Baumer

Passion for Sensors

Manual

Inclination sensor GIM500R with CANopen® interface

Firmware version 1.00 and up

03.19· 174.02.073/4

Contents Page

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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	Measuring direction	Device name	EDS file
GIM500R	0x40	1-dimensional	GIM500	160502_GIM500R_V1_00_PDO_SPEC_1_1dimensional
GIM500R	0x40	2-dimensional	GIM500	160502_GIM500R_V1_00_PDO_SPEC_1_2dimensional

2 Safety and operating instructions

Intended use

- The inclination sensor is a precision measuring device to determine angular positions and to supply the downstream device with measured values in the form of electronic output signals. The inclination sensor must not be used for any other purpose.
- Make sure the appropriate safety measures are present to prevent damage to persons, the system or operating facilities in case of sensor error or failure.

Personnel qualification

- The inclination sensor must only be installed by a qualified electronics and precision mechanics.
- Observe the user manual of the machine manufacturer.

Maintenance

- The inclination sensor is maintenance-free and must not be opened or modified in its electronics or mechanical design. Opening the sensor can lead to personal injury.

Disposal

- The inclination sensor contains electronic components. At its disposal, local environmental guidelines must be followed.

Installation

- Avoid mechanical impacts or shocks on the housing.

Electrical commissioning

- Do not perform any electrical modifications at the inclination sensor.
- Do not carry out any wiring work when the inclination sensor is live.
- Do not dock or undock the electrical connection while the inclination sensor 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 sensor and supply cables separately or far away from lines with high interference emissions (frequency converters, contactors, etc.).
- Provide 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 sensor to protective earth (PE) using shielded cables. The braided shield must be connected to the cable gland or connector. Ideally, aim at a bilateral connection to protective earth (PE), the housing via the mechanical assembly and the cable shield via the downstream devices. In case of earth loop problems, earth on one side only as a minimum requirement.

Supplementary information

- This manual is intended as a supplement to already existing documentation (i.e. catalogue, product information and mounting instruction).

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 commercialized 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 CAN-bus characteristics

- Data rate of 1 MBaud with network expansion up to 40 m
- Network connected on both sides
- The bus medium is a twisted-pair cable
- Real time capability: Defined maximum waiting time for high-priority messages.
- Theoretically 127 users at one bus, but physically only 32 are possible (due to the driver).
- Ensures data consistency across the network. Damaged messages are notified as faulty for all network nodes.
- Message-oriented communication
  The message is identified by a message identifier. All network nodes use the identifier to test whether the message is of relevance for them.
- Broadcasting, multicasting
  All network nodes receive each message simultaneously. Synchronization is therefore possible.
- Multimaster capability
  Each user in the field bus is able to independently transmit and receive data without being dependent upon the priority of the master. Each user is able to start its message when the bus is not occupied. When messages are sent simultaneously, the user with the highest priority prevails.
- Prioritization of messages
  The identifier defines the priority of the message. This ensures that important messages are transmitted quickly via the bus.
- Residual error probability
  Safety procedures in the network reduce the probability of an undiscovered faulty data transmission to below 10^{-11}. In practical terms, it is possible to ensure a 100% reliable transmission.
- Function monitoring
  Localization of faulty or failed stations. The CAN protocol encompasses a network node monitoring function. The function of network nodes which are faulty is restricted, or they are completely uncoupled from the network.
- Data transmission with short error recovery time
  By using several error detection mechanisms, falsified messages are detected to a high degree of probability. If an error is detected, the message transmission is automatically repeated.

In the CAN Bus, several network users are connected by means of a bus cable. Each network user is able to transmit and receive messages. The data between network users is serially transmitted.

Examples of network users for CAN bus devices are:
- Automation devices such as PLCs
- PCs
- Input and output modules
- Drive control systems
- Analysis devices, such as a CAN monitor
- Control and input devices as Human Machine Interfaces (HMI)
- Sensors and actuators

3.2 CANopen

Under the technical management of the Steinbeis Transfer Centre for Automation, the CANopen profile was developed on the basis of the Layer 7 specification CAL (CAN Application Layer). In comparison with CAL, CANopen only contains the functions suitable for this application. CANopen thus represents only a partial function of CAL optimized for the application in hand, so permitting a simplified system structure and the use of simplified devices. CANopen is optimized for fast data exchange in real time systems.
The organization CAN in Automation (CiA) is responsible for the applicable standards of the relevant profiles.
CANopen permits:
• Simplified access to all device and communication parameters
• Synchronization of several devices
• Automatic configuration of the network
• Cyclical and event-controlled process data communication

CANopen comprises four communication objects (COB) with different characteristics:
• Process data objects for real time data (PDO)
• Service data objects for parameter and program transmission (SDO)
• Network management (NMT, Heartbeat)
• Pre-defined objects (for synchronization, emergency message)

All device and communication parameters are subdivided into an object directory. An object directory encompasses the name of the object, data type, number of subindexes, structure of the parameters and the address. According to CiA, this object directory is subdivided into three different parts. Communication profile, device profile and a manufacturer-specific profile (see object directory).

