IK360

Absolute Inclination sensor

User manual CANopen

184/23

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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 and the associated technical specifications.

The User manual for actuator 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/ik360

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 which case the extension "d" will be 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 IK360 records the absolute position information. The sensor can be parameterized and read out via the CAN interface using the CANopen protocol.

2.1 Switching on the supply voltage

IK360 initializes after being switched on. During initialization, the configuration parameters are loaded from the non-volatile memory to the random memory of the controller.

The 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, the sensor send a specific NMT command, the boot-up message, which informs the system about their availability. The IK360 is now in the pre-operational mode. In this state, the encoder can be parameterized via SDO commands in accordance with the requirements of the application. This applies to configuration parameters of the sensor unit as well as to the way it makes available to the system its position values (asynchronous or synchronous data transmission).

3 Communication via CAN bus (CANopen)

The basis for the inclinometer IK360 is the CANopen communication profile CiA 301, the device profile for inclinometer CiA 410. 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.

3.1 Process data exchange

3.1.1 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. Each of these is dynamically mappable and will be transmitted in three possible operating modes.

The IK360 supports the Transmit PDO services TPDO1, TPDO2, TPDO3 and TPDO4.

3.1.1.1 Transmit-PDO (from the IK360 to the master)

PDO transfer from the IK360 to the bus master can be initiated as a result of various events:

Cyclic transmission with predefined period

Event-controlled transmission on value change

Synchronous transmission after receiving a SYNC message

The operating modes for the PDO transmission will be set with the standardized TPDO communication parameters at 1800h to 1803h. Within these TPDO communication parameters, the transmission type, inhibit time and event time can be adjusted.

The TPDO can be enabled or disabled by setting the valid flag (bit 31) in the PDOs COB-ID. Only if the TPDO is disabled, the mapping of the PDOs data can be configured. The TPDO communication parameters of all 4 TPDOs can be stored to the persistent memory.

3.1.1.2 TPDO mapping

The data for the PDO transmission will be set with the standardized TPDO mapping parameters at 1A00h to 1A03h. Within these TPDO mapping parameters, the mapped object and the size in number of bits of the object's data can be defined.

Only the following mappable objects can be set in the parameters:

Index	Sub Index	Parameter	Max. number of bits	Entry Value
3000h	01h	Status Byte ST0	8	0x30000108
3010h	01h	Acceleration Value X Axis	16	0x30100110
	02h	Acceleration Value Y Axis	16	0x30100210
	03h	Acceleration Value Z Axis	16	0x30100310
3011h	00h	Acceleration HiRes X Axis	32	0x30110020
3012h	00h	Acceleration HiRes Y Axis	32	0x30120020
3013h	00h	Acceleration HiRes Z Axis	32	0x30130020
3020h	01h	Gyroscope Value X Axis	16	0x30200110
	02h	Gyroscope Value Y Axis	16	0x30200210
	03h	Gyroscope Value Z Axis	16	0x30200310
3021h	00h	Gyroscope HiRes X Axis	32	0x30210020
3022h	00h	Gyroscope HiRes Y Axis	32	0x30220020
3023h	00h	Gyroscope HiRes Z Axis	32	0x30230020
6110h	00h	Slope long32	32	0x61100020
6120h	00h	Slope lateral32	32	0x61200020
6511h	00h	Device temperature	8	0x65110008

Table 1: TPDO mapping

Before the mapping parameters can be set, the TPDO has to be disabled and the first entry of the object has to be set to 0. After the mapping parameters were changed, the first entry of the object has to be set to the number of mapped objects (maximal 8) and the TPDO has to be enabled.

The TPDO mapping parameters of all 4 TPDOs can be stored to the persistent memory.

