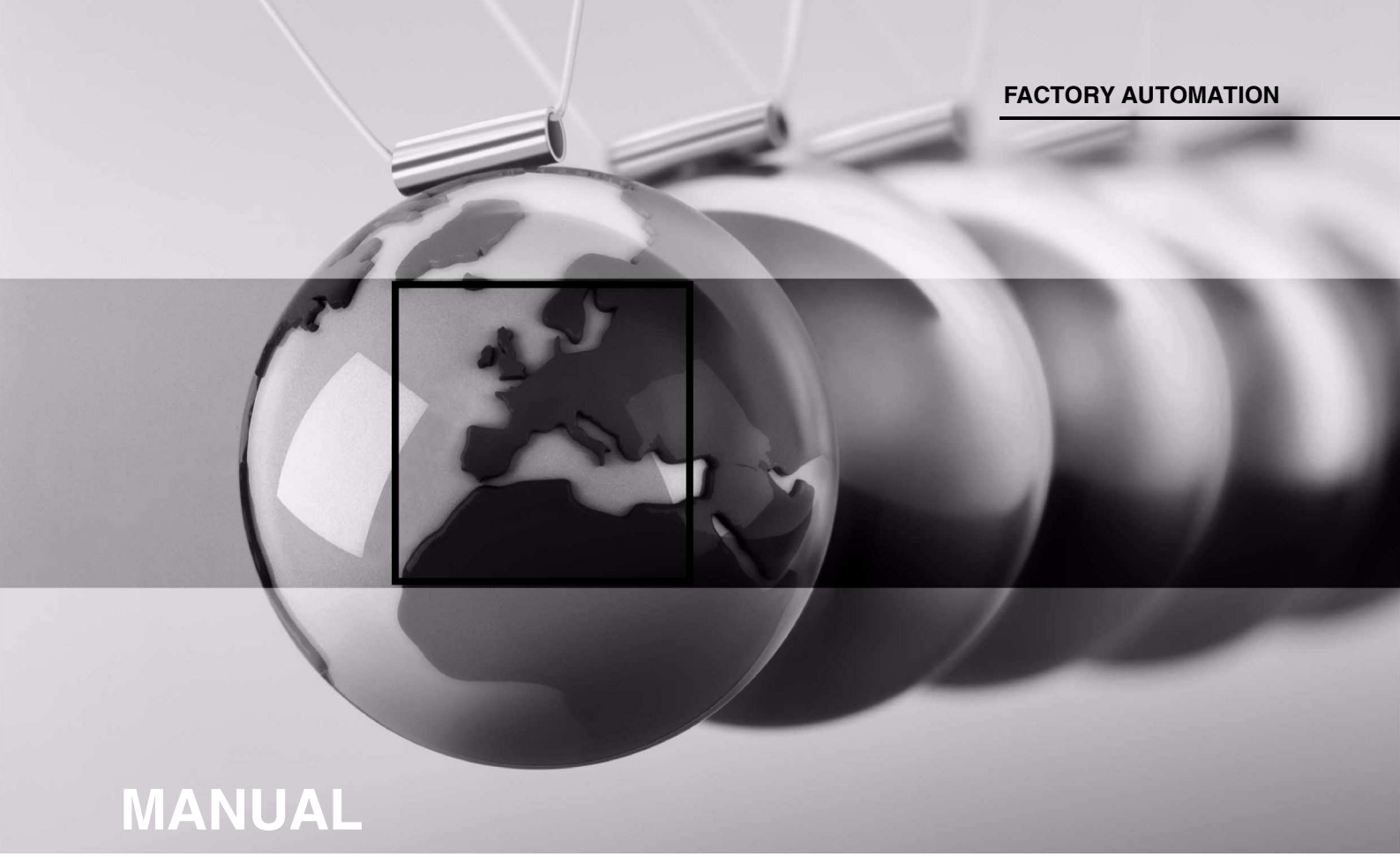
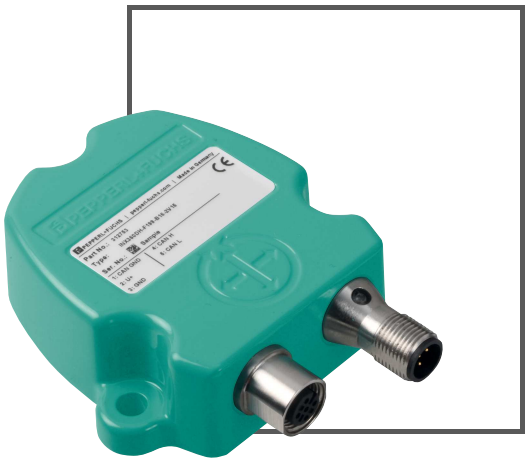


MANUAL

INX***DH-F199-B16-***,
INY***DH-F199-B16-***

with CANopen Interface



PEPPERL+FUCHS
SENSING YOUR NEEDS

With regard to the supply of products, the current issue of the following document is applicable: The General Terms of Delivery for Products and Services of the Electrical Industry, published by the Central Association of the Electrical Industry (Zentralverband Elektrotechnik und Elektroindustrie (ZVEI) e.V.) in its most recent version as well as the supplementary clause: "Expanded reservation of proprietorship"

1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note!

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note!

This symbol brings important information to your attention.

Action

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

1.4 Intended Use

The inclination sensors of the INX***DH-F199-B16-*** series and the INY***DH-F199-B16-*** series sense and measure the angle of tilt of an object in relation to the force of gravity and provide inclination data via CANopen interface.

Read through these instructions thoroughly. Familiarize yourself with the device before installing, mounting, or operating.

Always operate the device as described in these instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and plant is only guaranteed if the device is operated in accordance with its intended use.

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1.5 General Safety Notes

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Installation and commissioning of all devices may only be performed by trained and qualified personnel.

The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.

If serious faults occur, stop using the device. Secure the device against inadvertent operation. In the event of repairs, return the device to your local Pepperl+Fuchs representative or sales office.

Note!

Disposal

Electronic waste is hazardous waste. When disposing of the equipment, observe the current statutory requirements in the respective country of use, as well as local regulations.

1.6 Declaration of conformity

This product was developed and manufactured under observance of the applicable European standards and guidelines.

Note!

A Declaration of Conformity can be requested from the manufacturer.

The product manufacturer, Pepperl+Fuchs GmbH, D-68307 Mannheim, has a certified quality assurance system that conforms to ISO 9001.

ISO**9001**

2 Product Description

2.1 Use and Application

INX***DH-F199-B16-*** and the INY***DH-F199-B16-*** series inclination sensors sense and measure the tilt angle (inclination/slope/elevation) of an object in relation to the force of gravity. The basic principle behind these inclination sensors is a microelectromechanical systems (MEMS) sensor cell that is embedded in a fully molded application-specific integrated circuit (ASIC). The angle is measured via the relative change in electrical capacitance in the MEMS cell.

INX***DH-F199-B16-*** sensors are 1-axis sensors that sense and measure tilt on the x-axis

INY***DH-F199-B16-*** sensors are 2-axis sensors that sense and measure tilt on the x-axis and y-axis.

Communication with the inclination sensors, including configuration and data output, runs via a CANopen interface.

CANopen Interface

CANopen is based on the Controller Area Network (CAN), which was developed by automotive industries in the 80s. The CANopen application protocol was introduced by the multi-vendor association CAN in Automation (CiA) to ensure full compatibility of industrial automation products. It is a multiple-access system (maximum: 127 devices), which means that all devices can access the bus.

These devices are the components of the CANopen bus. In simple terms, CANopen works as a client-server model. Each device checks whether the bus is free, and if it is free the device can send messages. If two devices try to access the bus at the same time, the device with the higher priority level has permission to send its message first. Devices with the lowest priority level must cancel their data transfer and wait before re-trying to send their message.

