For each axis a separate measured value is provided.
As default parameter the inclination sensor will apply the selected sensing range to both the X- and Y-axis, for example ±15° with the zero passage being precisely in the horizontal line.

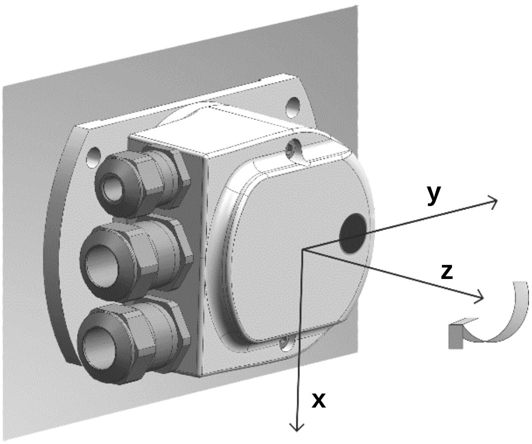

Default 0°

Measured inclination +30°

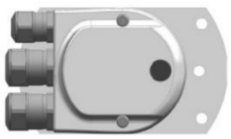
Default 0°

Measured inclination +30°

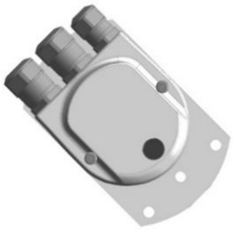
Installation position - Sensing range 360°



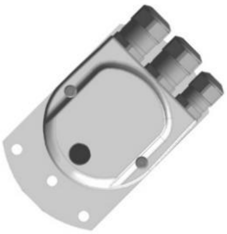
The inclination sensor featuring a 360º sensing range must be installed in a way that the X-axis as in the illustration is in parallel alignment with gravity. The deflection may not be more than ±3º.
Please note that the inclination sensor must fully and evenly rest on the contact surface and whilst inclination/rotation must not be subject to any misalignment in the X- or Y-direction since this would affect the sensing accuracy.
The 360° inclination sensor default position is 0° as shown in the following illustration but may be optionally configured by help of the preset function.
The measuring direction may also be inverted. Default parameter of the inclination sensor's sensing direction is clockwise from 0...360°, in case of active inversion counter-clockwise.



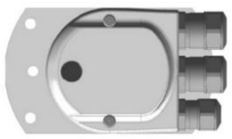
Default 0°



Measured inclination 45°



Measured inclination 135°



Measured inclination 180°

6.2. Electrical connection

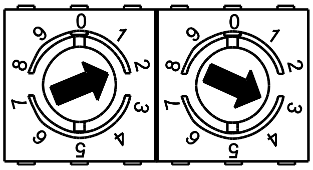
The inclination sensor must fully rest on the base plate and be firmly screwed in place.
For e-connection of the bus cover please proceed as follows:

- Release both fastening screws of the bus cover
- Carefully loosen the bus cover and lift off from the base plate in the axial direction.

6.2.1. Setting the user address

Setting the user address is by EEPROM. The Node-ID (user address) is defined in object 2101h. Another option is decimal setting of the user address using two rotary switches provided in the bus cover. If the switches are on 0 the Node-ID out of the EEPROM will be utilized. As soon as the switches are set to a certain value this will be utilized as user address. Maximum user total is 99.

- Decimal setting of the user address using two rotary switches 1 and 2 (default 00).



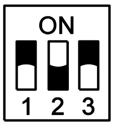
Example: 23

6.2.2. Setting the baud rate

The baud rate is defined in object 2100h. Another option is binary setting of the baud rate using the 3-pin-DIP switches 1 to 3 provided in the bus cover. The baud rate out of the EEPROM will be ingnored as soon as the switches are not on 0.

