IKM360R

Redundant 1-axis inclinometer with CANopen-interface

User manual

SIKO

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Table of contents

1 General Information 4
1.1 Documentation 4
1.2 Definitions 4

2 Intended use 4
2.1 Switching on the supply voltage 5

3 LED-signal 6

4 Functional description 7
4.1 Measuring range 7
4.2 Calibration 7
4.3 Reset to factory settings 7

5 Communication via CAN bus (CANopen) 7
5.1 Telegram structure 7
5.2 Node control 9
5.2.1 Network management (NMT) services 9
5.2.1.1 NMT communication states 10
5.2.1.2 Toggling between the NMT communication states 10
5.2.2 Boot-Up 11
5.2.3 SYNC object 11
5.3 Process data exchange 11
5.3.1 Transfer of process data objects (PDO) 11
5.3.1.1 Transmit-PDO (from the IKM360R to the master) 11
5.4 Parameter data exchange 12
5.4.1 Transmission of Service Data Objects (SDO) 12
5.4.1.1 Expedited Request/Response 12
5.4.1.2 Normal Request/Response 13
5.4.1.3 Error Response in SDO exchange 15
5.4.1.4 SDO examples 15
5.5 Node monitoring 17
5.5.1 Emergency service (EMCY) 17
5.5.2 Node Guarding 19
5.5.3 Heartbeat 19
5.6 Layer Setting Service (LSS) 20
5.6.1 State change 21
5.6.1.1 Switch states of all LSS devices (Switch state global) 21
5.6.1.2 Switch states of individual LSS devices (Switch state selective) 21
5.6.2 Configuration 22
5.6.2.1 Setting the Node ID (Configure Node ID) 22
5.6.2.2 Configuration of the baud rate (Configure bit timing parameters) 23
5.6.2.3 Activate baud rate (Activate bit timing parameters) 24
5.6.2.4 Store configuration 24

5.6.3 Requesting parameters 25
5.6.3.1 Request Vendor ID 25
5.6.3.2 Request Product Code 25
5.6.3.3 Request revision number 26
5.6.3.4 Request serial number 26
5.6.3.5 Request Node ID 26
5.7 Directory of objects 27
5.7.1 Overview of objects 27
5.7.2 Object Description 28
5.7.2.1 1000h: Device Type 28
5.7.2.2 1001h: Error Register 28
5.7.2.3 1002h: Manufacturer Status Register 29
5.7.2.4 1003h: Pre-defined Error Field 29
5.7.2.5 1005h: COB ID SYNC message 30
5.7.2.6 1008h: Manufacturer Device Name 30
5.7.2.7 1009h: Manufacturer Hardware Version 31
5.7.2.8 100Ah: Manufacturer Software Version 31
5.7.2.9 100Ch: Guard Time 31
5.7.2.10 100Dh: Life Time Factor 32
5.7.2.11 1010h: Store Parameter 32
5.7.2.12 1011h: Restore Parameter 34
5.7.2.13 1014h: COB ID Emergency message 36
5.7.2.14 1017h: Producer Heartbeat Time 37
5.7.2.15 1018h: Identity Object 37
5.7.2.16 1200h: Server SDO Parameter 38
5.7.2.17 1800h: 1st Transmit PDO Parameter 39
5.7.2.18 1A00h: 1st Transmit PDO Mapping Parameter 40
5.7.2.19 2000h: Digital filter cut-off frequency 41
5.7.2.20 5F0Ah: Node ID and baud rate Bus CAN 41
5.7.2.21 6000h: Resolution 42
5.7.2.22 6010h: Slope long16 42
5.7.2.23 6011h: Slope long16 operating parameter 43
5.7.2.24 6012h: Slope long16 Preset value (calibration value) 43
5.7.2.25 6013h: Slope long16 Offset 44
5.7.2.26 6014h: Differential Slope long16 Offset 44
5.7.2.27 6511h: Device temperature 44

1 General Information

1.1 Documentation

The following documents are associated with this document:

- The data sheet describes the technical data, the dimensions, the pin assignment, the accessories and the order key.
- The installation instructions describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.
- The User manual for sensor commissioning and integration into a fieldbus system.
- EDS file (electronic data sheet); this file enables integration and configuration in a CANopen network by means of commercial CANopen configurators.

You can also download these documents at **http://www.siko-global.com/p/ikm360r**.

1.2 Definitions

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

2 Intended use

The IKM360R 1-axis is designed for redundant slope detection in one dimension. The inclinometer can be parameterized and read out via the CAN interface using the CANopen protocol. The sensor can be used for applications up to Performance Level D (PLd) in the overall system. For this purpose, a higher-level, safe evaluation device is required because the inclinometer sensor with its internal sensor diagnosis is not able to initiate actions itself such as the initiation of a safe state. Increased demands are placed on the electrical and mechanical connection of the inclinometer.