Communication Profile and Operating Modes

INX***DH-F199-B16-*** and INY***DH-F199-B16-*** series inclination sensors conform to the CANopen communication profile CiA DS 410 for inclinometers.

Various software tools for configuration and parameter-setting are available from different suppliers. It is easy to align and program the inclination sensors using the EDS (electronic datasheet) configuration file provided at www.pepperl-fuchs.com.

The devices support the following operating modes:

- Polled mode: The position value is transmitted only on request.
- Cyclic mode: The position value is sent cyclically (regular, adjustable intervals) on the bus.
- SYNC mode: The position value is sent after a synchronization message (SYNC) is received. The position value is sent every n SYNCs ($n \geq 1$).
- State change mode: The position value is transmitted whenever the position of the inclinometer changes (minimum time interval settable).

2.2 Accessories

Various accessories are available. See datasheet or relevant product page on the Internet www.pepperl-fuchs.com.

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3 Installation

3.1 Instructions for Mechanical and Electrical Installation

Observe the following instructions to ensure safe operation of the inclination sensor:

Warning!

Work must only be performed by trained and qualified personnel.

Commissioning and operation of this electrical equipment must only be performed by trained and qualified personnel. This means individuals who are qualified to commission (in accordance with safety technology), connect to ground, and label devices, systems, and circuits.

Warning!

Only perform work when the system is in a de-energized state.

De-energize your device before performing work on the electrical connections. Short circuits, voltage peaks, and similar events can lead to faults and undefined statuses. This presents a significant risk of personal injury and property damage.

Warning!

Check electrical connections before switching on the system.

Check all electrical connections before switching on the system. Incorrect connections present a significant risk of personal injury and property damage. Incorrect connections can lead to malfunctions.

Caution!

Do not remove the housing.

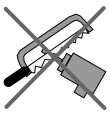
Do not remove the sensor housing under any circumstances, as damage and contamination can occur as a result of taking improper action.

Caution!

Do not perform any electrical modifications.

It is not permitted to perform electrical modifications on the inclination sensor. If you open or modify the device yourself, not only are you endangering yourself and others but you will also void any warranty and absolve the manufacturer of any liability.

Do not allow the inclination sensor to fall or be exposed to mechanical load.



Do not make any alterations to the housing of the inclination sensor.

3.2 Mounting Instructions

The inclination sensors are pre-calibrated devices that can be put into immediate operation after easy installation. The mounting surface must be flat and free of dust and grease.

Depending on the sensor model, ensure that the sensor is oriented correctly for inclination measurement.

The following figures show the correct axis orientation for each sensor model.

INX*DH-F199-B16-***

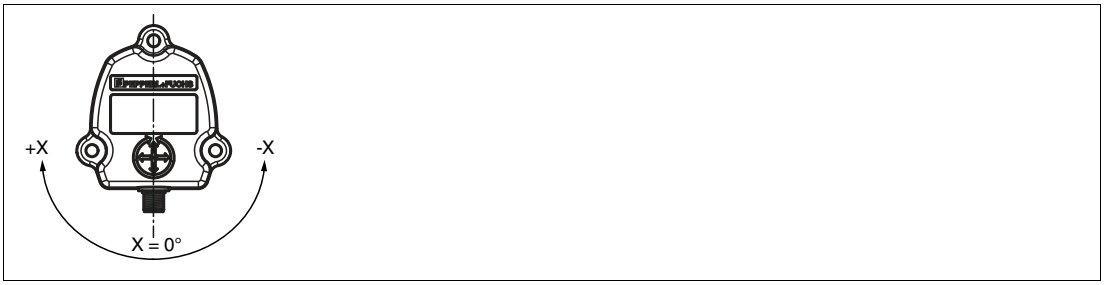


Figure 3.1 1-axis sensor

The above figure shows the correct axis orientation for a 1-axis sensor with one connector. There are also models with two connectors.

INY*DH-F199-B16-***

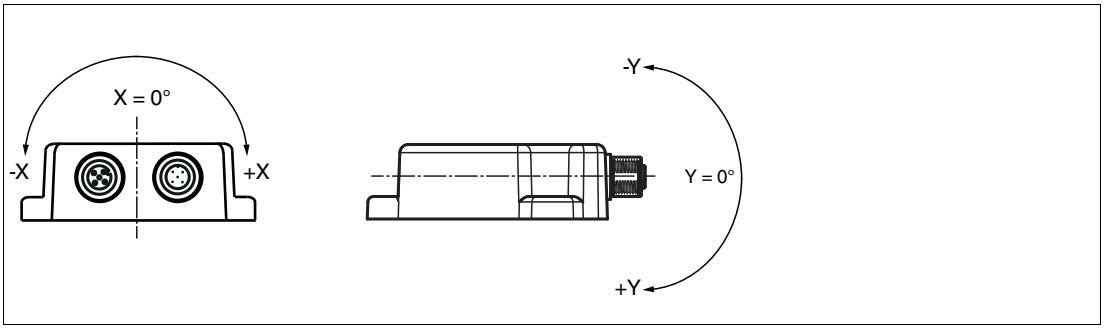


Figure 3.2 2-axis sensor

The above figure shows the correct axis orientation for a 2-axis sensor with two connectors. There are also models with one connector.

Fastening with Screws

We recommend hexagon head screws with M6 or UNC 1/4 for optimal and secure mounting.

1. Use all three screws for mounting and restrict the tightening torque to 10 Nm ± 10 %.
2. Use the same tightening torque for all three screws.
3. Align the M12 connectors perfectly and tighten them until the end with a torque in the range of 0.4 ... 0.6 Nm.

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3.3 Electrical Connection

The sensors are connected via M12 5-pin connectors with CAN bus. There are sensor models with one connector (V15) or two connectors (2V15).

The one-connector sensors have a male connector type.

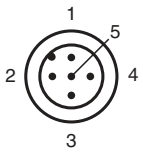
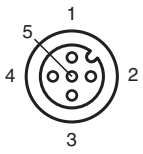
Signal	Bus In Pin	Bus Out Pin
CAN GND	1	1
+ U_b	2	2
GND	3	3
CAN-High	4	4
CAN-Low	5	5
Pinout		

Table 3.1

Warning!

Damage to the device

Connecting an alternating current or excessive supply voltage can damage the device or cause the device to malfunction.

Electrical connections with reversed polarity can damage the device or cause the device to malfunction.

Connect the sensor to direct current (DC). Ensure that the supply voltage rating is within the specified sensor range. Ensure that the connecting wires on the cordset in use are connected correctly.

Connecting the Sensor to Voltage

Connect the operating voltage to pins 2 and 3 of the 5-pin connector.

↳ The "Power" LED lights up green.

3.4 Configuring/Connecting the Terminator

To ensure a secure signal transfer, both ends within a CAN bus segment must be closed with a 120 Ω terminator. If the inclination sensor is installed at the beginning or the end of the CAN bus, a terminator must be used. The inclination sensor is equipped with a built-in terminator to be activated/deactivated by configuring Object 3002h Terminator (see chapter 7.3.7). It is also possible to use an external terminator, which can be more suitable in some cases.

The bus wires can be routed in parallel or twisted, with or without shielding in accordance with the electromagnetic compatibility requirements. A single-line structure minimizes reflection.

4 Modes and Parameters

The purpose of this chapter is to describe the available configuration parameters of these inclination sensors with CANopen interface. Before going into details the following information describes useful technical terms and acronyms for CANopen network communication.

