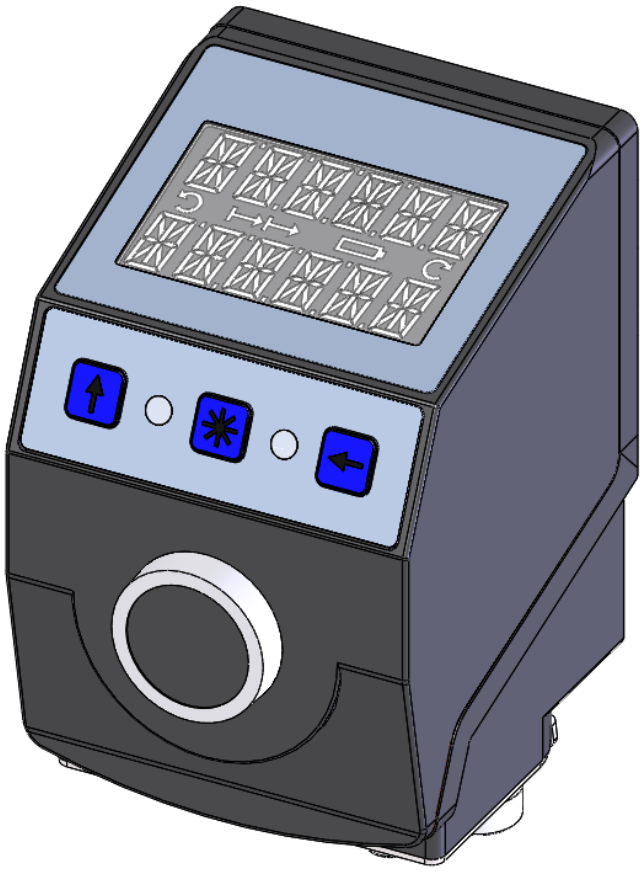
AP10T

Set point display with CANopen interface

User manual



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1 General Informaton

1.1 Documentation

The following documents describe this product:

- The data sheet describes the technical data, the dimensions, the pin assignments, the accessories and the order key.
- The installation instructions describe the mechanical and electrical installation including all safety-relevant requirements and the associated technical specification.
- The user manual for commissioning and integrating the set point display 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.

These documents can also be downloaded at **http://www.siko-global.com/p/ap10t**.

2 Intended use

The instrument is a set point display. Alpha-numeric set points can be transferred to the instrument via the CANopen interface and indicated via the backlit two-row LC display. Receipt of the set points can be acknowledged via the front button. The state of acknowledgment of the set points is signified by means of the two bi-color LEDs.

Acknowledgment can also be performed via the interface by means of a control word. Additionally, it can activate the LEDs in order to realize various visualization tasks. Acknowledgment and button states are output in the status word.

Some device parameters can be adjusted by means of the 3 buttons. You can change the set point, output the position value and adjust all device parameters via the integrated bus interface.

2.1 Switching on the supply voltage

The AP10T will be initialized after switching on the supply voltage. A display test is executed during initialization, the LEDs are lighted consecutively and the configuration parameters are loaded from the non-volatile memory into the RAM of the controller.
With the display still unconfigured all parameters are set to their default values. See to it that the bus will be connected only after correct adjustment of baud rate and ID (see chapter 3.6: Parameterization of the set point display and chapter 4.6: Auto-Functions). The AP10T functions with the data last parameterized.
After completing the initialization procedure, the AP10T with CAN interface sends a specific NMT command, the Boot-Up Message, which informs the system about the availability of the display. The AP10T is now in the Pre-Operational Mode. In this state, the display can be parameterized via SDO commands in accordance with the requirements of the application. This applies to configuration parameters as well as to the way it makes available to the system its position values (asynchronous or synchronous data transmission).

3 Brief description

3.1 General

The set point display has a two-line display with special characters and four control keys. The device is configured and activated via three symbol keys whereas received data is acknowledged via the fourth key. Two LEDs serve for signifying acknowledgement.

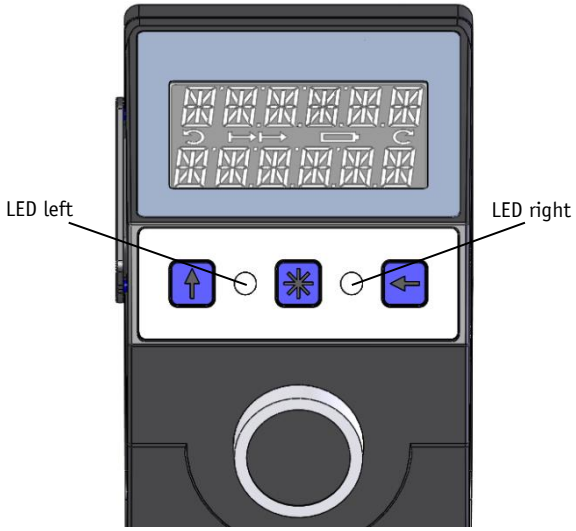

Fig. 1: Control elements

3.2 LCD display

NOTICE	The The display range is limited to -19999 ... 99999. Values outside this range are displayed with "FULL".