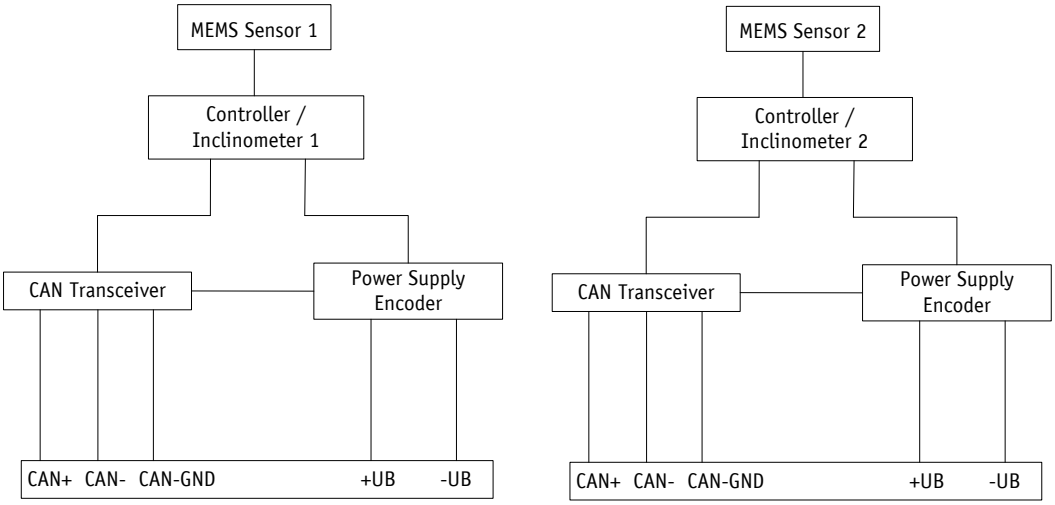

Fig. 1: Block diagram

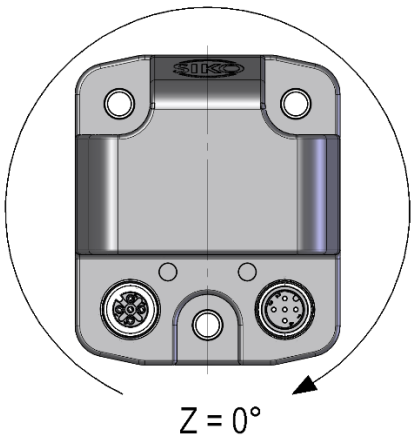

Fig. 2: Measurement axis

2.1 Switching on the supply voltage

The inclinometer initializes after being switched on. The configuration parameters are loaded from the nonvolatile memory into the main memory of the controller during initialization.

Each sensor will work with its default values as long as no changes have been made to it. With parameters changed, the sensor will work with the changed data, which must be stored if they are intended to be used after power off/on.

After completing the initialization procedure, each inclinometer sends a specific NMT command, the boot-up message, which informs the system about their availability. The inclinometer is now in the pre-operational mode. In this state, the sensor can be parameterized via SDO commands in accordance with the requirements of the application. This concerns both the configuration parameters of the sensor system and the way in which it makes its slope values available to the system (asynchronous or synchronous data transmission).

3 LED-signal

Each inclinometer has 2 LEDs in the colors green and red for diagnosis and status purposes.

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

The LSS waiting status is not indicated via the LEDs.

CAN diagnosis:

The CiA 303 Part 3 V1.4.0 indicator specification is the basis of the CAN diagnosis.

LED status	Description
On	LED is permanently on
Off	LED is permanently off
Flickering	Both LEDs alternately with the frequency of 10 Hz (50 ms on/off)
Flashing	LED flashes at a frequency of 2.5 Hz (200 ms on/off)
Single Flash	LED is 200 ms on, 1000 ms off
Double Flash	LED is 200 ms on, 200 ms off, 200 ms on, 1000 ms off

Table 1: CAN LED statuses acc. to CiA 303

CAN Run LED:

NMT state	LED status
Pre-Operational	Flashing
Operational	On
Stopped	Single Flash

Table 2: CAN Run LED

CAN Err LED:

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

Table 3: CAN Err LED

CAN Run LED and CAN Err LED alternately:

LSS state	LED status
Configuration	Flickering

Table 4: LSS configuration

4 Functional description

4.1 Measuring range

The inclinometer supports 2 measuring ranges. A measuring range of 0 ... 360° (resolution 0.1°) is set by default. The measuring range can be switched to ±180° (resolution 0.1°) via object 6011h: Slope long16 operating parameter.

4.2 Calibration

Owing to the absolute system, calibration is required only once when the system is taken into operation and can be performed at any position. This enables alignment of the inclinometer zero point with the system's mechanical zero point. During calibration, the calibration value is used to calculate the slope value.

4.3 Reset to factory settings

To return to the original condition of the device as delivered, there exist the following options:

Access	Coding		Settings are restored
CANopen (see object 1011h: Restore Parameter)	1011h "load"	Sub-index 1	All parameters
		Sub-index 2	Only bus parameters
		Sub-index 3	Only CiA 410 parameters
		Sub-index 4	Only manufacturer-specific parameters

Table 5: Access to factory settings

5 Communication via CAN bus (CANopen)

The basis for the inclinometer IKM360R is the CANopen communication profile CiA 301 V4.2, the device profile for inclinometer CiA 410 V2.0.0. The IKM360R supports device class C1. The details required for a better understanding of the operation are included in this documentation. If more in-depth information is required, we recommend the applicable technical literature on CAN or CANopen.

5.1 Telegram structure

The data telegram of a CAN message consists of the following fields:

SOF	Identifier (COB ID)	Control field	Data field (max. 8 Byte)	CRC	ACK / EOF

SOF:

(Start of Frame) start bit of the telegram.

Identifier (COB ID):

- By means of the identifier, all bus subscribers check whether the message is relevant for each of them.
- The identifier determines the priority of the message. The lower the value of the identifier, the higher is the priority of the message. This enables preferential transmission of important messages via the bus.

The Identifier field contains the identifier as well as bits for the recognition of the length of the identifiers (11 or 29 bits). The device address, channel selection as well as data direction are determined via the identifier as well.

Thus, the 11bits identifier (COB identifier) consists of a 4bit function code and a 7bit node number:

Bit no.	10	9	8	7	6	5	4	3	2	1	0
Type	Functional code				Node number (Node ID)						
Assignment	x	x	x	x	0	0	x	x	x	x	x

The following functional codes have been defined in the "Pre-defined Connection Set" (only the functional codes used in the present device are shown):

Object	Functional code	Resulting COB ID	Object	Page
Network management (NMT)	0000b	0	-	9
SYNC message	0001b	128d (80h)	1005h	11
Emergency message	0001b	128d (80h) + Node ID	1014h	17
TPD01	0011b	384d (180h) + Node ID	1800h	11
SDO (tx)	1011b	1408d (580h) + Node ID	1200h	12
SDO (rx)	1100b	1536d (600h) + Node ID	1200h	12
Heartbeat message	1110b	1792d (700h) + Node ID	-	19
Node Guard message	1110b	1792d (700h) + Node ID	-	19
LSS (tx)	-	2020d (7E4h)	-	20
LSS (rx)	-	2021d (7E5h)	-	20

Table 6: Overview of COB identifiers

Changes to COB IDs are only possible in the PRE-OPERATIONAL NMT status. First, the COB ID must be switched invalid via bit 31 = 1b before it can be changed and reactivated.

The COB ID of the Sync object is an exception, where bit 30 must be = 0b to enable the COB ID to be changed. As bit 30 cannot be set to 1b in the inclinometer, the COB ID could be changed at any time.

The node number (Node ID) (see also object 5F0Ah: Node ID and baud rate Bus CAN) is assigned once in every bus system with configuration of the master on IKM360R. The node numbers range from 1 to 127. Node ID = 0 is reserved and must not be used.

The adoption of a Node ID or baud rate which was reset occurs only after re-initialization (see chapter 5.2.1).