Node-ID	In the CAN network each device has a Node-ID that is used to address the device in the network and to define it's priority of.
EDS (Electronic Data Sheet)	An EDS file describes the communication properties of a device on the CAN network (baud rates, transmission types, I/O features, etc.). It is provided by the device manufacturer and is used in the configuration tool to configure a node (like a driver in an operating system).
PDO (Process Data Object)	CANopen frame containing I/O data. We distinguish between: ■ Transmit-PDO (TPDO): data provided by a node ■ Receive-PDO (RPDO): data to be consumed by a node The transmission direction is always seen from a node's point of view.
SDO (Service Data Object)	SDOs are typically used to read or write parameters while the application is running.
COB-ID (Communication Object Identifier)	Each CANopen frame starts with a COB-ID working as the Identifier. During the configuration phase, each node receives the COB-ID(s) for which it is the provider (or consumer).
NMT (Network Management Transition)	The NMT protocols are used to issue state machine change commands (i.e. to start and stop the devices), detect remote device boot ups and error conditions.

Table 4.1

4.1 Pre-Operational Mode

If the device is in this state, its configuration can be modified. However, only SDOs can be used to read or write device-related data.

The device enters pre-operational mode:

- After power-up
- Upon receiving the "Enter Pre-Operational" NMT indication, if it was in operational mode before

Once configuration is complete, the device enters one of the following states upon receiving the corresponding indication:

- "Stopped" upon receiving the "Stop Remote Node" NMT indication
- "Operational" upon receiving the "Start Remote Node" NMT indication

To set a node to pre-operational mode, the master must send the following message:

Identifier	Byte 0	Byte 1	Description
0h	80h	00h	NMT-PreOp, all nodes
0h	80h	NNh	NMT-PreOp, NN

Table 4.2

NNh: node number

4.2 Operational Mode

The device enters the operational state if it was in the pre-operational state upon receiving the "Start Remote Node" indication. If the CANopen network is started using the "Node Start" NMT services in operational state, all device functionalities can be used. Communication can use PDOs or SDOs.

Note!

Modifications to the configuration in operational mode may have unexpected consequences and should therefore only be made in pre-operational mode.

To put one or all nodes in operational mode, the master has to send the following message:

Identifier	Byte 0	Byte 1	Description
0h	01h	00h	NMT-Start, all nodes
0h	01h	NNh	NMT-Start, NN

Table 4.3

NNh: node number

4.3 Stopped Mode

The device enters stopped mode upon receiving the "Node Stop" indication (NMT service) if it was in pre-operational or operational mode. In stopped mode, the device cannot be configured. No service is available to read or write device-related data (SDO). Only the slave monitoring function "Node Guarding" remains active.

To put one or all nodes in stopped mode, the master has to send the following message:

Identifier	Byte 0	Byte 1	Description
0h	02h	00h	NMT-Stop, all nodes
0h	02h	NNh	NMT-Stop, NN

Table 4.4

NNh: node number

4.4 Reinitializing the Inclination Sensor

If a node is not operating correctly, it is advisable to carry out a reinitialization. After reinitialization, the inclination sensor accesses the bus in pre-operational mode.

Identifier	Byte 0	Byte 1	Description
0h	82h	00h	Reset communication all CANopen devices
0h	82h	NNh	Reset communication node
0h	81h	00h	Reset all CANopen devices
0h	81h	NNh	Reset node

Table 4.5

NNh: node number

4.5 Transmission Modes

Polled Mode	Via a remote transmission request telegram, the connected host calls for the current process value. The inclination sensor uses the current position value, calculates set-parameters, and sends back the obtained process value by the same identifier.
Cyclic Mode	The inclination sensor transmits cyclically the current process value, without being called by the host. The cycle time can be programmed in milliseconds for values between 1 ms and 65536 ms.
Sync Mode	The inclination sensor answers with current process value after receiving a sync telegram. The parameter sync counter can be programmed to skip a certain number of sync telegrams before answering again.
Heartbeat Function	A node signals its communication status by cyclically transmitting a heartbeat message. This message is received by one or any number of members (heartbeat consumers) in the bus and so they can control the dedicated node (heartbeat producer).

Table 4.6

4.6 Boot-Up Procedure

The general boot-up procedure for the CANopen inclination sensors and the mapping of various modes are illustrated below:

Number	Description
1	Power up inclination sensor
2	After initialization, the inclination sensor automatically enters pre-operational mode.
3	NMT: Start Remote Node
4	NMT: Pre-Operational Mode
5	NMT: Stop Remote Node
6	NMT: Reset Node
7	NMT: Reset Communication

Table 4.7

4.7 Using Layer Settings Service (LSS)

The integrated Layer Setting Services (LSS) functionality is designed in accordance with the CiA normative DS305V200 CANopen Layer Setting Services. These services and protocols can be used to inquire or to change settings of several parameters (of the physical, data link, and application layer) on a CANopen device with LSS slave capability by a CANopen device with LSS master capability via the CAN network. The inclination sensor will be the LSS slave device and the PLC (control) has to support LSS master device functionality. The LSS-functionality of these inclination sensors is limited to the following parameters of the application layer, namely node number and baud rate.

The LSS master device requests the LSS address from the LSS slave device. The LSS address is defined in object 1018h Identity Object; it consists of vendor ID, product code, revision number, and serial number, as shown in the table below. After receiving this information, the control system can identify the inclination sensor. The node number and baud rate can then be set. The exact procedure varies in detail, depending on the PLC tool being used. This object provides the general identification of the inclination sensor.

Subindex	Description	Data Type	Default Value
0	Number of entries	Unsigned 8	04h
1	Vendor ID	Unsigned 32	ADh
2	Product code	Unsigned 32	43415032h
3	Revision number	Unsigned 32	00010000h Prone to change with every revision.
4	Serial number	Unsigned 32	-

Table 4.8

5 Software Configuration Overview

These inclination sensors are flexible, remote-configurable devices. All parameters are programmable via CAN bus.

This chapter is divided into two main parts — one describing how to put the inclination sensors into operation and the other for PDO/SDO programming of the inclination sensors.

Note!

Save Parameters after Modification

After modifying parameters, save the new settings into the inclination sensor by using operations with object 1010h or object 2300h. Otherwise, after boot-up the formerly stored values of parameters will overwrite the current values.

5.1 Factory Settings

Note!

The factory settings can be restored at any time. Some parameters have to be reprogrammed to make the inclination sensor compatible with the controller or the existing CAN bus on which it is going to be installed.

Description	Object	Value
Device Type	1000h	4019Ah (2-axis) 3019Ah (1-axis)
Cyclic Timer	2200h	00h (0 ms)
Resolution	6000h	0Ah (0.01°)
Node Number	3000h	00h (Node number: 1)
Baud Rate	3001h	03h (125 kB)

Table 5.1

5.2 Active Programming Objects

Active CANopen objects depend on the state of inclination sensor: "x" in the table below indicates which CANopen objects are active in each state.

	Initialization	Pre-Operational	Operational	Stopped
PDO Object			x	
SDO Object		x	x	
Boot-Up	x		x	
NMT		x	x	x

Table 5.2

5.3 Programmable Parameters

Objects are based on the CiA-DS410 CANopen profile for inclinometer (www.can-cia.org). The table in the following chapter "Command Description" displays a list of the command identifiers sent and received by the inclination sensor. These are the standard commands used for communication and transmission between a master and a slave in a CAN bus. It is quite useful for the analysis of communication logs between the master and slave and for better understanding of the system under observation.

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5.4 Command Description

Command	Function	Telegram	Description
22h	Domain Download	Write Request	Parameter to inclination sensor
60h	Domain Download	Write Confirmation	Parameter Received
40h	Domain Upload	Read Request	Parameter Request
43h, 4Bh, 4Fh [1]	Domain Upload	Read Response	Parameter to Master
80h	Warning	Error Response	Transmission Error

Table 5.3

1) The value of the command byte depends on the data length of the called parameter (see next table).