3.3 CANopen communication

3.3.1 Communication profile

Communication between the network users and the Master (PC / Control) takes place by means of object directories and objects. The objects are addressed via a 16 bit index. The CANopen communication profile DS 301 standardizes the various communication objects. They are accordingly divided into several groups:

• Process data objects PDO for real time transmission of process data
• Service data objects SDO for read/write access to the object directory
• Objects for synchronization and error display of CAN users:
    - SYNC object (synchronization object) for synchronization of network users
    - EMCY object (emergency object) for error display of a device or its peripherals
• Network management NMT for initialization and network control
• Layer Setting Services LSS for configuration by means of serial numbers, revision numbers etc. in the middle of an existing network

3.3.2 CANopen message structure

The first part of a message is the COB ID (Identifier).
Structure of the 11-bit COB ID:

Function code				Node ID						
4-bit function code				7-bit node ID						

The function code provides information on the type 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 viewpoint of the sensor

The node ID can be freely selected by means of the CANopen bus between 1 and 127.
The sensors are supplied with the Node ID 1 and baud rate 50 kBit/s.
This can be changed with the service data object 2101h or object 2100h or using LSS.

A CAN telegram is made up of the COB ID and up to 8 bytes of data:

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

The precise telegram is outlined in more detail at a later point.

3.3.3 Service data communication

The service data objects correspond to the standards of the CiA. It is possible to access an object via index and subindex. The data can be requested or where applicable written into the object.

General information on the SDO

Structure of an **SDO telegram**:

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

An SDO-**COB ID** is composed as follows:
Master -> Sensor : 600h + Node ID
Sensor -> Master : 580h + Node ID

DLC (data length code) describes the length of the telegram. This is composed as follows:
1 byte command + 2 bytes object + 1 byte subindex + no. of data bytes (0 - 4).

The **command byte** defines whether data is read or set, and how many data bytes are involved.

SDO command	Description	Data length	
22h	Download request	Max. 4 Byte	Transmits parameter to sensor
23h	Download request	4 byte	
2Bh	Download request	2 byte	
2Fh	Download request	1 byte	
60h	Download response	-	Confirms receipt to master
40h	Upload request	-	Requests parameter from sensor
42h	Upload response	Max. 4 byte	Parameter to master with max. 4 byte
43h	Upload response	4 byte	
4Bh	Upload response	2 byte	
4Fh	Upload response	1 byte	
80h	Abort message	-	Sensor signals error code to master

An **abort message** indicates an error in the CAN communication. The SDO command byte is 80h. The object and subindex are those of the requested object. The error code is contained 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 results in the SDO abort message (byte 8 = MSB).
The following messages are supported:

05040001h : Command byte is not supported
06010000h : Incorrect access to an object
06010001h : Read access to write only
06010002h : Write access to read only
06020000h : Object is not supported
06090011h : Subindex is not supported
06090030h : Value outside the limit
06090031h : Value too great
08000000h : General error
08000020h : Incorrect save signature
08000021h : Data cannot be stored

SDO examples

Request of the resolution value by the master from the slave
A frequent request will be a request for the 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 by the slave **to the request** for a value
The resolution is 2 bytes long, the precise values can be found under object 6000h.

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

Writing of a value by the master into the slave
Inclination setting can be performed with preset for longitudinal slope. → Object 6012h

COB ID	DLC	Command	Object L	Object H	Subindex	Data 0	Data 1	Data 2	Data 3
600h+node ID	8	2Bh	12h	60h	0	a	b	c	d

Slave's **response** to the **writing of a value**

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

3.3.4 Process data communication

Process data objects are used for real time data exchange for process data, for example inclination or operating status. PDOs can be transmitted synchronously or cyclically (asynchronously).

Synchronous

In order to transmit the process data synchronously, a value between 1 and F0h (=240) must be written into the object 1800h Subindex 2. If the value is 3, the PDO is transmitted on every third sync telegram (if the value 1 is entered, transmission takes place on every sync telegram). The counter for the number of PDOs to be transmitted is reset in the event of a position change or NMT reset, i.e. unless it is changed, the position is transmitted five times. If the position changes, it is transmitted a further five times.

In synchronous operation, the PDO is requested by the master via the Sync telegram.