In the case of the inclinometer IKM360R, an inclinometer with node ID 1 (1h) and the redundant inclinometer with node ID 2 (2h) are delivered ex works.

Control field:

Contains bit-by-bit information concerning the number of user data and determines whether a data frame or RTR frame (Remote Transmission Request frame) is concerned.

Data field:

Contains up to 8 bytes of user data. The user data has a different meaning depending on the channel selection.

CRC:

Contains bits for error detection.

ACK/EOF:

The ACK/EOF field contains telegram acknowledgment bits as well as bits for determining the end of telegram.

For a detailed description of the telegram please refer to the applicable technical CAN literature. For simplification, only identifier (COB ID) and data field will be dealt with in the subsequent telegram descriptions.

5.2 Node control

5.2.1 Network management (NMT) services

The master configures, manages and monitors network nodes via the NMT service. The device is always in one of the four communication states "INITIALIZATION", "PRE-OPERATIONAL", "OPERATIONAL" or "STOPPED" (see Fig. 3).

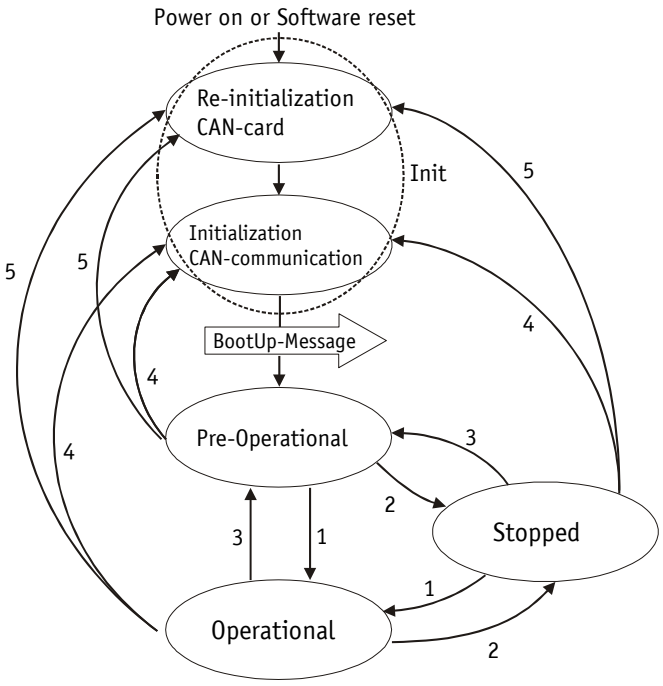

Fig. 3: NMT status diagram

5.2.1.1 NMT communication states

NMT Status INITIALIZATION

The device is not involved in the bus actions in this state. All hardware and software components are initialized. This state is attained after switching on the device or after receipt of the command code 81h ("Reset node") of the own or global addresses. Following receipt of the command code 82h ("Reset Communication"), the inclinometer will enter the initialization stage as well. But only hardware and software associated with CAN communication will be reinitialized. The device signals automatically the completion of initialization by sending a boot-up message. As soon as the boot-up message was sent successfully, the device will enter the "PRE-OPERATIONAL" status.

NMT Status PRE-OPERATIONAL

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

NMT Status OPERATIONAL

The exchange of process data is enabled as well. However, COB ID and Transmit PDO Mapping parameters can no longer be changed in this status.

NMT Status STOPPED

Communication is stopped except for heartbeat and node guarding Only NMT communication is enabled.

5.2.1.2 Toggling between the NMT communication states

For toggling between the communications states, telegrams with the following structures are used:

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

Table 7: Toggling between communication states

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

5.2.2 Boot-Up

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

COB ID	Byte 0
700h + Node ID	00h

Table 8: Boot-Up message

5.2.3 SYNC object

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

5.3 Process data exchange

5.3.1 Transfer of process data objects (PDO)

Process data objects (PDO) serve for fast exchange of process data. A maximum of 8 bytes of user data can be transferred in a PDO. The IKM360R supports the Transmit PDO services TPDO1 and TPDO2 according to CiA 301 and CiA 410.

5.3.1.1 Transmit-PDO (from the IKM360R to the master)

PDO transfer from the IKM360R to the bus master can be initiated as a result of various events:

- asynchronous, controlled by an internal device timer
- synchronous as a response to a SYNC telegram
- as a response to an RTR message

The TPDO1 contains the slope long16. The transfer behavior of TPDO1 is determined via the objects 1800h and 1A00h and is assigned to asynchronous transmission. Synchronous data transmission is set at delivery. Other TPDOs are not supported.

COB ID	Process data in binary code	
	Byte 0 (LSB)	Byte 1 (MSB)
TPDO1 180h + Node ID	Slope long16	

Table 9: TPDO message

Asynchronous data transmission

If a TPDO1 is to be sent cyclically, 254 (FEh) or 255 (FFh) must be entered in object 1800h, sub-index 02h. The cycle time can be entered in milliseconds in object 1800h, sub-index 05h. The TPDO1 will not be sent if the value 0 ms is written. The function is disabled. The minimum value to be set is 1h (= 1 ms).

Synchronous data transfer

As delivered, the device responds to every SYNC Message received with the output of the TPDO1 message. 1h is entered for synchronous transmission in object 1800h, sub-index 02h. If a value n is entered between 1d and 240d (= F0h), the device will respond to every nth SYNC message.

RTR

Queries can be sent via RTR (see chapter 5.1) toTPDO1.

5.4 Parameter data exchange

5.4.1 Transmission of Service Data Objects (SDO)

Service data objects serve mainly device configuration via the directory of objects. SDOs in the expedited Request/Response and in the normal Request/Response are supported.

The identifier is set to 11 bits and cannot be changed.

Two SDO services are available:

- SDO (rx) (Master → Slave): 600h + Node ID
- SDO (tx) (Slave → Master): 580h + Node ID

Two SDO services are available!

5.4.1.1 Expedited Request/Response

Except for reading the objects 1008h: Manufacturer Device Name and 100Ah: Manufacturer Software Version all SDOs are exchanged between two subscribers in the expedited Request/Response method. The user data is provided already with the initialization message.