Data Length of Commands

Command	Data Length	Data Type
43h	4 Byte	Unsigned 32
4Bh	2 Byte	Unsigned 16
4Fh	1 Byte	Unsigned 8

Table 5.4

5.5 Frequently Used Commands

The following list shows the most frequently used objects for programming the inclination sensor. This list offers important programming tips and FAQ which are necessary for the proper use of the inclinometer.

See chapter 7 for the whole list of CANopen objects.

Object Name	Object ID	Description
Position Value X-Axis	6010h	For INX*** and INY*** inclination sensors, this object provides the X-Axis position value. This a read only object and the position values are limited depending on the resolution set.
Position Value Y-Axis	6020h	For INY*** inclination sensors, this object provides the Y-axis position value. This a read only object and the position values are limited depending on the resolution set.
Store Parameters	1010h	This object is used to store either all parameters or only parts of the object dictionary if necessary.
Save Parameters with Reset	2300h	This object stores and saves all current parameters with an additional NMT reset of the inclination sensor.
Resolution in Degree	6000h	This parameter is used to program the desired resolution. The resolution can be set to 1° (1000d), 0.1° (100d) or 0.01° (10d) Default is 10d = 0.01°
Preset Value X-Axis	6012h	The Preset Value is the desired position value (for example 0°), which should be reached at a certain physical position of the measurement x-axis. The position value is set to the desired process value by the parameter Preset.
Preset Value Y-Axis	6022h	The Preset Value is the desired position value (for example 0°), which should be reached at a certain physical position of the measurement y-axis. The position value is set to the desired process value by the parameter Preset.
Baud Rate	3001h	The Baud rate can be programmed via SDO. (Default 125 kBaud
Node Number	3000h	The setting of the Node Number can be achieved via SDO-Object. Valid addresses range from 1 to 127, each address can only be used once. The value set in this object is incremented by one to prevent setting the Node Number 0. For inclination sensors programmed via SDO, the default is 0h = Node Number 1
Filters	3100h 3022h	The filter is a routine to process the data stream of the base sensor. It can be used to adjust the averaging or weighting of measurements and calculation of position values. ■ Object 3100h corresponds to moving average filter ■ Object 3022h is for the digital recursive filter Default: Object 3100h: 100d, Object 3022h: 0.

Table 5.5

5.6 PDO Transmission

Process Data Objects (PDOs) communicate process information/data and enable them to be exchanged in real time. A CANopen device's PDO set describes the implicit exchanges between this device and its communication partners on the network. The exchange of PDOs is only authorized if the device is in "Operational" mode.

Note!

The PDOs can be directly mapped into memory locations on the controller and can be viewed upon reading those memory locations.

5.6.1 Object 1800h: 1st Transmit PDO Communication Parameter

This object contains the communication parameter of the 1st transmit PDO.

Subindex [1]	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	05h	ro	yes
01h	COB-ID	Unsigned 32	180h + Node ID	rw	yes
02h	Transmission Mode	Unsigned 8	01h	rw	yes
03h	Inhibit Time	Unsigned 32	00h	rw	yes
04h	Not Available				
05h	Event Timer	Unsigned 32	00h	rw	yes

Table 5.6

1) Second degree identifier used in combination with the object. (Follows the object number).

5.6.2 Object 1801h: 2nd Transmit PDO Communication Parameter

This object contains the communication parameter of the 2nd transmit PDO.

Subindex [1]	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	05h	ro	yes
01h	COB-ID	Unsigned 32	280h + Node ID	rw	yes
02h	Transmission Mode	Unsigned 8	FEh	rw	yes
03h	Inhibit Time	Unsigned 32	00h	rw	yes
04h	Not Available				
05h	Event Timer	Unsigned 32	00h	rw	yes

Table 5.7

1) Subindex: Second degree identifier used in combination with the object. (Follows the object number).

5.6.3 Transmission Mode

The transmission mode (Sub index 2) for Objects 1800h and 1801h can be configured as described below:

Transfer Value (Dec)	Transmission Mode					Note
	Cyclic	Acyclic	Synchronous	Asynchronous	RTR Only	
0		x	x			Send PDO on first sync message following an event
1 ... 240	x		x			Send PDO every x sync messages
241 ... 251	Reserved					
252			x		x	Receive Sync and send PDO on remote request
253					x	Update data and send PDO on remote request
254				x		Send PDO on event
255				x		Send PDO on event

5.6.4 Inhibit Time

The inhibit time is the minimum interval for PDO transmission if the transmission type is set to 254d (FEh) and 255d (FFh). The value is defined as multiple of 100 µs. The inhibit time cannot be changed while the respective PDO is in operation.

5.6.5 Event Timer

The event timer only works in asynchronous transmission mode (transmission mode 254d and 255d). The value is defined as multiple of 1 ms.

A transmit PDO is sent after the event timer expires (for values > 0). The range is 1 ... 65535 ms. The event timers of TPDO1 and TPDO2 are hardwired, i.e., if one timer is changed, the other one is adjusted accordingly.

5.6.6 Cyclic Timer

The cyclic timer is hardwired with both event timers of TPDO1 and TPDO2. Due to the fact that it is possible to save either communication parameters (event timers) or manufacturer parameter (cyclic time), the parameters could hold different values after a power off/on cycle. The inclination sensor prevents this mismatch by checking these values during startup. The event timer value is copied to the cyclic time if they do not match.

5.6.7 Object 1A00h: 1st Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 1st transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	2 = INY*** 2 subindexes 1 = INX*** 1 subindex	ro	yes
01h	Mapped object	Unsigned 32	60100010h	rw	yes
02h	Mapped object	Unsigned 32	60200010h	rw	yes

Table 5.8

5.6.8 Object 1A01h: 2nd Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 2nd transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	2 = INY*** 2 subindexes 1 = INX*** 1 subindex	ro	yes
01h	Mapped object	Unsigned 32	60100010h	rw	yes
02h	Mapped object	Unsigned 32	60200010h	rw	yes

Table 5.9

5.6.9 Types of SDO

Service Data Objects (SDOs) allow a device's data to be accessed by using explicit requests. The SDO service is available if the device is in the operational or pre-operational state. There are two types of SDOs:

- Read SDOs (Download SDOs)
- Write SDOs (Upload SDOs)

The SDO protocol is based on a "Client/Server" model:

Download SDO	The client sends a request indicating the object to be read. The server returns the data contained within the object.
Upload SDO	The client sends a request indicating the object to be written to with the desired value. After the object has been updated, the server returns a confirmation message.
Unprocessed SDO	The server returns an error code (80) in both cases if an SDO could not be processed.

Table 5.10

6 CANopen Configuration Examples

The following examples illustrate how you can configure the inclination sensor via CANopen objects.

A transmit message basically consists of the following:

- COB-ID 600h + node ID (0 ... 7F) e. g. 601h at node number 1
- Data byte 1: 1 command byte
- Data byte 2 and 3: CANopen object code
- Data byte 4: Subindex if applicable
- Data bytes 5...8 dependent on the case (type of command, read or write)

A received message basically consists of the following:

- COB-ID 580h + node ID (0 ... 7F) e. g. 581h at node number 1
- Data byte 1: 1 command byte
- Data byte 2 and 3: CANopen object code
- Data byte 4: Subindex if applicable
- Data bytes 5...8 dependent on the information depth from the inclination sensor

6.1 Store All Parameters (Object 1010h)

To save all parameters from the corresponding registers of the inclination sensor into its non-volatile memory, you have to send CANopen object 1010h in the following order.

Object 1010h, Sub-Index: 01h: Store All Parameters

	COB-ID	Data byte 1 Command	Data byte 2 Object	Data byte 3 Index	Data byte 4 Subindex	Data byte 5	Data byte 6	Data byte 7	Data byte 8
Request	601h	22h	10h	10h	01h	73h (="s")	61h (="a")	76h (="v")	65h (="e")
Answer	581h	60h	10h	10h	01h	00h	00h	00h	00h

Table 6.1

6.2 Restore All Parameters (Object 1011h)

To restore all parameters from the non-volatile memory into the corresponding registers of the inclination sensor, you have to send CANopen object 1011h in the following order.