Byte 0	Byte 1
COB ID = 80	0

Cyclical (asynchronous)

If you wish the PDOs to be transmitted cyclically, the value FEh must be written into the object 1800h / 1801h Subindex 2. In addition, the cycle time in milliseconds must be entered in the same object subindex 5. The entered time is rounded off to 1 ms. If the value is stored for 0 ms, the PDOs are not transmitted. The function is switched off.

Overview
In the following table, the different transmission modes for PDOs are summarized:

1800h		Summarized description
Sub2	Sub5	
FEh/FFh	3ms	Cyclical transmission every 3 ms
FEh/FFh	0ms	Transmit PDO switched off
3	xxx	Transmit with every third sync telegram

Object 1A00h subindex 0-3 defines the PDO - mapping. The format is shown in the following table:

ID	DLC	Byte 1+2	Byte 3+4	Byte 5+6
181h	6	6511h (Temperature)	6010h (horizontal / long Value / X)	6020h (vertical / lateral Value / Y)

3.3.5 Emergency service

Internal device error or bus problems initiate an emergency message:

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 ID		Manufacturer Specific			

Byte 0+1: Error Codes

Error Code (hex)	Meaning
0000	Error Reset or No Error
1000	Generic Error
4200	Device Temperature (Internal temperature above working temperature)
5010	Physical Measurement Error (Sensor is out of measuring range)
FF01	Internal Sensor Error

The GIM500 inclination sensor features varied diagnostic options.
In the event of error affecting device operation, an emergency message is once transmitted by Error ID.
The error should be considered as active, until the sensor is sending 0000h Error code for the corresponding Error ID.
The LED is red continuous as long as the error is present. For the time of error presence, the inclination value should be considered invalid. Should the error prevail and remain active, please contact Baumer support.

Diagnosis active errors

CANopen

- The LED status indicator lights up red.
- If the error is active, an error message is sent.

CANopen EMCY-Message Frame Structure:

COB-ID [hex]	Error Code LSB [hex]	Error Code MSB [hex]	Error Register [hex]	Error Module LSB [hex]	Error Module MSB [hex]	Error ID MSB [hex]	Error ID LSB [hex]	Reserved [hex]	Description
0x80+Node-ID	00	10	00	See error list	See error list	See error list	See error list	00	“Generic error” was set
0x80+Node-ID	00	00	00	See error list	See error list	00	00	00	“Generic error” was reset
0x80+Node-ID	00	42	00	00	10	10	00	00	“Temperature error” was set
0x80+Node-ID	00	00	00	00	10	00	00	00	“Temperature error” was reset
0x80+Node-ID	01	FF	00	00	22	10	01	00	„Longitudinal sensor defect“ was set

0x80+Node-ID	00	00	00	00	22	00	00	00	„Longitudinal sensor defect“ was reset
0x80+Node-ID	10	50	00	00	06	10	00	00	“Longitudinal value out of range” was set
0x80+Node-ID	00	00	00	00	06	00	00	00	“Longitudinal value out of range” was reset

CANopen Error List

Error Module ID	Error ID	Error Description
0x0000	0x0005	index out of bound
0x0001	0x1001	scheduler initialization
	0x0001	zero pointer
0x0002	0x0005	index out of bound
0x0003	0x0001	zero pointer
	0x0005	index out of bound
	0x0006	switch default case reached
0x0004	0x0006	switch default case reached
0x0005	0x0004	checksum
0x0006	0x000B	division by zero
	0x1000	device flipped
0x0007	0x1001	overvoltage 5v operating
	0x1002	overvoltage 5v max
	0x1003	overvoltage 3.3v max
	0x1004	overvoltage 3.3v operating
0x0008	0x0001	zero pointer
0x0009	0x1000	stack overflow
0x000A	0x1000	RAM test wrong area
	0x1001	RAM error
	0x0006	switch default case reached
0x000B	0x0001	zero pointer
	0x0006	switch default case reached
	0x1000	acc sensor configuration
	0x1001	acc control register
	0x1002	FIFO overflow
	0x1003	wrong full scale range
0x000C	0x0001	zero pointer
0x000D	0x1001	IWDG restart
0x000E	0x0005	index out of bound
	0x0009	time out
	0x1000	I2C clock speed
	0x1003	I2C data length
	0x1004	I2C GPIO Stuck
0x000F	0x0005	index out of bound
0x0010	0x0005	index out of bound