SDO messages are set up as follows:

COB ID	**User data in binary code**							
	Byte 0 read / write	**Byte 1 LSB**	**Byte 2 MSB**	**Byte 3**	**Byte 4 LSB**	**Byte 5**	**Byte 6**	**Byte 7 MSB**
SDO rx/tx + Node ID	Command byte	Index		Sub-index	User data (parameter)			

Command byte, byte 0:

The command byte determines the type of access and the number of valid data bytes. The following command bytes are valid for the IKM360R:

Command byte		Type	Function
Write Request	23h	SDO (rx), Initiate Download Request, expedited	Send parameter to slave (all 4 data bytes valid)
Write Request	2Bh	SDO (rx), Initiate Download Request, expedited	Send parameter to slave (2Bytes of 4 data bytes valid)
Write Request	2Fh	SDO (rx), Initiate Download Request, expedited	Send parameter to slave (1Byte of 4 data bytes valid)
Write Request	60h	SDO (tx), Initiate Download Response, expedited	Acknowledgment of data acquisition to master
Read Request	40h	SDO (rx), Initiate Upload Request	Request parameter from slave
Read Response	43h	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (all 4 data bytes valid)
Read Response	4Bh	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (2Bytes of 4 data bytes valid)
Read Response	4Fh	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (1Byte of 4 data bytes valid)
Error Response	80h	SDO (tx), Abort Domain Transfer	Slave reports error code to master

Table 10: Command coding

Index, bytes 1 and 2:

The index (object number) is entered in the user data byte 2 (low byte) and user data byte 3 (high byte) in the Intel data format. Here, the index of the object to be parameterized is entered.

Sub-index, byte 3:

The sub-index indicates the number of the fields for objects realized as an array.

User data (parameters), bytes 4 ... 7:

In the user data, the value of the parameter is entered in left-aligned Intel notation. Byte 4 = Low-Byte ... Byte 7 = High-Byte.

5.4.1.2 Normal Request/Response

If more than 4 bytes of service data are to be transferred, the data is exchanged between two subscribers via the normal Request/Response. This procedure is also initiated by an initialization message, and the actual user data will be transferred in the subsequent segment messages.

For the IKM360R this is only the case with reading of the objects 1008h: Manufacturer Device Name and 100Ah: Manufacturer Software Version.

The initialization message has the following structure:

COB ID	User data in binary code							
	Byte 0 read / write	Byte 1 LSB	Byte 2 MSB	Byte 3	Byte 4 LSB	Byte 5	Byte 6	Byte 7 MSB
SDO rx/tx + Node ID	Command byte	Index		Sub-index	User data (number of user data)			

The segment message has the following structure:

COB ID	User data in binary code							
	Byte 0 read / write	Byte 1 LSB	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7 MSB
SDO rx/tx + Node ID	Command byte	User data						

Initialization and segment message: Command byte, byte 0:

The command byte determines the type of access and the number of valid data bytes. The following command bytes are valid for the IKM360R:

Command byte		Type	Function
Read Request	40h	SDO (rx), Normal Initiate Upload Request	Request parameter from slave (number of bytes to be transferred)
Read Request	60h	SDO (rx), Normal Segment Upload Request	Request parameter from slave (user data)
Read Response	41h	SDO (tx), Normal Initiate Upload Response	Report parameter to master (number of bytes to be transferred)
Read Response	03h	SDO (tx), Normal Segment Upload Response	Report parameter to master (user data)
Error Response	80h	SDO (tx), Abort Domain Transfer	Slave reports error code to master

Table 11: Command coding

Initialization message: Index, bytes 1 and 2:

The index (object number) is entered in the user data byte 2 (low byte) and in the user data byte 3 (high byte) in the Intel data format. Here, the index of the object to be parameterized is entered.

Initialization message: Sub-index, byte 3:

The sub-index indicates the number of the fields for objects realized as an array.

Initialization message: User data (parameters), byte 4 ... 7:

In the service data range, the value of the parameter is entered in left-aligned Intel notation. Byte 4 = Low-Byte ... Byte 7 = High-Byte.

Segment message: User data (parameters), byte 1 ... 7:

In the user data range, the value of the parameter is entered in left-aligned Intel notation. Byte 1 = Low-Byte ... Byte 7 = High-Byte.

5.4.1.3 Error Response in SDO exchange

With invalid access, an error message (Abort) is returned to the master.

The error codes are described in the CANopen profile (CiA 301) or in the inclinometer profile (CiA 410), respectively. The table below shows the error codes used:

Error code	Description
05030000h	Toggle bit in Normal Transfer of Request/Response unequal.
06010000h	Wrong access to an object.
06010001h	Read access to Write-Only.
06010002h	Write access to Read-Only.
06020000h	Object doesn't exist in the object directory.
06090011h	Sub-index does not exist.
06090030h	Wrong value range of selected parameter.
08000020h	Parameters cannot be transferred to application or stored.
08000022h	Parameters cannot be transferred to application or stored due to the current device status.
08000024h	No data available

Table 12: Error codes

5.4.1.4 SDO examples

Example of reading SDO parameters with the expedited Request/Response:

The calibration value stored in object 1017h of the directory of objects is to be read from the slave with device address 3h.

Calculation of the identifier: 600h + Node ID = 600h +1h = 601h

Command: 40h
Index: 1017h
Sub-index: 00h
The current value is 1000d = 3E8h.

Request of master from slave with Node ID 1h:

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	40h	17h	10h	00h	x	x	x	x

Response to the request by the slave:

Calculation of the identifier: 580h + Node ID = 581h

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
581h	4Bh (2 bytes valid)	17h	10h	00h	E8h	03h	00h	00h

Example of writing SDO parameters with the expedited Request/Response:

In the slave with device address 1h the cycle timer, which is stored with 2 bytes in object 1017h of the object dictionary, is to be changed.

Calculation of the identifier: 600h + Node ID = 600h + 1h = 601h

Command: 2 bytes are to be written: 2Bh
Index: 1017h
Sub-index: 00h
The new value shall be 100d = 64h.

Writing of a value from master to slave with Node ID 1h:

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	2Bh (2 bytes valid)	17h	10h	00h	64h	00h	00h	00h

Response to the command by the slave:

Calculation of the identifier: 580h + Node ID = 580h + 1h = 581h

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
581h	60h	17h	10h	00h	00h	00h	00h	00h

Example of reading SDO parameters with normal Request/Response:

The manufacturer device name stored in object 1008h of the directory of objects is to be read from the IKM360R with device address 1h.