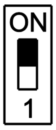
Baud rate	DIP-switch position		
	1	2	3
10 kBit/s	OFF	OFF	OFF
20 kBit/s	OFF	OFF	ON
50 kBit/s *	OFF	ON	OFF
125 kBit/s	OFF	ON	ON
250 kBit/s	ON	OFF	OFF
500 kBit/s	ON	OFF	ON
800 kBit/s	ON	ON	OFF
1 MBit/s	ON	ON	ON

* Default



6.2.3. Terminating resistor

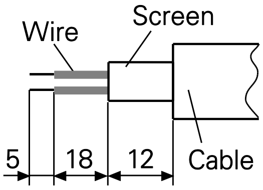
If the inclination sensor is the final device in the bus line the bus must be terminated using the terminating resistor in the bus cover by switching the one-pin DIP switch to “ON” (default OFF).

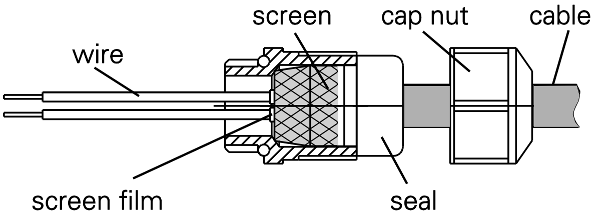


ON = last user
OFF = user X

6.2.4. Connecting the inclination sensor

- Release the cap nut of the cable gland
- Push the cap nut and seal insert with contact sleeve onto the cable sheath.
- Strip the cable sheath and cores, shorten the shield film where existing (see fig.)
- Bend over the braided shield by approx. 90°
- Push the seal insert with contact sleeves along as far as the braided shield. Insert the sealing insert with contact sleeve and cable flush into the cable gland and tighten the cap nut.

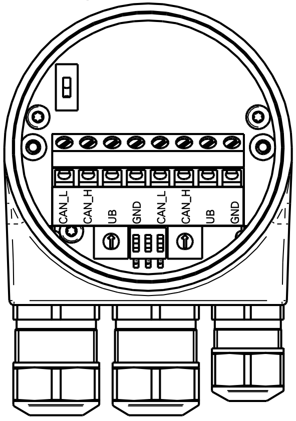




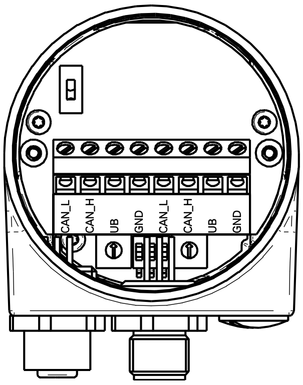
- Clamps of the same designation are internally connected to each other.
- For supply voltage use cable gland 3 only. For the bus lines, either cable gland 1 or 2 may be used. Please observe the admissible cable cross-sections.
- Guide the cores the shortest way from the cable gland to the terminal connector. Please observe the admissible core cross-sections. Use ferrules in case of flexible cores.
- Avoid any crossings of data lines with the supply line.
- Seal up the unused cable gland using a sealing bolt (included in the delivery).

View inside the inclination sensor

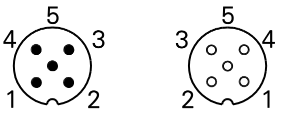
Cable gland



M12 connector



6.2.5. Terminal assignment

Pin	Terminal	Explanation	M12-connector (male/female)
1	GND	Ground connection relating to UB	
2	UB	Supply voltage 10...30 VDC	
3	GND	Ground connection relating to UB	
4	CAN_H	CAN Bus signal (dominant High)	
5	CAN_L	CAN Bus signal (dominant Low)	

Terminals with the same designation are connected to each other internally and identical in their functions. Maximum load on the internal clamps UB-UB and GND-GND is 1 A each.

6.3. Status LEDs (status indicators)

An integrated DUO-LED is provided on the back of inclination sensor housing.

LED green	LED red	Status
Off	Off	No supply voltage
Flashing	Off	Pre-operational Mode
On	Off	Operational Mode
On	On	Stopped/Prepared Mode
Off	Flashing	Alert/warning
Off	Off	Error