	0x1000	operating temperature beyond specified area
0x0011	0x0005	index out of bound
0x0012	0x0001	zero pointer
	0x0004	checksum
	0x0005	Array Index error
	0x000B	division by zero
0x0013	0x0005	index out of bound
0x0014	0x0005	index out of bound
0x0015	0x0005	index out of bound
0x0016	0x0001	zero pointer
	0x1000	Wrong DAC channel
0x0017	0x0001	zero pointer
	0x0006	switch default case reached
	0x0009	time out
0x0018	0x0001	zero pointer
0x0019	0x0005	index out of bound
0x001A	0x0001	zero pointer
	0x1000	FRAM volume
	0x1001	FRAM write error
	0x1002	FRAM reset status
0x001B	0x0001	zero pointer
	0x1001	Wrong error module ID
	0x1002	Not existing Error ID
0x001C	0x0001	zero pointer
	0x1000	DAC output mode
	0x1001	Channel number
	0x1002	Channel initialization
	0x1003	Gain zero
	0x1004	Position beyond specified area
0x001D	0x0001	zero pointer
	0x000B	division by zero
0x001E	0x0006	switch default case reached
	0x1000	CPU operation error
	0x1001	CPU operation error
	0x1002	CPU operation error
	0x1003	CPU operation error
	0x1004	CPU operation error
	0x1005	CPU operation error
	0x1006	CPU operation error
	0x1007	CPU operation error
	0x1008	CPU operation error
	0x1009	CPU operation error
	0x100A	CPU operation error
	0x100B	CPU operation error
	0x100C	CPU operation error
	0x100D	CPU operation error
0x001F	0x000A	Overflow
0x0020	0x0001	zero pointer
	0x0006	switch default case reached

0x0021	0x0001	zero pointer
	0x0005	index out of bound
	0x0006	switch default case reached
0x0022	0x0005	index out of bound
	0x1000	MEMS initialization
	0x1001	Static acc data
0x0023	0x1000	Parameterization error
	0x1001	Parameterization error
	0x1002	Parameterization error
	0x1003	Parameterization error
	0x1004	Parameterization error
	0x1005	Parameterization error
	0x1006	Parameterization error
	0x1007	Parameterization error
0x0024	0x0005	index out of bound
0x0025	0x0006	switch default case reached
0x0026	0x0006	switch default case reached
0x0027	0x0006	switch default case reached
0x0028	0x0006	switch default case reached
	0x000A	Overflow
0x0029	0x0005	index out of bound
0x002A	0x0006	switch default case reached
	0x000A	Overflow
0x002B	0x0006	switch default case reached

3.3.6 Network management services

Network management can be divided into two groups.
Using the NMT services for **device monitoring**, bus users can be initialized, started and stopped.
In addition, NMT services exist for **connection monitoring**.

Description of the NMT command

The commands are transmitted as unconfirmed objects and are structured as follows:

Byte 0	Byte 1	Byte 2
COB ID = 0	Command byte	Node number

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

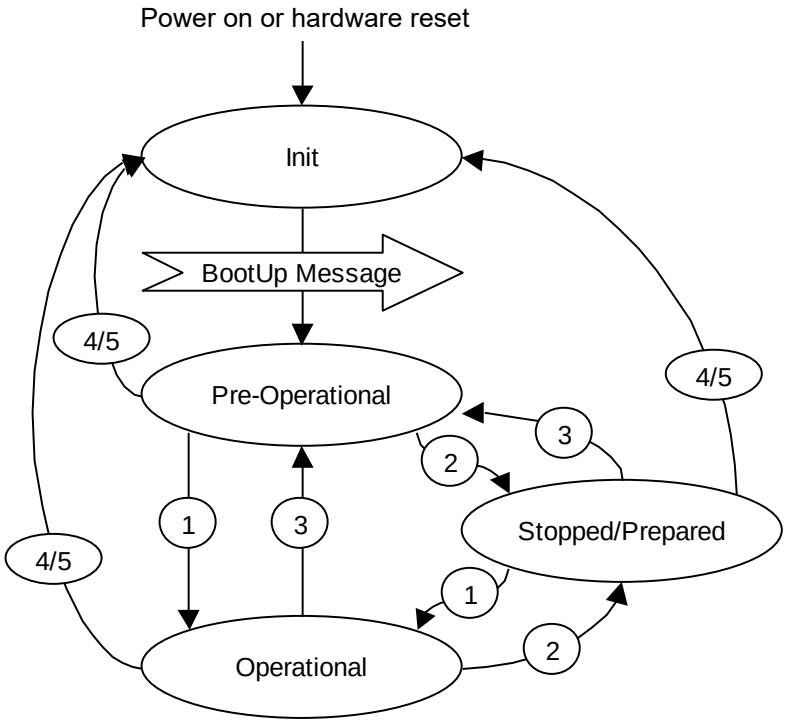
Command byte

Command byte	Description	In state event drawing
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** corresponds to the node ID of the required users. With node number = 0, all users are addressed.