Calculation of the identifier: 600h + Node ID = 600h +1h = 601h

Command: 40h
Index: 1008h
Sub-index: 00h

First request (= initialization) of master from slave with Node ID 1h:

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	40h	08h	10h	00h	x	x	x	x

Response to the request by the slave:

Calculation of the identifier: 580h + Node ID = 581h

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
581h	41h	08h	10h	00h	07h	00h	00h	00h

Number of expected user data bytes: 7

Second request of master from slave with Node ID 1h:

COB ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	60h	00h	00h	00h	x	x	x	x

Response to the request by the slave:

COB ID	User data							
	Command	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6
581h	01h	49h ("I")	4Bh ("K")	4Dh ("M")	33h ("3")	36h ("6")	30h ("0")	52h ("R")

5.5 Node monitoring

5.5.1 Emergency service (EMCY)

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

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

Identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
11/ 29 Bit	Emergency Error Code		Error Register (object 1001h)	Manufacturer-specific error field				

Emergency Error Code:

Error Description	Error Code
Cause of the error removed	0000h
Device power supply error Vin	3100h

Error Description	Error Code
Internal device power supply error Vcc, Vref	3200h
Device temperature error	4200h
Device hardware error	5000h
Device software error	6100h
CAN communication error	8100h
CAN buffer overflow error	8110h
CAN passive error	8120h
Heartbeat or life guarding error	8130h
CAN recovered from bus-off error	8140h
PDO error not processed due to invalid length	8210h
PDO length exceeded error	8220h
Device-specific/sensory error	FF00h

Table 13: Emergency Error Code

Manufacturer-specific error field:

Error Description	Error Code
Lower limit value violation error	0001h
Upper limit value violation error	0002h
Vcc or Vref error	0004h
Temperature error	0008h
MEMS sensor element error	0010h
Controller error	0020h
Memory error	0040h
Operating mode error	0080h
Hardware component error	0100h
MEMS saturation measuring range/measuring range exceedance error	0200h
MEMS self-test error	0400h
MEMS communication error	0800h
MEMS output rate (sample frequency) error	1000h

Table 14: Manufacturer-specific error field

The identifier of the emergency object is set to 80h + Node ID by default; however, it can be changed via object 1014h (see 1014h: COB ID Emergency message). Transmission of an emergency message is enabled in the NMT statuses "OPERATIONAL" or "PRE-OPERATIONAL" only. Transmission of the emergency messages can be disabled by setting the COB ID Valid bit to 1.

5.5.2 Node Guarding

Node guarding is available for failure monitoring of the CANopen network. During node guarding, the master transmits remote frames (RTR, remote transmit request, message request telegrams) on the guarding identifiers of the nodes to be monitored. The latter respond with the guarding message. This message contains the current NMT status of the node as well as a toggle bit whose value must change after each message. The master assumes that a node error has occurred if status or toggle bits do not correspond with those expected by the master or if there is no response.

Via objects 100Ch (Guard Time) and 100Dh (Life Time Factor) the time interval (Life-Time) is set within which the NMT master expects to receive a response. The time interval "Life Time" is calculated from the cycle time "Guard Time", multiplied with the factor "Life Time Factor". If the NMT master does not receive a response to its RTR frame within the "Life Time", it may react with suitable measures. Upon switching on, node guarding will be enabled by sending the first RTR frame of the master to the slave. Node Guarding is deactivated if the value of either object (100Ch or 100Dh) is set to 0h.

The answer of the node to the RTR frame of the master is formed as follows:

Identifier	**Byte 0**	
700h + Node ID	Bit 7: Toggle Bit	Bit 6 ... 0: NMT state

Toggle Bit:

The toggle bit must alternate between two subsequent responses of the device. After the guarding protocol has been enabled, the toggle bit must have the value 0 with the first response.

NMT state:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

The identifier of the node guarding protocol is permanently set to 700h + Node ID and cannot be changed. A node guard message can be sent in the NMT statuses "OPERATIONAL", "PRE-OPERATIONAL" or "STOPPED".

Note:

Literature recommends heartbeat to be used for node monitoring. Only the master can detect missing communication via the node guarding protocol as opposed to the heartbeat that can be received by all subscribers.

5.5.3 Heartbeat

The master monitors the state of the slave device via Heartbeat protocol. While doing this, the device sends independently its NMT status cyclically. The IKM360R is a heartbeat producer, it does not receive nor process heartbeat protocols itself. The cycle time of the heartbeat message is set via object 1017h. The heartbeat protocol is deactivated if the cycle time is 0h.

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

COB ID	Byte 0
700h + Node ID	NMT state

NMT state:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

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

5.6 Layer Setting Service (LSS)

Layer Setting Service (LSS) is a special method described in CiA 305 it serves for retrieving and configuring various parameters (Node ID, baud rate, and Identity Object 1018h).

Every device must have a unique LSS number composed of the entries in Object 1018h.

- Vendor ID: 0000 0195h
- Product code: 0202 0001h
- Revision number: FFFF FFFFh
- Serial number: xxxx xxxxh (respective serial number of the inclinometer)

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

Two LSS services are available:

- LSS (rx) (LSS Master → Slave): 7E5h
- LSS (tx) (Slave → LSS Master): 7E4h

These LSS identifiers cannot be changed!

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

Service	LSS waiting	LSS configuration
Switch state global	yes	yes
Switch state selective	yes	no
Activate bit timing parameters	no	yes, if all devices on the bus support LSS
Configure bit timing parameters	no	yes
Configure Node ID	no	yes

Service	LSS waiting	LSS configuration
Store configuration	no	yes
Request LSS address	no	yes
Request Node ID	no	yes

Table 15: State behavior of the supported LSS services

5.6.1 State change

5.6.1.1 Switch states of all LSS devices (Switch state global)

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	04h	Mode	00h	00h	00h	00h	00h	00h

Mode:

00h: Switch to LSS waiting state

01h: Switch to LSS configuration state

5.6.1.2 Switch states of individual LSS devices (Switch state selective)

With this command, Individual LSS slave devices can be set to the LSS Configuration state via the unique LSS number.

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	40h	Vendor ID				00h	00h	00h

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	41h	Product code				00h	00h	00h

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	42h	Revision number				00h	00h	00h

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	43h	Serial number				00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E4h	44h	00h	00h	00h	00h	00h	00h	00h

5.6.2 Configuration

5.6.2.1 Setting the Node ID (Configure Node ID)

The LSS master can set the node ID of individual nodes to configuration mode to configure the LSS slave. If the new node ID is intended to still be available after Power off/on, the "Save configuration" command must be output after the change. For immediate activation of the new node ID, the LSS slave must be set to the LSS Waiting mode, followed by an NMT "Reset Communication" 82h. Another possibility would be to execute power off/on after "Save configuration".