3.2 Node monitoring

3.2.1 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 (not used)				

Emergency Error Code:

Error description	Error Code
Cause of the error removed	0000h
Supply voltage	3100h
Longitudinal value out of range	5010h
Lateral value out of range	5020h
CAN overrun (objects lost)	8110h
CAN in error passive mode	8120h
Recovered from bus off	8140h
CANopen device specific	FF00h
Longitudinal sensor is defect	FF01h
Lateral sensor is defect	FF02h

Table 2: Emergency Error Code

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.

3.2.2 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 IK360 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".

3.3 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: 0001 869Fh

Revision number: 0000 0000h

Serial number: xxxx xxxxh (Serial number of the sensor)

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 → IK360): 7E5h

LSS (tx) (IK360 → 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.

Services	LSS waiting	LSS configuration
Switch state global	yes	yes

Services	LSS waiting	LSS configuration
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
Store configuration	no	yes
Request LSS address	no	yes
Request Node-ID	no	yes

Table 3: State behavior of the supported LSS Services

3.4 Directory of objects

The object dictionary is a list of accessible functions and parameters of a device. It is the interface between application program and device. Each line in the list of the dictionary represents a communication object, which is accessible by a specific 16-bit index and an 8-bit sub-index.

3.4.1 Overview of objects

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

Name	Description	Page
1000h: Device Type	Device profile and inclinometer type.	11
1001h: Error Register	Current error state of the device.	12
1003h: Pre-defined Error Field	The object stores the 8 error states that have occurred last.	12
1005h: COB-ID SYNC	Setting of the COB ID of the SYNC object.	12
1008h: Manufacturer Device Name	Device name in ASCII notation.	13
1009h: Manufacturer Hardware Version	Indicates the hardware version of the device.	13
100Ah: Manufacturer Software Version	Indicates the software version of the device.	13
1010h: Store Parameter	Object for non-volatile storage of the settings.	14
1011h: Restore Parameter	Object for restoring the factory settings.	15
1014h: COB-ID Emergency-Message	COB ID of the Emergency object.	17
1017h: Producer Heartbeat Time	Setting of the cycle time of the heartbeat timer.	17
1018h: Identity object	Contains the manufacturer number.	17
1800h: 1. Transmit PDO Parameter	Transmit PDO for asynchronous transfer (timer controlled).	18

Name	Description	Page
3200h: Auto Zero	Set zero point of the given axis/axes to current position	44
3210h: Slope Long Zero Offset (Inclination X Axis)	Indicates the slope value for the longitudinal slope	44
3220h: Slope Lateral Zero Offset (Inclination Y Axis)	Indicates the slope value for the lateral slope	45
6000h: Resolution	Indicates the resolution of the longitudinal and lateral slope	45
6110h: Slope Longitudinal (Inclination X Axis)	32-bit slope value of the longitudinal axis	45
6111h: Slope Long Operating Parameter (Inclination X Axis)	Indicates the interpretation of the 32-bit longitudinal slope	46
6120h: Slope Lateral (Inclination Y Axis)	32-bit slope value of the lateral axis	46
6121h: Slope Lateral Operating Parameter (Inclination Y Axis)	Indicates the interpretation of the 32-bit lateral slope	46
6511h: Device Temperature	Provides the temperature of the inclinometer	46

Table 4: Overview of objects

3.4.2 Object Description

3.4.2.1 1000h: Device Type

Object 1000h indicates the device profile number.

Subindex	00h			
Description	Information about the device profile and sensor type			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	1 axis: 0703019Ah 2 axes: 0704019Ah			
EEPROM	no			
Data content	Device profile number		Additional information	
	Byte 0	Byte 1	Byte 2	Byte 3
	9Ah	01h	03h / 04h	07h

019Ah (= 410d): CANopen Device Profile for inclinometers

Type:

0703h: 1 axis

0704h: 2 axes

3.4.2.2 1001h: Error Register

Object 1001h indicates the error state of the device.

Subindex	00h
Description	pending error status
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

3.4.2.3 1003h: Pre-defined Error Field

In object 1003h, the 16 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 6.2.1.