NMT state event

Following initialization, the encoder is in the pre-operational mode. In this status, SDO parameters can be read and written. In order to request PDO parameters, the encoder must first be moved to the operational mode status.



The various NMT statuses

Init

Following initialization, the encoder logs on to the CAN bus with a BootUp message. The encoder then goes automatically to the pre-operational mode status.

The COB ID of the BootUp message is made up of 700h and the node ID.

COB ID	Byte 0
700h + node ID	00

Pre-operational mode

In the pre-operational mode, SDOs can be read and written.

Operational mode

In the operational mode, the encoder transmits the requested PDOs. In addition, SDOs can be read and written.

Stopped or prepared mode

In the stopped mode, only NMT communication is possible. No SDO parameters can be read or set. LSS is only possible in the stopped mode.

Status change

Start remote node (1)

With the start command, the encoder is switched to the operational mode status.

COB ID	Command byte	Node number
0	1h	0…127

Stop remote node (2)

With the stop command, the encoder is switched to the stopped or prepared mode status.

COB ID	Command byte	Node number
0	2h	0…127

Enter pre-operational mode (3)

Change to the pre-operational mode status.

COB ID	Command byte	Node number
0	80h	0…127

Reset remote node (4) or reset communication (5)

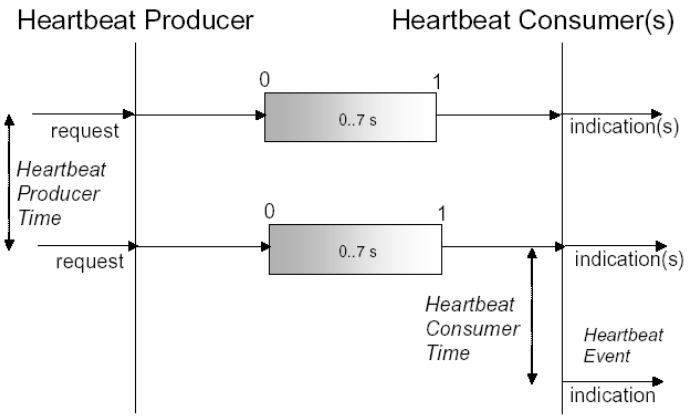
With the reset command, the sensor is re-initialized.
Reset remote node (4):

COB ID	Command byte	Node number
0	81h	0…127

Reset communication (5):

COB ID	Command byte	Node number
0	82h	0…127

3.3.6.1 Heartbeat protocol



The heartbeat protocol should substitute the life/node guarding protocol. Heartbeat is active, if object 2110h Bit5 has the value '0'. It is highly recommended to implement the heartbeat protocol for new device designs. A Heartbeat Producer transmits the Heartbeat message cyclically with the frequency defined in Heartbeat producer time object. One or more Heartbeat Consumer may receive the indication. The relationship between producer and consumer is configurable via Object Dictionary entries. The Heartbeat Consumer guards the reception of the Heartbeat within the Heartbeat consumer time. If the Heartbeat is not received within this time a Heartbeat Event will be generated "Communication error object 1029h-1h".

Example for a heartbeat protocol

COB-ID	Data/Remote	Byte 0
701h	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).

3.3.6.2 Layer Setting Services

In the spring of 2000, CiA drafted a new protocol intended to ensure standardized occurrence. The procedure is described under
Layer Setting Services and Protocol, CiA Draft Standard Proposal 305 (LSS).
The sensor is supplied by us as standard with the node ID 1 and a baud rate of 50 kBaud. Several sensors can be connected to the bus system with the same node ID. To allow individual sensors to be addressed, LSS is used.
Each sensor is fitted with its own unique serial number and is addressed using this 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 only be executed in the **Stopped Mode**.

Message structure

COB ID:

Master → Slave : 2021 = 7E5h
Master ← Slave : 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
7E4h ←	44h	Mode	reserved

Vendor ID : ECh
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 encoder'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	SpecError	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.

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

This protocol saves the configuration parameters in the EEPROM.