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	11h	NID	00h	00h	00h	00h	00h	00h

NID:

01h ... 7Fh: Node ID

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E4h	11h	Error code	Spec error	00h	00h	00h	00h	00h

Error Code:

00h: Transmission successful

01h: no valid Node ID

FFh: Implementation error see Spec error

Spec error:

This byte is nonzero only in case of an implementation error and Error Code FFh.

5.6.2.2 Configuration of the baud rate (Configure bit timing parameters)

The baud rate of a single or of multiple LSS slaves can be configured via this command. If the new baud rate is intended to still be available after Power off/on, the "Save configuration" command must be output after the change. To activate the new baud rate the Activate baud rate (Activate bit timing parameters) command must be output and the LSS slave set to the LSS Waiting state. Another possibility of activating the new baud rate would be to execute power off/on after "Save configuration".

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	13h	Table selector	Table index	00h	00h	00h	00h	00h

Table selector:

00h: CiA 301 bit timing table

80h ... FEh: Manufacturer-specific bit timing table

Table index:

Table index	Baud rate
0	1000 kbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s
5	reserved
6	50 kbit/s
7	20 kbit/s
8	not supported
9	not supported

The device supports only Table selector 00h and Table index 0 until 7.

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E4h	13h	Error code	Spec error	00h	00h	00h	00h	00h

Error Code:

00h: Transmission successful

01h: no valid baud rate

FFh: Implementation error see Spec error

Spec error:

This byte is nonzero only in case of an implementation error and Error Code FFh.

5.6.2.3 Activate baud rate (Activate bit timing parameters)

This command activates the new baud rate set via Configuration of the baud rate (Configure bit timing parameters) without requiring Power off/on.

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2 MSB	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	15h	Switch delay		00h	00h	00h	00h	00h

Switch Delay:

The Switch delay parameter defines the length of two delay periods (d1, d2) of the same length and must correspond with a multiple of 1 ms. After expiry of the individual processing time and delay time d1, the new baud rate will be adopted internally. After expiry of the delay time d2, the LSS slave will report with the boot up via the newly set baud rate. This procedure prevents the synchronous presence on the bus of devices with different baud rates. The LSS slave cannot send messages during the two delay periods d1 and d2.

5.6.2.4 Store configuration

This command must only be executed if only one LSS slave is in the configuration mode. The current settings will be stored subsequently.

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	17h	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E4h	17h	Error code	Spec error	00h	00h	00h	00h	00h

Error Code:

00h: Transmission successful

01h: Store configuration is not supported

02h: Error occurred during storing

FFh: Implementation error see Spec error

Spec error:

This byte is nonzero only in case of an implementation error and Error Code FFh.

5.6.3 Requesting parameters

The following requests must only be executed if only one LSS slave is in the configuration mode.

5.6.3.1 Request Vendor ID

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	5Ah	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2	Byte 3	Byte 4 MSB	Byte 5	Byte 6	Byte 7
7E4h	5Ah	Vendor ID (see object 1018.1h)				00h	00h	00h

5.6.3.2 Request Product Code

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	5Bh	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2	Byte 3	Byte 4 MSB	Byte 5	Byte 6	Byte 7
7E4h	5Bh	Product code (see object 1018.2h)				00h	00h	00h

5.6.3.3 Request revision number

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	5Ch	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2	Byte 3	Byte 4 MSB	Byte 5	Byte 6	Byte 7
7E4h	5Ch	Revision number (object 1018.3h)				00h	00h	00h

5.6.3.4 Request serial number

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	5Dh	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2	Byte 3	Byte 4 MSB	Byte 5	Byte 6	Byte 7
7E4h	5Dh	Serial number (object 1018.4h)				00h	00h	00h

5.6.3.5 Request Node ID

Master → Slave

COB ID	User data							
	Byte 0 Command	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
7E5h	5Eh	00h	00h	00h	00h	00h	00h	00h

Slave → Master

COB ID	User data							
	Byte 0 Command	Byte 1 LSB	Byte 2	Byte 3	Byte 4 MSB	Byte 5	Byte 6	Byte 7
7E4h	5Eh	Node ID (NID)				00h	00h	00h

5.7 Directory of objects

5.7.1 Overview of objects

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

Name	Description	See page
1000h: Device Type	Device profile and inclinometer type.	28
1001h: Error Register	Current error state of the device.	28
1002h: Manufacturer Status Register	Contains the Transmit Error Counter and the Receive Error Counter.	29
1003h: Pre-defined Error Field	The object stores the 8 error states that have occurred last.	29
1005h: COB ID SYNC message	Setting of the COB ID of the SYNC object.	30
1008h: Manufacturer Device Name	Device name in ASCII notation.	30
1009h: Manufacturer Hardware Version	Indicates the hardware version of the device.	31
100Ah: Manufacturer Software Version	Indicates the software version of the device.	31
100Ch: Guard Time	Parameter for Node Guarding.	31
100Dh: Life Time Factor	Parameter for Node Guarding.	32
1010h: Store Parameter	Object for non-volatile storage of the settings.	32
1011h: Restore Parameter	Object for restoring the factory settings.	34
1014h: COB ID Emergency message	COB ID of the Emergency object.	36
1017h: Producer Heartbeat Time	Setting of the cycle time of the heartbeat timer.	37
1018h: Identity Object	Contains the manufacturer number.	37
1200h: Server SDO Parameter	SDO Parameter.	38
1800h: 1st Transmit PDO Parameter	Transmit PDO for asynchronous transfer (timer controlled).	39
1A00h: 1st Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO1.	40
2000h: Digital filter cut-off frequency	Defines the set filter time.	41
5F0Ah: Node ID and baud rate Bus CAN	Setting of Node ID and baud rate.	41
6000h: Resolution	Resolution of the slope long16 value.	42
6010h: Slope long16	slope long16 value (longitudinal slope).	42
6011h: Slope long16 operating parameter	Operating parameter	43
6012h: Slope long16 Preset value (calibration value)	Calibration value for longitudinal slope (slope long16 preset value).	43

Name	Description	See page
6013h: Slope long16 Offset	Application offset of the slope (slope long16 offset).	44
6014h: Differential Slope long16 Offset	Specifies the offset of the slope long16 value.	44
6511h: Device temperature	Indicates the device temperature.	44

Table 16: Overview of objects

5.7.2 Object Description

5.7.2.1 1000h: Device Type

Object 1000h indicates the device profile number.