Object 1011h, Sub-Index: 01h: Restore All Parameters

	COB-ID	Data byte 1 Command	Data byte 2 Object	Data byte 3 Index	Data byte 4 Subindex	Data byte 5	Data byte 6	Data byte 7	Data byte 8
Request	601h	22h	11h	10h	01h	6Ch (="l")	6Fh (="o")	61h (="a")	64h (="d")
Answer	581h	60h	11h	10h	01h	00h	00h	00h	00h

Table 6.2

6.3 Write (new) Node-ID (Object 3000h)

To write a new node number into the corresponding register of the inclination sensor, you have to send CANopen object 3000h the following order.

Object 3000h, Sub-Index: 00h: Write (new) Node-ID (10h)

	COB-ID	Data byte 1 Command	Data byte 2 Object	Data byte 3 Index	Data byte 4 Subindex	Data byte 5	Data byte 6	Data byte 7	Data byte 8
Request	601h	22h	00h	30h	01h	0Fh	not used	not used	not used
Answer	581h	60h	00h	30h	00h	00h	00h	00h	00h

Table 6.3

Note!

Note that the new node number is only stored permanently after a storage operation with the corresponding object (object 1010h or object 2300h).

6.4 Read Baud Rate (Object 3001h)

To read the current baud rate out of the inclination sensor, you have to send CANopen object 3001h the following order.

Object 3001h, Sub-Index: 00h: Read Baud Rate

	COB-ID	Data byte 1 Command	Data byte 2 Object	Data byte 3 Index	Data byte 4 Subindex	Data byte 5	Data byte 6	Data byte 7	Data byte 8
Request	601h	40h	01h	30h	00h	not used	not used	not used	not used
Answer	581h	4Fh	01h	30h	00h	03h	00h	00h	00h

Table 6.4

Data byte 5 = 03h means 125 kBaud

7 CANopen Objects

7.1 CANopen Object Overview

The following table shows an overview of the valid CANopen objects of the INX***DH-F199-B16-*** series and the INY***DH-F199-B16-*** series inclination sensors.

The CANopen objects are grouped in the following way:

- Communication profile: Objects 1000 ... 1FFF
- Manufacturer specific: Objects 2000 ... 3FFF
- Device profile: Objects 6000 ... 6FFF

Note!

Save Parameters after Modification

After modifying parameters, save the new settings into the inclination sensor by using operations with object 1010h or object 2300h. Otherwise, after boot-up the formerly stored values of parameters will overwrite the current values.

The next chapters provide details about the individual CANopen objects.

Note!

If saving or restoring not all but only a part of the parameters, notice a special behavior. This concerns communication, application, or manufacturer parameters as well as cyclic time (object 2200) and preset X, preset Y (INY* version, objects 2600 and 2601) or preset (INX* version, object 2600).

Cyclic time is hardwired with the event timers of TxPDO1 and TxPDO2. If only the event timers (communication parameters) or cyclic time (manufacturer parameter) is/are saved, the parameters would hold different values after a power off/on cycle. Therefore, if the values do not match, the value of the event timers is copied to the cycle time, too. Preset parameters work the same way, with the application parameters (objects 6xxx) having the higher priority.

Object Name	Object No. ID hex	Access	Data Type
Communication profile			
Device type	1000	Read-only	UNSIGNED32
Error Register	1001	Read-only	UNSIGNED8
Predefined Error Field	1003	–	ARRAY
Sub 0: Number of errors	1003.0	Read/Write	UNSIGNED8
Sub 1: New error	1003.1	Read-only	UNSIGNED32
COB-ID SYNC	1005	Read/Write	UNSIGNED32
Device Name	1008	Read-only	VISIBLE_STRING
Hardware Version	1009	Read-only	VISIBLE_STRING
Software Version	100A	Read-only	VISIBLE_STRING
Guard Time	100C	Read/Write	UNSIGNED16
Life Time Factor	100D	Read/Write	UNSIGNED8
Store Parameters	1010	–	ARRAY
Highest sub-index supported	1010.0	Read-only	UNSIGNED8
Save all parameters	1010.1	Read/Write	UNSIGNED32

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Object Name	Object No. ID hex	Access	Data Type
Save communication parameters	1010.2	Read/Write	UNSIGNED32
Save Application parameters	1010.3	Read/Write	UNSIGNED32
Save Manufacturer parameters	1010.4	Read/Write	UNSIGNED32
Restore Default Parameters	1011	–	ARRAY
Highest sub-index supported	1011.0	Read-only	UNSIGNED8
Restore all parameters	1011.1	Read/Write	UNSIGNED32
Restore communication parameters	1011.2	Read/Write	UNSIGNED32
Restore application parameters	1011.3	Read/Write	UNSIGNED32
Restore manufcturer parameters	1011.4	Read/Write	UNSIGNED32
COB-ID Emergency	1014	Read-only	UNSIGNED32
Consumer Heartbeat Time	1016	–	ARRAY
Sub 0: No. of Entries	1016.0	Read-only	UNSIGNED8
Sub 1: Consumer Heartbeat Time	1016.1	Read/Write	UNSIGNED32
Producer Heartbeat Time	1017	Read/Write	UNSIGNED16
Identity Object	1018	–	RECORD
Number of Entries	1018.0	Read-only	UNSIGNED8
Vendor ID	1018.1	Read-only	UNSIGNED32
Product Code	1018.2	Read-only	UNSIGNED32
Revision Number	1018.3	Read-only	UNSIGNED32
Serial Number	1018.4	Read-only	UNSIGNED32
TxPDO1 Comm Parameter	1800	–	RECORD
Sub 0: No. of Entries	1800.0	Read-only	UNSIGNED8
Sub 1: COB-ID	1800.1	Read/Write	UNSIGNED32
Sub 2: Transmission Type	1800.2	Read/Write	UNSIGNED8
Sub 3: Inhibit Time	1800.3	Read/Write	UNSIGNED16
Sub 5: Event Timer	1800.5	Read/Write	UNSIGNED16
TxPDO2 Comm Parameter	1801	–	RECORD
Sub 0: No. of Entries	1801.0	Read-only	UNSIGNED8
Sub 1: COB-ID	1801.1	Read/Write	UNSIGNED32
Sub 2: Transmission Type	1801.2	Read/Write	UNSIGNED8
Sub 3: Inhibit Time	1801.3	Read/Write	UNSIGNED16

Object Name	Object No. ID hex	Access	Data Type
Sub 5: Event Timer	1801.5	Read/Write	UNSIGNED16
TxPDO1 Mapping	1A00	–	RECORD
Sub 0: Number of entries	1A00.0	Read-only	UNSIGNED8
Sub 1: 1st mapped object	1A00.1	Read/Write	UNSIGNED32
Sub 2: 2nd mapped object	1A00.2	Read/Write	UNSIGNED32
TxPDO2 Mapping	1A01	–	RECORD
Sub 0: Number of entries	1A01.0	Read-only	UNSIGNED8
Sub 1: 1st mapped object	1A01.1	Read/Write	UNSIGNED32
Sub 2: 2nd mapped object	1A01.2	Read/Write	UNSIGNED32
Manufacturer specific			
Cyclic Time	2200	Read/Write	UNSIGNED16
Store Parameters	2300	Write-only	UNSIGNED32
Preset X-Axis	2600	Read/Write	INTEGER16
Preset Y-Axis	2601	Read/Write	INTEGER16
Node Number	3000	Read/Write	UNSIGNED8
Baud rate	3001	Read/Write	UNSIGNED8
Terminator	3002	Read/Write	UNSIGNED8
Digital Recursive Filter	3022	Read/Write	UNSIGNED16
Moving Average Filter	3100	Read/Write	UNSIGNED16
Device Profile			
Resolution	6000	Read/Write	UNSIGNED16
Slope long16 (Position Value X-Axis)	6010	Read-only	INTEGER16
Slope long16 operating parameter (Rotation Direction Value X-Axis)	6011	Read/Write	UNSIGNED8
Slope long16 preset value (Preset Value X-Axis)	6012	Read/Write	INTERGER16
Slope long16 offset (Offset Value X-Axis)	6013	Read-only	INTEGER16
Differential slope long16 offset (Offset Value X-Axis)	6014	Read/Write	INTEGER16
Slope lateral16 (Position Value Y-Axis)	6020	Read-only	INTEGER16
Slope lateral16 operating parameter (Rotation Direction Value Y-Axis)	6021	Read/Write	UNSIGNED8