7E5h →	17h	reserved

7E4h ←	17h	ErrCode	SpecError	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 slave in ms.
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 : = ECh

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

3.4 Object Dictionary

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

- **Standard communication objects**:
  1000h – 1FFFh
- **Manufacturer-specific objects**:
  2000h - 5FFFh
- **Device-specific objects**:
  6000h - FFFFh

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

Object Object number in Hex
Name Name of the parameter
Format Data type
Access ro = ReadOnly, wo = WriteOnly, rw = ReadWrite
Default Default upon first init or restore default
Save yes → saved in None Volatile Memory

3.4.1 Communication Parameter (CiA DS-301, CiA DS-302 Part 2)

Object Sub-Index	Name	Format	Access	Default	Save
1000h	Device Type	U32	ro	102019Ah	
1001h	Error Register	U8	ro	0h	
1002h	Manufacturer Status register	U32	ro	0h	
1003h	PreDefined ErrorField				
00h	Maximum Subindex	U8	rw	0h	yes
01h	Latest entry	U32	ro		
..	..	..	..	..	
05h	Oldest entry	U32	ro		
1005h	Sync COB-ID	U32	rw	80h	yes
1008h	DeviceName	VSTR	ro	GIM500	
1009h	Hardware Version	VSTR	ro	1.00 or higher	
100Ah	Software Version	VSTR	ro	1.00 or higher	
1010h	Store Parameters				
00h	Maximum Subindex	U8	ro	4h	
01h	Save all parameters	U32	rw		
02h	Communication parameters	U32	rw		
03h	Application parameters	U32	rw		
04h	Manufacturer- specific parameters	U32	rw		
1011h	Restore Default Parameters				
00h	Maximum Subindex	U8	ro	4h	
01h	Restore all parameters	U32	rw		
02h	Restore communication parameters	U32	rw		
03h	Restore application parameters	U32	rw		
04h	Restore manufacturer specific parameters	U32	rw		
1014h	Emergency COB-ID	U32	rw	80h + Node-ID	yes
1016h	Consumer heartbeat time				yes
00h	Maximum Subindex	U8	ro	1h	
01h	Consumer heartbeat time	U32	rw	10000h	yes
1017h	Producer Heartbeat Time	U16	rw	0h	yes
1018h	Identity Object				
00h	Maximum Subindex	U8	ro	4h	
01h	VendorID	U32	ro	ECh	
02h	Product Code	U32	ro	40h	
03h	Revision Number	U32	ro	Works-defined	yes
04h	Serial Number	U32	ro	Works-defined	yes
1800h	Transmit PDO1 Parameter				
00h	Maximum subindex	U8	ro	5h	
01h	COB-ID	U32	rw	180h+id	yes
02h	PDO Type	U8	rw	FFh	yes

Object Sub-Index	Name	Format	Access	Default	Save
05h	EventTimer	U16	rw	C8h	yes
1A00h	Transmit PDO1 Mapping				
00h	Maximum Subindex	U8	ro	3h	
01h	Content of PDO1	U32	ro	65110010h	
02h	Content of PDO1	U32	ro	60100010h	
03h	Content of PDO1	U32	ro	60200010h	
1F80h	NMT startup	U32	rw	0h	yes

3.4.1.1 Store Parameters (1010h)

In order to save parameters object 1010h has to be accessed. In order to avoid storage of parameters by mistake, storage shall be only executed when a specific signature is written to the appropriate sub-index. The signature that shall be written is "save":

Signature	MSB			LSB
ISO8859 character	e	v	a	s
hex	65h	76h	61h	73h

The data saving process takes a few milliseconds and interrupts the data processing. Be careful to store the parameters when device data is not used.

3.4.1.2 Restore Parameters (1011h)

In order to avoid the restoring of default parameters by mistake, restoring shall be only executed when a specific signature is written to the appropriate sub-index. The signature that shall be written is "load":

Signature	MSB			LSB
ISO8859 character	d	a	o	l
hex	64h	61h	6Fh	6Ch

The restore is active after a power cycle or a after a CANopen reset.

3.4.1.3 NMT Startup (1F80h)

This object (specified in DS-302 Part 2) determines if the device will go to OPERATIONAL state after reset. For this option a 08h has to be written to the device. To turn off the auto OPERATIONAL state a 00h has to be written.

3.4.2 Manufacturer Specific Parameter

Object Sub-Index	Name	Format	Access	Default	Save
2100h	Baud rate	U8	rw	2h	yes
2101h	Node-ID	U8	rw	1h	yes
2106h	Axis Alignment				
00h	Maximum subindex	U8	ro		
01h	Axis Mapping	U8	rw	24h	yes
02h	Sign Configuration	U8	rw	0h	yes
2202h	Diagnostic Information		ro		
2203h	Layout ID		ro		
2204h	Diagnostic Information Switch		ro		
2205h	Device Revision		ro		
2603h	Digital Filter Configuration	U16	rw	32h	yes

3.4.2.1 Baud rate (2100h)

The baud rate can be changed and read through this object (Additionally to LSS). The following parameters are possible:

Baud rate (2100h)	
Value	**Description**
2	50kBaud
3	100kBaud
4	125kBaud
5	250kBaud
6	500kBaud
7	800kBaud
8	1000kBaud

The new baud rate will take effect after a restart. 10kBaud is not supported.