Sub-index	00h			
Description	Information about the device profile and encoder type			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	0001019Ah			
EEPROM	no			
Data content	Device profile -number		Additional information	
	Byte 0	Byte 1	Byte 2	Byte 3
	9Ah	01h	01h	00h

019Ah (= 410d): CANopen Device profile for inclinometer

0001h: Class C1, Default PDO mapping

5.7.2.2 1001h: Error Register

Object 1001h indicates the error state of the device.

Sub-index	00h	
Description	pending error status	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	no	
Data content	Bit	Meaning
	0	set bit indicates the occurrence of any error condition
	1 … 6	not used

5.7.2.3 1002h: Manufacturer Status Register

Object 1002h outputs the counter readings of the "Receive Error Counter" and "Transmit Error Counter" registers. The contents of these registers provide information on the transmit faults present at the mounting site of the encoder.

Sub-index	00h			
Description	Transmit Error Counter and Receive Error Counter			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	0h			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	Receive Error Counter	Transmit Error Counter	01h	00h

5.7.2.4 1003h: Pre-defined Error Field

In object 1003h, the 8 latest error states are archived.

- The entry under sub-index 0 indicates the number of errors saved.
- The latest error status is always stored in sub-index 01h. Previous error messages "slip onwards" in their position by one sub-index.
- The whole error list is deleted by writing the value 0 in sub-index 00h.
- The entries in the error list have the format described in chapter 5.5.1.

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

Sub-index	01h ... 08h
Description	error messages that occurred
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

5.7.2.5 1005h: COB ID SYNC message

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

Sub-index	00h	
Description	Defines the COB ID of the synchronization object (SYNC)	
Access	rw (writable in the "Pre-Operational" state only see chapter 5.2.1)	
PDO mapping	no	
Data type	UNSIGNED 32	
Default	80h	
EEPROM	yes	
Data content	Bit 31	not defined
	Bit 30	0: The device generates no SYNC message
	Bit 29	0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B)
	Bit 28 ... 11	0: if bit 29 = 0 X: Bits 28 ... 11 of the SYNC-COB ID, if Bit 29 = 1
	Bit 10 ... 0	X: Bits 10 ... 0 of the SYNC-COB ID

5.7.2.6 1008h: Manufacturer Device Name

Object 1008h indicates the device name. Since the latter comprises 7 data bytes, normal transfer is required for reading the SDO (see chapter 5.4.1.2).

Sub-index	00h							
Description	Device name in ASCII notation							
Access	const							
PDO mapping	no							
Data type	Visible_String							
EEPROM	no							
Data content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
	-	49h ("I")	4Bh ("K")	4Dh ("M")	33h ("3")	36h ("6")	30 ("0")	52h ("R")

5.7.2.7 1009h: Manufacturer Hardware Version

Object 1009h indicates the hardware version.

Sub-index	00h							
Description	Hardware version in ASCII notation							
Access	const							
PDO mapping	no							
Data type	Visible_String							
Default	0h							
EEPROM	no							
Data content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
	30h ("0")	00h -	00h -	00h -	00h -	00h -	00h -	00h -

5.7.2.8 100Ah: Manufacturer Software Version

Object 100Ah indicates the software version of the device. Because this contains 7 data bytes, the SDO Normal Transfer is required for reading (see chapter 5.4.1.2).

Sub-index	00h							
Description	Software version in ASCII notation							
Access	const							
PDO mapping	no							
Data type	Visible_String							
Default	0h							
EEPROM	no							
Data content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
	-	30h ("0")	2Eh (".")	39h ("9")	2Eh (".")	30h ("0")	30h ("0")	39h ("9")

5.7.2.9 100Ch: Guard Time

Object 100Ch indicates the cycle time set in the master for node guarding (see chapter 5.5.2). The cycle time is indicated in milliseconds Value "0h" means that Node Guarding is deactivated.

Sub-index	00h
Description	Guard Time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

5.7.2.10 100Dh: Life Time Factor

Object 100Dh indicates the life time factor set in the master for node guarding (see chapter 5.5.2). Value "0h" means that Node Guarding is deactivated.

Sub-index	00h
Description	Life Time Factor
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

5.7.2.11 1010h: Store Parameter

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

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

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

Sub-index	02h			
Description	save only communication parameters (1000h ... 1FFFh, CiA 301)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	73h ("s")	61h ("a")	76h ("v")	65h ("e")
	Read:			
	Bit 31 ... 2	0: reserved		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

Sub-index	03h			
Description	save only application parameters (6000h ... 9FFFh, CiA 410)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	73h ("s")	61h ("a")	76h ("v")	65h ("e")
	Read:			
	Bit 31 ... 2	0: reserved		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

Sub-index	04h			
Description	save only manufacturer-specific parameters (2000h ... 5FFFh)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	73h ("s")	61h ("a")	76h ("v")	65h ("e")
	Read:			
	Bit 31 ... 2	0: reserved		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

5.7.2.12 1011h: Restore Parameter

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

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

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

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

Sub-index	03h			
Description	set only application parameters to factory settings (6000h ... 9FFFh, CiA 410)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1h			
EEPROM	no			
Data content	Write:			
	Byte 0	Byte 1	Byte 2	Byte 3
	6Ch ("l")	6Fh ("o")	61h ("a")	64h ("d")
	Read:			
	Bit 31 ... 1	0: reserved		
	Bit 0	1: Device permits loading of default parameters.		

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

5.7.2.13 1014h: COB ID Emergency message

The COB ID of the Emergency object is set via object 1014h (see chapter 5.5.1).

Sub-index	00h	
Description	Defines the COB ID of the Emergency object (EMCY)	
Access	rw (writable in the "Pre-Operational" state only see chapter 5.2.1)	
PDO mapping	no	
Data type	UNSIGNED 32	
Default	80h + Node ID	
EEPROM	yes	
Data content	Bit 31	0: EMCY object exists / is valid 1: EMCY object does not exists / is invalid
	Bit 30	always 0b
	Bit 29	0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B)
	Bit 28 … 11	0: if bit 29 = 0b X: Bits 28 … 11 of the EMCY-COB ID, if Bit 29 = 1b
	Bit 10 … 0	X: Bits 10 … 0 of the EMCY-COB ID

5.7.2.14 1017h: Producer Heartbeat Time

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

Sub-index	00h
Description	defines the cycle time of the heartbeat monitoring service
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0d, 10d ... 65535d (0h, Ah ... FFFFh); the numerical value corresponds to a multiple of 1 ms. Value 0h disables the service.