Subindex	00h
Description	number of the error messages stored
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	ja

Subindex	01h ... 10h
Description	error messages that occurred
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

3.4.2.4 1005h: COB-ID SYNC message

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

Subindex	00h

Description	Defines the COB ID of the synchronization object (SYNC)
Access	rw (writable in the "Pre-Operational" state only)
PDO mapping	no
Data type	UNSIGNED 32
Default	80h
EEPROM	yes

3.4.2.5 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.

Subindex	00h						
Description	Device name in ASCII notation						
Access	const						
PDO mapping	no						
Data type	Visible_String						
Default	IK360						
EEPROM	no						
Data content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
	49h ("I")	4Dh ("M")	53h ("S")	33h ("3")	36h ("6")	30h ("0")	

3.4.2.6 1009h: Manufacturer Hardware Version

Object 1009h indicates the hardware version.

Subindex	00h
Description	Hardware version in ASCII notation
Access	const
PDO mapping	no
Data type	Visible_String
Default	-
EEPROM	no
Data content	The hardware version is coded in one byte and is the revision number. (Example: 2)

3.4.2.7 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.

Subindex	00h

Description	Software version in ASCII notation
Access	const
PDO mapping	no
Data type	Visible_String
Default	-
EEPROM	no
Data content	The software version is coded in 3 bytes and is separated in major version (MA), minor version (MI) and release number (REL) of the software. (Example: 1.2r7)

3.4.2.8 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.

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

Subindex	01h			
Description	save user 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
	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		

3.4.2.9 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.

Subindex	00h
Description	indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Subindex	01h			
Description	Load all user parameters			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	-			
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.		

Subindex	02h			
Description	Restore only communication parameters to factory settings (1000h ... 1FFFh, CiA 301)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	-			
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.		

Subindex	03h			
Description	Restore only application parameters to factory settings (6000h ... 9FFFh, CiA 410			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	-			
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.		

Subindex	04h			
Description	set only manufacturer-specific parameters to factory settings (2000h ... 5FFFh)			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	-			
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.		

Subindex	05h			
Description	Restore all parameters to factory settings			
Access	rw			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	-			
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.

3.4.2.10 1014h: COB-ID Emergency message

The COB ID of the Emergency object is set via object 1014h.

Subindex	00h
Description	Defines the COB ID of the Emergency object (EMCY)
Access	rw (writable in the "Pre-Operational" state only)
PDO mapping	no
Data type	UNSIGNED 32
Default	80h + Node-ID
EEPROM	yes

3.4.2.11 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.

Subindex	00h
Description	defines the cycle time of the heartbeat monitoring service
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0
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.

3.4.2.12 1018h: Identity object

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

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

Subindex	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	195h
EEPROM	no

Subindex	02h
Description	Product Code (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	1869Fh
EEPROM	no

Subindex	03h
Description	Revision number (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Subindex	04h
Description	Serial Number
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	1h
EEPROM	yes

3.4.2.13 1800h: 1. Transmit PDO Parameter

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

Subindex	00h
Description	indicates the largest supported sub-index
Access	const

PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

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

Subindex	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
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").

Subindex	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

Subindex	04h (is not used, access attempt generates error message)
Description	reserved
Access	Const.
PDO mapping	no
Data type	UNSIGNED 8
Default	0h

EEPROM	no

Subindex	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.

3.4.2.14 1801h: 2. Transmit PDO Parameter

The communication parameters for TPDO2 are set via object 1801h.

Subindex	00h
Description	indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Subindex	01h
Description	COB ID of PDO2
Access	rw (writable in the "Pre-Operational" state only)
PDO mapping	no
Data type	UNSIGNED 32
Default	80000280h + Node-ID
EEPROM	yes

Subindex	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	1h (1d) … FOh (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").