With supply voltage applied to the set point display with factory settings, set points are displayed in both rows depending on validity and acknowledgment status. If there is no valid set point, "---" will be displayed in the 2nd row. A valid set point flashes until after acknowledgement.

Two 6-digit set points can be displayed. Both rows are freely writeable.

3.2.1 Extended display range

Values up to -999999 can be displayed by means of the control word. If the relevant bit has been set and the value to be displayed is between -199999 and -999999, then the negative sign and the digit of the highest order will flash alternately. If the value range drops below -99999, "FULL" will be displayed.

3.3 LED display

With factory settings, the LED display works according to the following table.

Operating mode	LED	Status	Meaning
There is no valid set point.	both	off	
There is a valid set point.	LED left	red	Set point1 not acknowledged
		green	Set point1 acknowledged
	LED right	red	Set point2 not acknowledged
		green	Set point2 acknowledged

Table 1: LED display in the Alpha-numeric display operating mode

With the basic function of the LEDs inactivated, every LED can be controlled independently via the control word (see object 5F12h: Display orientation and LEDs and chapter 4.3.2: Control word).

3.4 Keys

With the Auto-ID function, the new ID is adopted by actuating the key (see chapter 4.6.2: Auto-ID).

Pressing the key acknowledges a pending error (see chapter 3.7.2: Errors).

Pressing the key starts the parameterization mode (see chapter 3.6: Parameterization of the set point display).

When pressing the front button with factory settings active, the previously received set points (set point1 and set point2) will be acknowledged.

3.5 Communication

Set point1 (in row 1) is received via the receive data object 1 (RPDO1). Likewise, set point2 (in row 2) is received via RPDO2. The data identifier must be correctly set in the respective control word. The data identifier serves for determining whether the data is interpreted and displayed as number or as alpha-numeric characters (ASCII) (see chapter 4.3.2: Control word).

Control word: (see chapter 4.3.2)

In the control word, the respective type (number or character string) and the validity of the set point are transferred to the display. Additionally, the set point can be acknowledged via the control word.

Status word: (see chapter 4.3.3)

Type, validity and acknowledgement status of the set points are recorded in the status word.

3.6 Parameterization of the set point display

The set point display can be completely parameterized via the bus interface. The most significant bus parameters (node address and baud rate) can be parameterized manually by means of the keyboard.

3.6.1 Manual parameterization

3.6.1.1 Starting parameterization

After applying supply voltage and passing initialization, the set point display will be on the uppermost level of the menu structure (default/factory settings).

By actuating the ← key, the set node address and baud rate is displayed. Parameterization starts if this key is actuated during the enable period (see object 2005h: Configuration enable via keyboard and delay of start of configuration).

3.6.1.2 Value input

Enter values via the ↑ key and the ← key. Confirm values entered by pressing the ✳ key.

← - decimal place selection key

↑ - value input key

3.6.1.3 Value selection

For some parameters you can select values from a list.

Direct value input is not possible there.

Pressing the ↑ key, the value can be selected from the list. By pressing the ✳ key, the selection is confirmed.

3.6.1.4 Adjustable parameters

The following parameters can be adjusted.

Display	Parameter	Options
ID	Node-ID	1 … 127 (see chapter 4.6.2)
KBAUD	Baud rate	Auto baud (see chapter 4.6.1)
		125 kbaud
		250 kbaud
		500 kbaud
		800 kbaud
		1000 kbaud
CODE	System commands	Load factory settings (see chapter 3.8.1)
		Start diagnosis (see chapter 3.8.2)

Table 2: Manually adjustable parameters

3.6.2 Parameterization via interface

The set point display can be completely parameterized in the CANopen interface (see chapter 4: Communication via CAN bus (CANopen)).

3.7 Warnings / Errors

No warnings or errors occur as there is no sensor unit. Communication errors are not displayed but partly recorded in the error memory (see chapter 3.8.2: Diagnosis).

3.7.1 Warnings

No warnings are output.

3.7.2 Errors

No errors are displayed.