5.7.2.15 1018h: Identity Object

The manufacturer identification number (Vendor ID) is indicated by object 1018h.

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

Sub-index	01h
Description	the manufacturer identification number (vendor ID) for the company SIKO GmbH allocated by the CiA
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	00000195h
EEPROM	no

Sub-index	02h
Description	Product Code
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	02020001h
EEPROM	no

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

Sub-index	04h
Description	Serial number
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	1h
EEPROM	yes

5.7.2.16 1200h: Server SDO Parameter

The COB IDs for the server SDOs are indicated via object 1200h. The COB IDs cannot be changed.

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

Sub-index	01h
Description	COB ID Client -> Server (rx)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	00000600h + Node ID
EEPROM	no

Sub-index	02h
Description	COB ID Server -> Client (tx)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	00000580h + Node ID
EEPROM	no

5.7.2.17 1800h: 1st Transmit PDO Parameter

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

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

Sub-index	01h
Description	COB ID of PDO1
Access	rw (writable in the "Pre-Operational" state only see chapter 5.2.1)
PDO mapping	no
Data type	UNSIGNED 32
Default	180h + Node ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	01h	
EEPROM	yes	
Data content	1h (1d) ... F0h (240d)	PDO is sent after received 1d ... 240d SYNC messages.
	FCh (252d) FDh (253d)	Device responds only to RTR request if RTR Bit 30 is enabled in the COB ID.
	FEh (254d) FFh (255d)	PDO has asynchronous characteristics (PDO is sent depending on the "Event Timer").

Sub-index	03h (is not used, access attempt generates error message)

Sub-index	04h (is not used, access attempt generates error message)

Sub-index	05h
Description	Event timer for TPDO1
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	The service is disabled by writing the value 0h. If the value is changed with the timer running, the change will be applied only with the next timer operation.

5.7.2.18 1A00h: 1st Transmit PDO Mapping Parameter

Object 1A00h determines the objects that are mapped on the first Transmit PDO (TPDO1).

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

Sub-index	01h
Description	1st Object of the PDO1 message (Data byte 0 and 1)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	60100010h (Slope long16 object 6010h, sub-index 00h, 16bit)
EEPROM	yes

5.7.2.19 2000h: Digital filter cut-off frequency

The filter time can be set in object 2000h.

Sub-index	00h
Description	Defines the set filter time.
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	14h (20d)
EEPROM	yes
Data content	1d = 0.1 Hz. Default value: 20 Hz. Possible values: 1d … 20d (1d … 14h) in steps of one (= 0.1 … 1.0 Hz in 0.1 Hz steps); 10d … 200d (14h … C8h) in steps of ten (= 1.0 … 20.0 Hz in 1 Hz steps)

5.7.2.20 5F0Ah: Node ID and baud rate Bus CAN

Node ID and baud rate of the bus can be set via Object 5F0Ah.

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

Sub-index	01h
Description	Node ID
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h (redundant inclinometer 2h)
EEPROM	yes
Data content	01h … 7Fh

Sub-index	02h
Description	Baud rate of the CAN bus
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	5h (500 kbit/s)
EEPROM	yes
Data content	1h: 20 kbit/s 2h: 50 kbit/s 3h: 125 kbit/s 4h: 250 kbit/s 5h: 500 kbit/s (Default) 6h: 800 kbit/s 7h: 1000 kbit/s

5.7.2.21 6000h: Resolution

The resolution of the slope long16 value can be set in object 6000h.

Sub-index	00h	
Description	Resolution	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 16	
Default	64h	
EEPROM	yes	
Data content	1d (1h)	Resolution 0.001°
	10d (Ah)	Resolution 0.01° (Default for measuring range ±180°)
	100d (64h)	Resolution 0.1° (Default for measuring range 360°)
	1000d (3E8h)	Resolution 1.0°

Scaling of dependent objects with the formula Object * [Object 6000h] / 1000.

5.7.2.22 6010h: Slope long16

Object 6010h indicates the current slope long16 value (longitudinal slope).

Sub-index	00h
Description	slope long16 value (longitudinal slope)
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes

5.7.2.23 6011h: Slope long16 operating parameter

Operating parameters can be set via object 6011h. If scaling of object 6010h is active, the following formula applies:

Slope long16 = slope physical measured + differential slope long16 preset + slope long16 offset

If scaling is not active, the slope long16 value corresponds to the physically measured slope.

Sub-index	00h	
Description	Operating parameter	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	yes	
Data content	Bit 6 ... 7	not used
	Bit 5	0 = Measuring range 0 ... 360° (Resolution 0.1°) 1 = Measuring range ±180° (Resolution 0.1°) If the measuring range is changed, the new resolution is set provided that the default value was not changed beforehand.
	Bit 2 ... 4	not used
	Bit 1	0 = Scaling of object 6010h inactive 1 = Scaling of object 6010h active
	Bit 0	0 = Inverting of object 6010h inactive 1 = Inverting of object 6010h active

5.7.2.24 6012h: Slope long16 Preset value (calibration value)

The preset value for the longitudinal slope (slope long16 preset value) can be set by object 6012h. The slope long16 value is immediately set to the transferred value. The slope long16 preset value must be specified in ° with the preset resolution of object 6000h. The calculated application offset of the longitudinal slope value (slope long16 offset) is specified in object 6013h and is dependent on object 6014h.

Sub-index	00h
Description	Calibration value for longitudinal slope
Access	rw
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes
Data content	0h ... FFFFh

5.7.2.25 6013h: Slope long16 Offset

The application offset of the longitudinal axis is specified in object 6013h. The value must be specified in ° with the resolution set for object 6000h.

Slope long16 offset = slope long16 –slope physical measured – differential slope long16 preset

Sub-index	00h
Description	Application offset of the slope (slope long16 offset)
Access	rw
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes
Data content	0h ... FFFFh

5.7.2.26 6014h: Differential Slope long16 Offset

Object 6014h indicates the offset of the slope long16 value (object 6010h) as a function of the slope long16 preset value (object 6012h) and the slope long16 offset (object 6013h). The value must be specified in ° with the resolution set for object 6000h.

Sub-index	00h
Description	Specifies the offset of the slope long16 value.
Access	rw
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	yes
Data content	0h ... FFFFh

5.7.2.27 6511h: Device temperature

The current device temperature can be read in object 6511h.

Sub-index	00h
Description	Device temperature in 1° increments.
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	0h
EEPROM	no

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