Subindex	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

Subindex	04h (is not used, access attempt generates error message)
Description	reserved
Access	Const.
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	05h
Description	Event timer for TPDO2
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.

3.4.2.15 1802h: 3. Transmit PDO Parameter

The communication parameters for TPDO1 are set via object 1802h.

Subindex	00h
Description	indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h

EEPROM	no

Subindex	01h
Description	COB ID of PDO3
Access	rw (writable in the "Pre-Operational" state only)
PDO mapping	no
Data type	UNSIGNED 32
Default	80000380h + Node-ID
EEPROM	yes

Subindex	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
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").

Subindex	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

Subindex	04h (is not used, access attempt generates error message)
Description	reserved
Access	Const.
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	05h
Description	Event timer for TPDO3
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.

3.4.2.16 1803h: 4. Transmit PDO Parameter

The communication parameters for TPDO4 are set via object 1803h.

Subindex	00h
Description	indicates the largest supported sub-index
Access	const
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Subindex	01h
Description	COB ID of PDO4
Access	rw (writable in the "Pre-Operational" state only)
PDO mapping	no
Data type	UNSIGNED 32
Default	80000480h + Node-ID
EEPROM	yes

Subindex	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
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").

Subindex	03h
Description	Inhibit time
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

Subindex	04h (is not used, access attempt generates error message)
Description	reserved
Access	Const.
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	05h
Description	Event timer for TPDO4
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.

3.4.2.17 1A00h: 1. Transmit PDO Mapping Parameter

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

Subindex	00h
Description	Number of mapped objects
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes

Subindex	01h
Description	1st Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	61100020h (Slope long32 object 6010h, sub-index 00h, 32bit)
EEPROM	yes

Subindex	02h
Description	2nd Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	61200020h (Slope lateral32 object 6020h, sub-index 00h, 32bit) – Only for 2 axes sensor
EEPROM	yes

Subindex	03h
Description	3rd Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	04h
Description	4th Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	05h
Description	5th Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	06h
Description	6th Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	07h
Description	7th Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	08h
Description	8th Object of the PDO1 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

3.4.2.18 1A01h: 2. Transmit PDO Mapping Parameter

Object 1A01h determines the objects that are mapped on the first Transmit PDO (TPDO2).

Subindex	00h
Description	Number of mapped objects
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes

Subindex	01h
Description	1st Object of the PDO2 message
Access	rw

PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	02h
Description	2nd Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	03h
Description	3rd Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	04h
Description	4th Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	05h
Description	5th Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	06h
Description	6th Object of the PDO2 message
Access	rw

PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	07h
Description	7th Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	08h
Description	8th Object of the PDO2 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

3.4.2.19 1A02h: 3. Transmit PDO Mapping Parameter

Object 1A02h determines the objects that are mapped on the first Transmit PDO (TPDO3).

Subindex	00h
Description	Number of mapped objects
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

Subindex	01h
Description	1st Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	02h
Description	2nd Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	03h
Description	3rd Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	04h
Description	4th Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	05h
Description	5th Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	06h
Description	6th Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	07h
Description	7th Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	08h
Description	8th Object of the PDO3 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

3.4.2.20 1A03h: 4. Transmit PDO Mapping Parameter

Object 1A03h determines the objects that are mapped on the first Transmit PDO (TPDO4).

Subindex	00h
Description	Number of mapped objects
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

Subindex	01h
Description	1st Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	02h
Description	2nd Object of the PDO4 message
Access	ro
PDO mapping	no
Data type	UNSIGNED 32

Default	0h
EEPROM	yes

Subindex	03h
Description	3rd Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	04h
Description	4th Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	05h
Description	5th Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	06h
Description	6th Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

Subindex	07h
Description	7th Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32

Default	0h
EEPROM	yes

Subindex	08h
Description	8th Object of the PDO4 message
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes

3.4.2.21 2000h: Logistic Data

Object 2000h contains information about the sensor and its production

Subindex	00h
Description	indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	no