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Object Name	Object No. ID hex	Access	Data Type
Slope lateral16 preset value (Preset Value Y-Axis)	6022	Read/Write	INTEGER16
Slope lateral16 offset (Offset Value Y-Axis)	6023	Read-only	INTEGER16
Differential slope lateral16 offset (Offset Value Y-Axis)	6024	Read/Write	INTEGER16
All 32-bit objects	61XX	–	–
Slope long32 (Position Value X-Axis)	6110	Read-only	INTEGER32
Slope long32 operating parameter (Rotation Direction Value X-Axis)	6111	Read/Write	UNSIGNED8
Slope long32 preset value (Preset Value X-Axis)	6112	Read/Write	INTERGER32
Slope long32 offset (Offset Value X-Axis)	6113	Read-only	INTEGER32
Differential slope long32 offset (Offset Value X-Axis)	6114	Read/Write	INTEGER32
Slope lateral32 (Position Value Y-Axis)	6120	Read-only	INTEGER32
Slope lateral32 operating parameter (Rotation Direction Value Y-Axis)	6121	Read/Write	UNSIGNED8
Slope lateral32 preset value (Preset Value Y-Axis)	6122	Read/Write	INTEGER32
Slope lateral32 offset (Offset Value Y-Axis)	6123	Read-only	INTEGER32
Differential slope lateral32 offset (Offset Value Y-Axis)	6124	Read/Write	INTEGER32

Table 7.1

7.2 Communication Profile

7.2.1 Object 1000h: Device Type

The object at index 1000h describes the type of device and its functionality. It is composed of a 16-bit field which describes the device profile that is used and a second 16-bit field which gives additional information about optional functionality of the device. The additional information parameter is device profile specific.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 32	3019Ah [1] 4019Ah [2]	ro

Table 7.2

1) Single-Axis

2) Dual-Axis

7.2.2 Object 1001h: Error Register

This object is used by the device to display internal faults. If a fault is detected, the corresponding bit is activated. The following errors are supported..

Bit	Description	Comments
00h	Generic Error	The generic error is signaled at any error situation

Table 7.3

The object description for error register.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 8	N/A	ro

Table 7.4

7.2.3 Object 1003h: Pre-Defined Error Field

The object holds the errors that have occurred on the device and have been signaled via the Emergency Object. The error code is located in the least significant word and additional information is located in the most significant word. Sub-index 0 contains the number of recorded errors.

Subindex	Description	Data Type	Default Value	Access
00h	Number of recorded errors	Unsigned 8	00h	rw
01h	Most recent errors	Unsigned 32	–	ro

Table 7.5

7.2.4 Object 1005h: COB-ID Sync

This object indicates the configured COB-ID of the synchronization object. In operational mode, sensor sends process data if SYNC message with same COB-ID is received. (Correct setting of transmission type of TxPDO(s) implied).

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 32	80h	rw

Table 7.6

7.2.5 Object 1008h: Mfr Device Name

This object contains the device name.

Subindex	Description	Data Type	Default Value	Access
00h	–	String	INX F199 CANopen or INY F199 CANopen	ro

Table 7.7

7.2.6 Object 1009h: Mfr Hardware Version

This object contains the hardware version of the circuit board.

Subindex	Description	Data Type	Default Value	Access
00h	–	String	–	ro

Table 7.8

7.2.7 Object 100Ah: Mfr Software Version

This object contains the manufacturer software version.

Subindex	Description	Data Type	Default Value	Access
00h	–	String	–	ro

Table 7.9

7.2.8 Object 100Ch: Guard Time

This object contains the guard time in milliseconds.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 16	00h	ro

Table 7.10

7.2.9 Object 100Dh: Life Time Factor

This object contains the life time factor parameters. The life time factor multiplied with the guard time gives the life time for the node guarding protocol.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 8	0	rw

Table 7.11

7.2.10 Object 1010h: Store Parameters

This object controls the saving of all writable parameters in non-volatile memory.

Subindex	Description	Data Type	Default Value	Access
00h	Number of subindexes	Unsigned 8	04h	ro
01h	Save all parameters	Unsigned 32	–	rw
02h	Save communication parameters	Unsigned 32	–	rw
03h	Save application parameters	Unsigned 32	–	rw
04h	Save manufacturer parameters	Unsigned 32	–	rw

Table 7.12

Storing Procedure: To save the parameters to non-volatile memory, the access signature “save” has to be sent to the corresponding sub-index of the device.

	Most Significant Word		Least significant word	
ASCII	e	v	a	s
Hex value	65h	76h	61h	73h

Table 7.13

7.2.11 Object 1011h: Restore Parameters

This object is used to restore device and CANopen related writeable parameters to default factory settings.

Subindex	Description	Data Type	Default Value	Access
00h	Number of subindexes	Unsigned 8	04h	ro
01h	Restore all parameters	Unsigned 32	–	rw
02h	Restore communication parameters	Unsigned 32	–	rw
03h	Restore application parameters	Unsigned 32	–	rw
04h	Restore manufacturer parameters	Unsigned 32	–	rw

Table 7.14

Loading procedure: To load the parameters from non volatile memory the access signature “load” has to be sent to the corresponding subindex of the device.

	Most Significant Word		Least significant word	
ASCII	d	a	o	l
Hex value	64h	61h	6Fh	06Ch

Table 7.15

Note!

A power off/on sequence is required for the restoration to take place after the message has been transmitted.

7.2.12 Object 1014h: COB-ID Emergency

This object indicates the configured COB-ID for the emergency write service. This has the highest priority among transmitted messages.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 32	81h	rw

Table 7.16

7.2.13 Object 1016h: Consumer Heartbeat Time

The consumer heartbeat time defines the expected heartbeat cycle time in ms. The device can only monitor one corresponding device. If the time is set to 0 the monitoring is not active. The value of this object must be higher than the corresponding time (object 1017) of the monitored device.

Subindex	Description	Data Type	Default Value	Access
00h	Number of indices	Unsigned 8	01h	ro
0h1	Consumer heartbeat time	Unsigned 32	00h	rw

Table 7.17

The context of subindex 1 is as follows:

Bit	31 to 24	23 to 16	15 to 0
Value	0h (reserved)	Address of monitored device (Node-ID)	Monitoring time (ms)

7.2.14 Object 1017h: Producer Heartbeat Time

The object contains the time interval in milliseconds in which the device has to produce a heartbeat message. The values are given in multiples of 1 ms.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 16	00h	rw

Table 7.18

7.2.15 Object 1018: Identity Object

This object provides the general identification of the inclination sensor.

Subindex	Description	Data Type	Default Value	Access
00h	Number of entries	Unsigned 8	04h	ro
01h	Vendor Id	Unsigned 32	ADh	ro
02h	Product Code	Unsigned 32	43415032h	ro
03h	Revision Number	Unsigned 32	00010000h[1]	ro
04h	Serial Number	Unsigned 32	–	ro

Table 7.19

1) Prone to change with every revision.