3.4.2.2 Node-ID (2101h)

The Node-ID can be changed and read through this object (Additionally to LSS). The parameters are possible:

Node-ID (2101h)	
Value	**Description**
1..127	Node-ID

The new Node-ID will take effect after a restart.

3.4.2.3 Axis Alignment (2106h)

By accessing this object a change of the device orientation can be done (swapping sign and switch axes). A change of the default orientation can lead to a loss of accuracy and is not suggested.

Axis mapping (subindex 1)

The axes can be switched as shown in the following tables:

Bit Mask:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved		Mapped Z Axis		Mapped Y Axis		Mapped X Axis	
Default	-		10		01		00	

Possible values:

Value (bit)	Axis
00	X-Axis
01	Y-Axis
10	Z-Axis
11	Invalid

Axis sign (subindex 2)

Bit Mask:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved					Z-Axis	Y-Axis	X-Axis
Default	-					0	0	0

Possible values:

Value (bit)	Sign
0	Positive
1	Negative

3.4.2.4 Digital Filter Configuration (2603h)

The digital filter's cut-off frequency can be adjusted through this object. The cut-off frequency has to be written to the device in 0.1 Hz resolution (i.e. a cut-off frequency of 5 Hz has to be configured by writing a 50d to the device. The following cut-off frequencies are possible:

Digital Filter Configuration (2603h)	
Cut-off Frequency	**Description**
0	Digital Filter deactivated
0.1..1Hz	In 0.1Hz steps
1..30Hz	In 1Hz steps

3.4.3 Device Profile Specific Parameter (CiA DS-410)

Object Sub-Index	Name	Format	Access	Default	Save
6000h	Resolution	U16	rw	64h	yes
6010h	Slope Long 16bit	I16	ro	-	yes
6011h	Slope long operating parameter X axis	U8	rw	2h	yes
6012h	Slope long 16bit preset value X axis	I16	rw	0h	yes
6013h	Slope long 16bit offset X axis	I16	rw	0h	yes
6014h	Differential slope long 16bit offset X axis	I16	rw	0h	yes
6020h	Slope lateral 16bit X axis (only for 2-Dimensional)	I16	ro	-	yes
6021h	Slope lateral operating parameter Y axis (only for 2-Dimensional)	U8	rw	2h	yes
6022h	Slope lateral 16bit preset value Y axis (only for 2-Dimensional)	I16	rw	0h	yes
6023h	Slope lateral 16bit offset Y axis (only for 2-Dimensional)	I16	rw	0h	yes
6024h	Differential slope lateral 16bit offset Y axis (only for 2-Dimensional)	I16	rw	0h	yes
6110h	Slope Long 32bit X axis	I32	ro	-	yes
6111h	Slope long 32bit operating parameter X axis	U8	rw	2h	yes
6112h	Slope long 32bit preset value X axis	I32	rw	0h	yes
6113h	Slope long 32bit offset X axis	I32	rw	0h	yes
6114h	Differential slope long 32bit offset X axis	I32	rw	0h	yes
6120h	Slope Lateral 32bit Y axis (only for 2-Dimensional)	I32	ro	-	yes
6121h	Slope lateral 32bit operating parameter Y axis (only for 2-Dimensional)	U8	rw	2h	yes
6122h	Slope lateral 32bit preset value Y axis (only for 2-Dimensional)	I32	rw	0h	yes
6123h	Slope lateral 32bit offset Y axis (only for 2-Dimensional)	I32	rw	0h	yes
6124h	Differential slope lateral 32bit offset (only for 2-Dimensional)	I32	rw	0h	yes
6511h	Device temperature	I16	ro	-	yes

3.4.3.1 Resolution (6000h)

This object shall indicate the resolution of the Slope at X axis (object 6010h) and the Slope a Y axis (object 6020h) objects based on 0,001°.
This resolution is also valid for the 32-bit value objects (6110h and 6120h). Ex works the default value is 0,1° (64h). The following table describes all possible resolutions:

Resolution (6000h)	
Value	**Description**
01h (1d)	0,001°
Ah (10d)	0,01°
64h (100d)	0,1°
3E8h (1000d)	1°

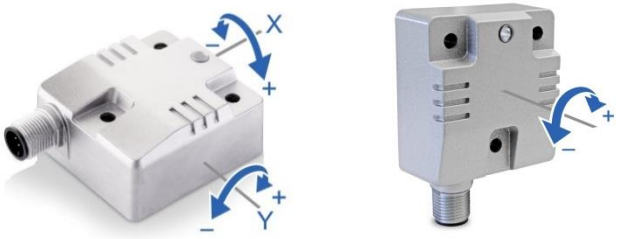
3.4.3.2 Operating Parameters (6011h/6021h/6111h/6121h)

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)

The scaling is active at the factory, the inversion of the sign is deactivated (object value 2H).