Subindex	01h
Description	Contains the serial number of the sensor
Access	ro
PDO mapping	no
Data type	Visible_String
Default	-
EEPROM	no

Subindex	02h
Description	Contains the version number of the sensor (Version number is shown on the type label after the product name “IK360- _ _ _ _”)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Subindex	03h

Description	Contains the device ID of the sensor						
Access	ro						
PDO mapping	no						
Data type	Visible_String						
Default	IK360						
EEPROM	no						
Data content	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
	49h ("I")	4Dh ("M")	53h ("S")	33h ("3")	36h ("6")	30h ("0")	

3.4.2.22 2001h: Baud rate

Object 2001h sets the baud rate of the communication

Subindex	00h
Description	Baud rate of the CAN bus
Access	rw
PDO mapping	no
Data type	UNSIGNED 32
Default	1E848h (125 kbit/s)
EEPROM	yes
Data content	1E848h: 125 kbit/s (Default) 3D090h: 250 kbit/s 7A120h: 500 kbit/s C3500h: 800 kbit/s F4240h: 1000 kbit/s

3.4.2.23 2002h: Node ID

Object 2002h sets the Node ID of the communication

Subindex	00h
Description	Node ID
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	32h
EEPROM	yes
Data content	01h ... 7Eh

3.4.2.24 2010h: Controller Settings

Object 2010h requests controller specific commands.

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

Subindex	01h
Description	Set Controller
Access	wo
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no
Data content	01h: Reset of the controller

3.4.2.25 2020h: Internal values

Object 2020h provides internal analogue diagnosis values.

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

Subindex	01h
Description	Contains the currently measured supply voltage with a resolution of 1 mV
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	-
EEPROM	no

3.4.2.26 20FFh: Version of Layout

Object 20FFh contains the layout version of the current used standard SDOs.

Subindex	00h
Description	Version of layout
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	1h
EEPROM	no

3.4.2.27 3000h: Status

Object 3000h contains status information of the sensor

Subindex	00h
Description	indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	no

Subindex	01h	
Description	Status Byte ST0	
Access	ro	
PDO mapping	yes	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	no	
Data content	**Bit**	**Description**
	3 … 7	Reserved
	2	0: At least one setting is deviant from the factory setting. 1: The factory settings are active.
	1	0: No error 1: Error in the sensor that prevents reliable calculation of the angle values and the compliance with the specification is no longer guaranteed. A set bit is an indication of a hardware problem.
	0	0: 1-axis sensor (360°) 1: 2-axes sensor (±90°)

Subindex	02h
Description	Status Byte ST1
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	03h
Description	Status Byte ST2
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	04h
Description	Status Byte ST3
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

Subindex	05h
Description	Status Byte ST4
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

3.4.2.28 3010h: Acceleration values

Object 3010h contains raw values of the acceleration of all three axes.

Subindex	00h
Description	indicates the largest supported sub-index
Access	ro
PDO mapping	no

Data type	INTEGER 16
Default	3h
EEPROM	no

Subindex	01h
Description	Raw value X axis (resolution is 0.001 g; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

Subindex	02h
Description	Raw value Y axis (resolution is 0.001 g; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

Subindex	03h
Description	Raw value Z axis (resolution is 0.001 g; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

3.4.2.29 3011h: Acceleration HiRes X axis

Object 3011h contains acceleration value of X axis

Subindex	00h
Description	Acceleration HiRes X Axis (resolution is 0.001 mg; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h

EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.30 3012h: Acceleration HiRes Y axis

Object 3012h contains acceleration value of Y axis

Subindex	00h
Description	Acceleration HiRes Y Axis (resolution is 0.001 mg; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.31 3013h: Acceleration HiRes Z axis

Object 3013h contains acceleration value of Z axis

Subindex	00h
Description	Acceleration HiRes Z Axis (resolution is 0.001 mg; 1 g = 9,81 m/s²)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.32 3020h: Gyro values

Object 3020h contains raw values of the gyroscope of all three axes.