7.2.16 Object 1800h: 1st Transmit PDO Communication Parameter

This object contains the communication parameter of the 1st transmit PDO.

Subindex [1]	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	05h	ro	yes
01h	COB-ID	Unsigned 32	180h + Node ID	rw	yes
02h	Transmission Mode	Unsigned 8	01h	rw	yes
03h	Inhibit Time	Unsigned 32	00h	rw	yes
04h	Not Available				
05h	Event Timer	Unsigned 32	00h	rw	yes

Table 7.20

1) Second degree identifier used in combination with the object. (Follows the object number).

7.2.17 Object 1801h: 2nd Transmit PDO Communication Parameter

This object contains the communication parameter of the 2nd transmit PDO.

Subindex [1]	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	05h	ro	yes
01h	COB-ID	Unsigned 32	280h + Node ID	rw	yes
02h	Transmission Mode	Unsigned 8	FEh	rw	yes
03h	Inhibit Time	Unsigned 32	00h	rw	yes
04h	Not Available				
05h	Event Timer	Unsigned 32	00h	rw	yes

Table 7.21

1) Subindex: Second degree identifier used in combination with the object. (Follows the object number).

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7.2.18 Object 1A00h: 1st Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 1st transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	2 = INY*** 2 subindexes 1 = INX*** 1 subindex	ro	yes
01h	Mapped object	Unsigned 32	60100010h	rw	yes
02h	Mapped object	Unsigned 32	60200010h	rw	yes

Table 7.22

7.2.19 Object 1A01h: 2nd Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 2nd transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after BootUp
00h	Number of sub indices	Unsigned 8	2 = INY*** 2 subindexes 1 = INX*** 1 subindex	ro	yes
01h	Mapped object	Unsigned 32	60100010h	rw	yes
02h	Mapped object	Unsigned 32	60200010h	rw	yes

Table 7.23

7.3 Manufacturer Specific

7.3.1 Object 2200h: Cyclic Timer

This object is used to determine the transmission interval during cyclic transmission mode. This object is hardwired with the event timers of TxPDO1 and TxPDO2. If cyclic timer and event timers of TxPDOs hold different values after power off/on cycle, the value of the event timers is copied to the cycle time.

Subindex	Description	Data Type	Default Value	Access
00h	–	Unsigned 16	00h	rw

Table 7.24

7.3.2 Object 2300h: Save Parameter with Reset

With this object, all parameters can be stored in the non-volatile memory. All parameters are saved with an additional reset executed afterward.

Subindex	Description	Data Type	Default Value	Access
00h	Access code	Unsigned 32	55AAAA55h	wo

Table 7.25

7.3.3 Object 2600h: Preset X-Axis

This object sets the x-axis to the desired value. It is hard-wired with the objects 6012 and 6112.

Subindex	Description	Data Type	Default Value	Access
00h	–	Integer 16	–	rw

Table 7.26

The valid "Preset Value" ranges depend on the current resolution of the inclination sensor. An error message will appear if the "Preset Value" is out of range.

The following table displays the relation between preset range and resolution as an example for INY160*** and INX360***.

Resolution	Preset Range (in decimal)	
Type	INY160***	INX360***
1°	± 80	0 ... 360
0.1°	± 800	0 ... 3600
0.01°	± 8000	0 ... 36000

Table 7.27

Note!

After setting the "Preset Value," a save command has to be given in order to set the preset value permanently.

7.3.4 Object 2601h: Preset Y-Axis

This object sets the y-axis to the desired value. It is hard-wired with the objects 6022 and 6122.

Subindex	Description	Data Type	Default Value	Access
00h	–	Integer 16	–	rw

Table 7.28

The valid "Preset Value" ranges depend on the current resolution of the inclination sensor. An error message will appear if the "Preset Value" is out of range.

The following table displays the relation between preset range and resolution as an example for INY160***.

Resolution	Preset Range (in decimal)
Type	INY160***
1°	± 80
0.1°	± 800
0.01°	± 8000

Table 7.29

Note!

After setting the "Preset Value," a save command has to be given in order to set the preset value permanently.

7.3.5 Object 3000h: Node Number

This object contains the node number of the device. The Pepperl+Fuchs standard node number is 01 decimal. The valid node numbers range from 01 to 127.

Subindex	Description	Data Type	Default Value	Access
00h	Node Number	Unsigned 8	00h	rw

Table 7.30

Note!

To avoid the node number zero (0), one (1) will be added to the value of this object. E.g.: To set node number 16 decimal, write 0Fh to the object and save. 0Fh+01h = 10h = 16 (dec) will finally be set as the node number. The new node number is only adopted after the device is reset. I.e., the node number needs to be saved prior to the reset to have an effect.

7.3.6 Object 3001h: Baud rate

This object contains the baud rate of the device. Valid value ranges from 00h to 07h.

Subindex	Description	Data Type	Default Value	Access
00h	Baud rate	Unsigned 8	03h	rw

Table 7.31

Eight different baud rates are provided. To adjust the baud rate only one byte is used. The default baud rate is 125 kB (03h).

Baud rate in kB	Stored Value in Object
20	00h
50	01h
100	02h
125	03h
250	04h
500	05h
800	06h
1000	07h

Table 7.32

Note!

The new baud rate is only adopted after the device is reset, i.e. the baud rate needs to be saved prior to the reset to have an effect.

7.3.7 Object 3002h: Terminator

This object is used to activate the terminator in case the inclination sensor is used at the edges of the transmission line to avoid reflection of data back into the line. The terminator should also be activated in case of (and/or) high transmission rates (> 50kB).

Subindex	Description	Data Type	Default Value	Access
00h	Activate terminator	Unsigned 8	00h	rw

Table 7.33

For Activation – Write 01h to the subindex 0 of the object

For De-activation – Write 00h decimal to the subindex 0 of the object

Note!

If activated, the terminator is only enabled while the device is powered.

7.3.8 Object 3022h: Digital Recursive Filter

This particular object controls the weighting factor of the recursive filter. If set to 0, the filter is deactivated. Valid values range from 0 to 999. The value specifies the weighting factor for the slope values obtained earlier, divided by 1000. Therefore, mathematically the weighting factor ranges from 0 to 1.

Subindex	Description	Data Type	Default Value	Access
00h	Digital Recursive Filter	Unsigned 16	00h	rw

Table 7.34

For calculation of the position values with the recursive filter activated:

New_Sensor_Value = {[Weighting_Factor x Old_Sensor_Value] + [(1 – Weighting_Factor) x New_Sensor_Value]}

7.3.9 Object 3100h: Moving Average Filter

This object contains the number of values which are averaged. If set to 0 then the filter is deactivated. The valid range of filter values accepted is from 0 to 250d.

Subindex	Description	Data Type	Default Value	Access
00h	Moving Average Filter	Unsigned 16	64h (100d)	rw

Table 7.35

Internal Calculation of position values when MAF is activated with value N:

$New\_Sensor\_Valuex = [Sensor\_Value_x + Sensor\_Value_{x-1} + ...+ Sensor\_Value_{x-N}] / N$

7.4 Device Profile

7.4.1 Object 6000h: Resolution

This object is used to set the resolution, i.e, the minimum angle difference displayed by the inclination sensor. The default value is 10d (000Ah).

Subindex	Description	Data Type	Default Value	Access
00h	Resolution	Unsigned 16	000Ah	rw

Table 7.36

Three possible resolutions can be used:

Angular Resolution	Value decimal	Byte hex
0.01°	10	000Ah
0.1°	100	0064h
1°	1000	03E8h

Table 7.37

7.4.2 Object 6010h: Slope Long16

Position Value X-Axis

This object provides the x-axis position value of the inclination sensors.

Subindex	Description	Data Type	Default Value	Access
00h	–	Integer 16	–	ro

Table 7.38

Three possible resolutions can be used.