Scaling means that the following equation is applied:

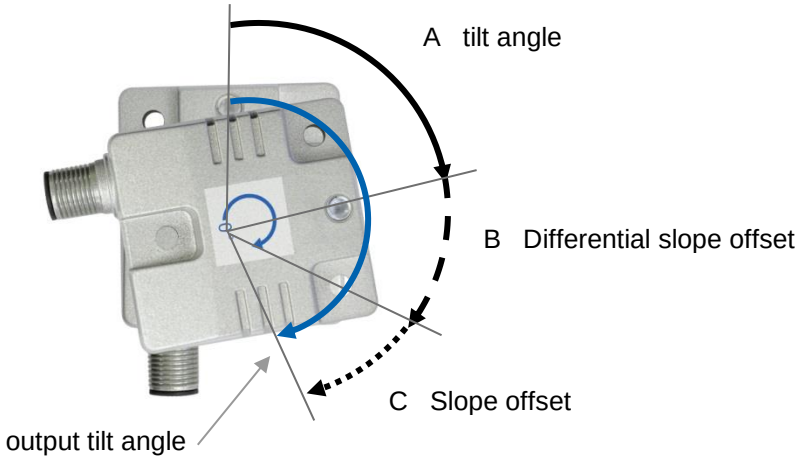
Output slope value = A + B + C

where

A is a physically measured angle (current tilt angle / value);
B is a differential slope offset (The difference slope offset is always added to the current skew);
C is a slope offset (Slope offset is set by the CANopen preset function).

(See chart scaling function)

Chart Scaling function for 1-dimensional:



The operating parameters are applied for the according slope (i.e. 6011h operating parameter influences 6010h slope).

The 16bit and 32bit values are hardwired internally (i.e. changing the operating parameter at 6011h changes the operating parameter at 6111h)

3.4.3.3 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;
B is a slope physical measured;
C is a differential slope offset when accessing object a preset object

The 16bit and 32bit values are hardwired internally (i.e. changing the differential offset at 6014h changes the differential offset at 6114h)

3.4.3.4 Device temperature (6511h)

The device temperature can be read by accessing object 6511h. The value is given in multiples of 1°C. It is also part of the standard PDO.

3.5 LED status display

The LED status display is according to DS-303 Part 3 V1.0.0 with some exceptions. The following defined LED behaviors are overwritten by the application in case of a severe internal error.

3.5.1 CANopen Status LED (Green)

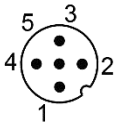
Status LED	State	Description
Single flash	STOPPED	The Device is in STOPPED state
Blinking	PREOPERATIONAL	The Device is in the PRE-OPERATIONAL state
On	OPERATIONAL	The Device is in the OPERATIONAL state
Off	Power off	The Device is not powered

3.5.2 CANopen Error LED (Red)

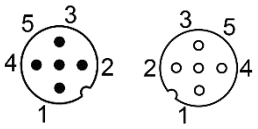
Error LED	State	Description
Single flash	Bus warning	The CAN controller is not receiving ACK messages (i.e. no master)
Off	No error	The Device is in working condition
On	Bus off / Internal Error	The CAN controller is bus off or an internal error is present.

4 Terminal assignment

4.1 M12 flange connector, 5-pin

Pin	Assignment	Description	M12 (male)
1	CAN_GND	Ground connection relating to CAN	
2	+Vs	Voltage supply	
3	GND	Ground connection relating to +Vs	
4	CAN_H	CAN Bus signal (dominant High)	
5	CAN_L	CAN Bus signal (dominant Low)	

4.2 2xM12 flange connector, 5-pin

Pin	Assignment	Description	M12 (male/female)
1	CAN_GND	Ground connection relating to CAN	
2	+Vs	Voltage supply	
3	GND	Ground connection relating to +Vs	
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 Vs-Vs and GND-GND is 1 A each.

4.3 Cable

Core color	Assignment	Description
White	+Vs	Voltage supply
Brown	GND	Ground connection relating to +Vs
Green	n.c.	-
Yellow	n.c.	-
Grey	n.c.	-
Pink	CAN_H	CAN Bus signal (dominant High)
Blue	CAN_L	CAN Bus signal (dominant Low)
Red	CAN_GND	Ground connection relating to CAN