Subindex	00h
Description	indicates the largest supported sub-index
Access	ro
PDO mapping	no
Data type	INTEGER 16
Default	3h
EEPROM	no

Subindex	01h

Description	Raw value X axis (resolution is 0.1 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

Subindex	02h
Description	Raw value Y axis (resolution is 0.1 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

Subindex	03h
Description	Raw value Z axis (resolution is 0.1 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 16
Default	0h
EEPROM	no
Data content	-32768 ... +32767

3.4.2.33 3021h: Gyro HiRes X axis

Object 3021h contains gyroscope value of X axis

Subindex	00h
Description	Gyroscope HiRes X Axis (resolution is 0.001 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.34 3022h: Gyro HiRes Y axis

Object 3022h contains gyroscope value of Y axis

Subindex	00h
Description	Gyroscope HiRes Y Axis (resolution is 0.001 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.35 3023h: Gyro HiRes Z axis

Object 3023h contains gyroscope value of Z axis.

Subindex	00h
Description	Gyroscope HiRes Z Axis (resolution is 0.001 degree per second)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	0h
EEPROM	no
Data content	-2,147,483,648 ... +2,147,483,647

3.4.2.36 3100h: CAN settings

Object 3100h stores the setup of the CAN configuration.

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

Subindex	01h
Description	CAN Protocol (Parameter changes will be effective after configuration storage and sensor restart only)
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes

Data content	1h: SAE J1939 protocol (refer to user manuel SAE J1939 for detailed information) 2h: CANopen protocol

Subindex	02h
Description	Automatic Bus Off recovery
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0h: Disabled (Automatic bus-off recovery is disabled – sensor stays in bus-off; Power-Off-On-Cycle or Reset necessary) 1h: Enabled (Automatic bus-off recovery is enabled – sensor automatically leaves bus-off status)

3.4.2.37 3110h: Filter configuration

Within the object 3110h a type for the low pass filter can be set or the sensor fusion with Kalman filter can be enabled.

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

Subindex	01h
Description	Low pass filter type
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes
Data content	00h: Filter disabled 01h: Butterworth filter 8th order 02h: Critical damped filter 8th order

Subindex	02h
Description	Sensor fusion filter (The parameter is setable only if sensor fusion is supported by the sensor)

Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	00h: Low-pass filter; Angle calculation based on the low-pass filtered acceleration values 01h: Sensor fusion filter (Kalman filter); Angle calculation based on acceleration values and gyroscope values

3.4.2.38 3111h: Low pass filter frequency

Object 3111h contains the cut off frequency of the digital low pass filter.

Subindex	00h
Description	Low pass filter frequency in mHz
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	7D0h (2000d)
EEPROM	yes
Data content	Butterworth filter enabled: 100 mHz ... 25000 mHz Critical damped filter: 100 mHz ... 8000 mHz

3.4.2.39 3112h: Kalman filter parameters

Object 3112h contains the parameter Q and R of the Kalman filter (sensor fusion).

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

Subindex	01h
Description	Parameter Q Mantissa
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	1 ... +127

Subindex	02h
Description	Parameter Q Exponent
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	-3h
EEPROM	yes
Data content	-10 ... +10

Subindex	03h
Description	Parameter R Mantissa
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	1 ... +127

Subindex	04h
Description	Parameter R Exponent
Access	rw
PDO mapping	no
Data type	INTEGER 8
Default	1h
EEPROM	yes
Data content	-10 ... +127

3.4.2.40 3120h: Sensor configuration

Object 3120h contains the configuration of the sensor.

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

Subindex	01h

Description	Defines the value range of the sensor
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	Depends on the pre-selected feature
EEPROM	yes
Data content	00h: 1-axis sensor (0...360°) 01h: 2-axes sensor (±90°)

3.4.2.41 3200h: Auto zero

Object 3200h sets the zero point of the given axis/axes to the current position by writing a valid value to this object.