The following table displays the relation between preset range and resolution as an example for INY160*** and INX360***.

Resolution	Preset Range (in decimal)	
Type	INY160***	INX360***
1°	± 80	0 ... 360
0.1°	± 800	0 ... 3600
0.01°	± 8000	0 ... 36000

Table 7.39

Calculation of position / slope value from CANopen readout

Inclination (Degree) = Slope Long 16[Object 6010] x Resolution [Object 6000]

Caution!

Changing of resolution may cause side effects on calculations!

If attribute "resolution" is changed, side effects will occur, as the sensor is adapting the already set parameters to the configured resolution. Rounding effects have to be taken into account. Attributes affected: write/read: preset slope long16, preset slope lateral16, differential slope long16 offset, differential slope lateral16 offset, preset slope long32, preset slope lateral32, differential slope long32 offset, differential slope lateral32 offset; read only: slope long16, slope lateral16, slope long16 offset, slope lateral16 offset, slope long32, slope lateral32, slope lateral32 offset, slope lateral32 offset.

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7.4.3 Object 6011h: Slope Long16 Operating Parameter

Rotation Direction Value X-Axis

This object controls the scaling and inversion of the slope long16 values. If bit 0 is set, inversion of slope long16 is enabled. If bit 1 is set, slope long16 offset and differential slope long16 offset are added to the slope long16. Both bits can be set at the same time.

Subindex	Description	Data Type	Default Value	Access
00h	Position Scaling and Inversion	Unsigned 8	00h	rw

Table 7.40

Calculation of position value based on the operating parameter

Slope Long16 = [(Physical inclination of slope long16 * Multiplier) + Slope long16 Offset + Differential Slope long16 Offset]

With:

- Physical inclination of slope long16 (X)
- Multiplier: if inversion is disabled: 1, if inversion is enabled: -1
- Slope Long16 Offset (6013) = Slope Long16 Preset (6012) – (Physical inclination of slope long16 (X) at tacc * Multiplier), with tacc = preset acquisition time
- Differential slope long16 offset (6014): Adds an absolute value (positive or negative) to the sensor

Position Calculation	Stored Value in Object
X	00h
-X (10000h – X for 16bit objects, 100000000h – X for 32bit objects)	01h
(X + Object 6013h + Object 6014h)	02h
(-X + Object 6013h + Object 6014h)	03h

Table 7.41

For detailed explanation please see the corresponding objects.

7.4.4 Object 6012h: Slope Long16

Preset Value X-Axis

This object is used to define a new, desired longitudinal slope value.

Caution!

Setting Preset Value X-Axis may cause side effects on calculations!

The values will be set only according to the current resolution, so extreme care should be taken in order to be within the range of the position value limits.

Subindex	Description	Data Type	Default Value	Access
00h	Preset Value X-Axis	Integer 16	00h	rw

Table 7.42

7.4.5 Object 6013h: Slope Long16 Offset

Offset Value X-Axis

This is a read only parameter. The parameter is recalculated every time Slope Long16 preset (6012h), Slope Long32 Preset (6112) or Preset X (2600) objects are changed.

This object does not exist for INX*** inclination sensors.

Subindex	Description	Data Type	Default Value	Access
00h	Offset Value	Integer 16	–	ro

Table 7.43

Calculation of Slope Long16 Offset

Offset Value = Preset Value – (Physical Value * Inversion)

[Inversion is -1 if activated; 1 if deactivated]

7.4.6 Object 6014h: Differential Slope Long16 Offset

Offset Value X-Axis

This parameter adds an additional, independent offset to slope long16, but only if scaling of slope long16 is enabled. Note that the values should be within the range of position attribute according to the resolution already set.

This object does not exist for INX*** inclination sensors.

Subindex	Description	Data Type	Default Value	Access
00h	Offset Value	Integer 16	–	rw

Table 7.44

The main difference between the objects 6013h and 6014h is that, 6013h is calculated automatically depending on the preset value whereas object 6014h is user defined.

7.4.7 Object 6020h: Slope Lateral16

Position Value Y-Axis

In INY* inclination sensors, this object provides the Y-axis position value. This a read only object and the position values are limited depending on the resolution set.

Subindex	Description	Data Type	Default Value	Access
00h	–	Integer 16	–	ro

Table 7.45

Calculation of position / slope value from CANopen readout

Inclination (Degree) = Slope Lateral 16[Object 6020] x Resolution [Object 6000]

7.4.8 Object 6021h: Slope Lateral16 Operating Parameter

Rotation Direction Value Y-Axis

This object controls the scaling and inversion of the slope lateral16 values. If bit 0 is set, inversion of slope lateral16 is enabled. If bit 1 is set, slope lateral16 offset and differential slope lateral16 offset are added to the slope lateral16. Both bits can be set at the same time.

Subindex	Description	Data Type	Default Value	Access
00h	Position Scaling and Inversion	Unsigned 8	00h	rw

Table 7.46

Calculation of position value based on the operating parameter

Slope Lateral16 = [(Physical inclination of slope lateral16 * Multiplier) + Slope lateral16 Offset + Differential Slope lateral16 Offset]

With:

- Physical inclination of slope long16 (X)
- Multiplier: if inversion is disabled: 1, if inversion is enabled: -1
- Slope Lateral16 Offset (6023) = Slope Lateral16 Preset (6022) – (Physical inclination of slope lateral16 (X) at tacc * Multiplier), with tacc = preset acquisition time
- Differential slope lateral16 offset (6024): Adds an absolute value (positive or negative) to the sensor output.

Position Calculation	Stored Value in Object
X	00h
-X (10000h – X for 16bit objects, 100000000h – X for 32bit objects)	01h
(X + Object 6023h + Object 6024h)	02h
(-X + Object 6023h + Object 6024h)	03h

Table 7.47

For detailed explanation, see the corresponding objects.

7.4.9 Object 6022h: Slope Lateral16 Preset Value

Preset Value Y-Axis

This object is used to define a new, desired lateral slope value. The values will be set only according to the current resolution, so extreme care should be taken in order to be within the range of the position value limits.

Subindex	Description	Data Type	Default Value	Access
00h	Preset Value	Integer 16	00h	rw

Table 7.48

Calculation of position / slope value from CANopen readout

Inclination (Degree) = Slope Lateral 16[Object 6020] x Resolution [Object 6000]

7.4.10 Object 6023h: Slope Lateral16 Offset

Offset Value Y-Axis

This is a read only parameter. The parameter is recalculated every time Slope Lateral16 preset (6022h), Slope Lateral32 Preset (6122h) or Preset Y (2601h) objects are changed.

Subindex	Description	Data Type	Default Value	Access
00h	Offset Value	Integer 16	–	ro

Table 7.49

Calculation of Slope Lateral16 Offset

Offset Value = Preset Value – (Physical Value * Inversion)

[Inversion is -1 if activated; 1 if deactivated]

7.4.11 Object 6024h: Differential Slope Lateral16 Offset

Offset Value Y-Axis

This parameter adds an additional, independent offset to slope lateral16, but only if scaling of slope lateral16 is enabled. Please note that the values should be within the range of position attribute according to the resolution already set.

Subindex	Description	Data Type	Default Value	Access
00h	Offset Value	Integer 16	–	rw

Table 7.50

The main difference between the objects 6023h and 6024h is that, 6023 is calculated automatically depending on the preset value whereas object 6024h is user defined.

7.4.12 Object 61xxh: All 32-bit Objects

32-bit objects are hardwired with corresponding 16 bit objects. The function of these 16-bit objects and the corresponding 32-objects is identical. Only the data length differs.

- Object 6110h – 6114h: Hardwired with 16-bit slope long16 objects.
- Objects 6120h – 6124h: Hardwired with 16-bit slope lateral16 objects.

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