Subindex	00h
Description	Set zero point to the current position
Access	wo
PDO mapping	no
Data type	UNSIGNED 8
Default	-
EEPROM	no
Data content	01h: Sets the first axis (X-axis) at the current position to 0 02h: Sets the second axis (Y-Axis) at the current position to 0. (Applicable in case of 2-axes sensor only) 03h: Sets the first and second axis at the current position to 0. (Applicable in case of 2-axes sensor only)

3.4.2.42 3210h: Slope long zero offset (Inclination X axis)

Object 3210h indicates the slope value for zero point adjustment for the longitudinal slope.

Accessing this object by means of SDO shall set directly the zero point value of the longitudinal slope. The calculated application offset triggered by auto zero of the longitudinal slope value is given in this object.

If the zero point value is not 0, then the slope long32 value (6110h) will be shifted by this zero point value.

Subindex	00h
Description	Slope long zero Offset (The value shall be given in angular degree with the resolution given in the data object 6000h.)
Access	rw
PDO mapping	no
Data type	INTEGER 32
Default	-
EEPROM	yes
Data content	-2,147,483,648 ... -2,147,483,647

3.4.2.43 3220h: Slope lateral zero offset (Inclination Y axis)

Object 3220h indicates the slope value for zero point adjustment for the lateral slope.

Accessing this object by means of SDO shall set directly the zero point value of the lateral slope. The calculated application offset triggered by auto zero of the lateral slope value is given in this object.

If the zero point value is not 0, then the slope lateral32 value (6110h) will be shifted by this zero point value.

Subindex	00h
Description	Slope lateral zero Offset (The value shall be given in angular degree with the resolution given in the data object 6000h.)
Access	rw
PDO mapping	no
Data type	INTEGER 32
Default	-
EEPROM	yes
Data content	-2,147,483,648 ... -2,147,483,647

3.4.2.44 6000h: Resolution

Object 6000h indicates the resolution of the objects such as slope long32 (6110h) and the slope lateral32 (6120h).

Subindex	00h
Description	The resolution is fixed at 0.01°.
Access	const
PDO mapping	no
Data type	UNSIGNED 16
Default	10
EEPROM	no

3.4.2.45 6110h: Slope longitudinal (Inclination X axis)

Object 6110h provides the 32-bit slope value of the longitudinal axis.

Subindex	00h
Description	Slope long32 (The value is given in angular degree with the resolution given in object 6000h.)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	-
EEPROM	no

3.4.2.46 6111h: Slope long operating parameter (Inclination X axis)

Object 6111h indicates the interpretation of the slope long32 value.

If scaling is disabled, the slope long32 value shall be equal to the physical measured angle.

Subindex	00h
Description	Slope long32 Operating Parameter
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

3.4.2.47 6120h: Slope lateral (Inclination Y axis)

Object 6120h provides the 32-bit slope value of the lateral axis.

Subindex	00h
Description	Slope lateral32 (The value is given in angular degree with the resolution given in object 6000h.)
Access	ro
PDO mapping	yes
Data type	INTEGER 32
Default	-
EEPROM	no

3.4.2.48 6121h: Slope long operating parameter (Inclination X axis)

Object 6121h indicates the interpretation of the slope lateral32 value.

If scaling is disabled, the slope lateral32 value shall be equal to the physical measured angle.

Subindex	00h
Description	Slope lateral32 Operating Parameter
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no

3.4.2.49 6511h: Device temperature

Object 6511h provides the temperature of the inclinometer.

The temperature value is not calibrated. An absolute temperature measurement or the use of the value for further control is not recommended.

Subindex	00h
Description	Device temperature with a resolution of 0.1°C
Access	ro
PDO mapping	yes
Data type	INTEGER 8
Default	-
EEPROM	no

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