3.8 System commands

3.8.1 Restore factory settings

For restoring the factory settings of the device, the following options are available:

Access	Coding		Factory settings are restored
Manuell	CODE	011100	all parameters
		011102	all, except bus parameters
		011105	only bus parameters
CANopen (see object 1011h: Restore Parameter)	1011h "load"	Subindex 1	all parameters
		Subindex 2	only bus parameters
		Subindex 3	only Draft Standard-406 parameters
		Subindex 4	only manufacturer-specific parameters

Table 3: Access to factory settings

The bus parameters are:

Display	Parameter address	Parameter
ID	5F0Ah	Node-ID
KBAUD	5F0Ah	Baud rate
-	1005h	COB-ID SYNC
-	100Ch	Guard Time
-	100Dh	Life Time Factor
-	1014h	COB-ID Emergency
-	1017h	Heartbeat timer value

Display	Parameter address	Parameter
-	1400h Subindex1	COB-ID RPDO1
-	1400h Subindex2	Transmission Type RPDO1
-	1401h Subindex1	COB-ID RPDO2
-	1401h Subindex2	Transmission Type RPDO2
-	1800h Subindex1	COB-ID TPDO1
-	1800h Subindex2	Transmission Type TPDO1
-	1800h Subindex5	Event Timer TPDO1
-	1801h Subindex1	COB-ID TPDO2
-	1801h Subindex2	Transmission Type TPDO2
-	5F09h Subindex1	Ext. Heartbeat value
-	5F09h Subindex2	Ext. Heartbeat source
-	1001h	Error Register

Table 4: Bus parameters

3.8.2 Diagnosis

In order to receive a list of all device errors occurring in connection with chapter 3.7 it is necessary to switch the device to the diagnosis mode. For this purpose, enter CODE "200000"in parameterization (see chapter 3.6.1: Manual parameterization) and confirm by pressing the ✳ key. Any errors occurring are output indicating the error number and total of occurrences in the upper row. The type of error is shown in the lower row. Error number 1 contains the latest error. The oldest error is output with the highest error number.

4 Communication via CAN bus (CANopen)

The CiA DS-301 V4.2 CANopen communication profile as well as the Device profile for Encoders CiA DS-406 V3.2 form the basis for AP10T, which supports device class C2. As this device is beyond the scope of an encoder's functionality, communication partly differs from the above-mentioned device profile. This document contains the details necessary for understanding the operation of the device. If more-in-depth information is required we recommend to consult the pertinent specialized literature on CAN or CANopen.

4.1 Telegram setup

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):

- All bus sharing units check via identifier whether the message is relevant for them.
- The identifier sets the priority of the message. The lower the value of the identifier, the higher the priority of the message. This results in preferential transfer of messages via the bus.

The Identifier field contains the identifier as well as bits for the recognition of the length of the identifierss (11 or 29 bit). Furthermore, the identifier serves for determining the device address, the channel selection as well as the direction of data transfer.

The 11bit 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	Function code				Node number (node ID)						
Assignment	x	x	x	x	0	0	x	x	x	x	x

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

Object	Function code	Resulting COB-ID	Object	Page
Network management (NMT)	0000b	0	-	-
SYNC message	0001b	128 (80h)	1005h	29
Emergency message	0001b	128 (80h) + Node-ID	1014h	35
TPD01	0011b	384 (180h) + Node-ID	1800h	42
RPD01	0100b	512 (200h) + Node-ID	1400h	38
TPD02	0101b	640 (280h) + Node-ID	1801h	44
RPD02	0110b	768 (300h) + Node-ID	1401h	39
SDO (tx)	1011b	1408 (580h) + Node-ID	1200h	37
SDO (rx)	1100b	1536 (600h) + Node-ID	1200h	37
Heartbeat message	1110b	1792 (700h) + Node-ID	-	-
Node Guard message	1110b	1792 (700h) + Node-ID	-	-

Table 5: Overview of COB identifiers

Changes to COB-IDs are only possible in the PRE-OPERATIONAL NMT status. First, the COB-ID must be deactivated via Bit 31 = 1b before it can be changed and reactivated.
The COB-ID of the SYNC object is an exception. There, Bit 30 must be = 0 to enable the change of the COB-ID. The COB-ID could be changed any time because Bit 30 cannot be set to 1 in the AP10T device.
The identifier determines the priority of the message. The lower the value of the identifier, the higher the priority of the message.

The node number (Node-ID) (see object 5F0Ah: Node-ID, Auto-ID and Baud rate Bus CAN) is assigned in every bus system once while AP10T is being configured. Node-ID = 0 is reserved and must not be used; thus the node numbers are in the range of 1 to 127.

A newly set node number will only be adopted with reinitialization (see chapter 4.2: Node control).

The set point display is delivered with the factory-set Node-ID 125 (7Dh).

Control field:

Contains bit-by-bit information on the number of user data and decides whether a data frame or a Remote Transmission Request (RTR) 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 acknowledgement bits as well as bits for determining the end of telegram.

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

4.2 Node control

4.2.1 Network management services (NMT)

The master configures, manages and monitors network nodes via the NMT service. The device is always in one of the four communication statuses "INITIALISATION", "PRE-OPERATIONAL", "OPERATIONAL" or "STOPPED" (see Fig. 2).

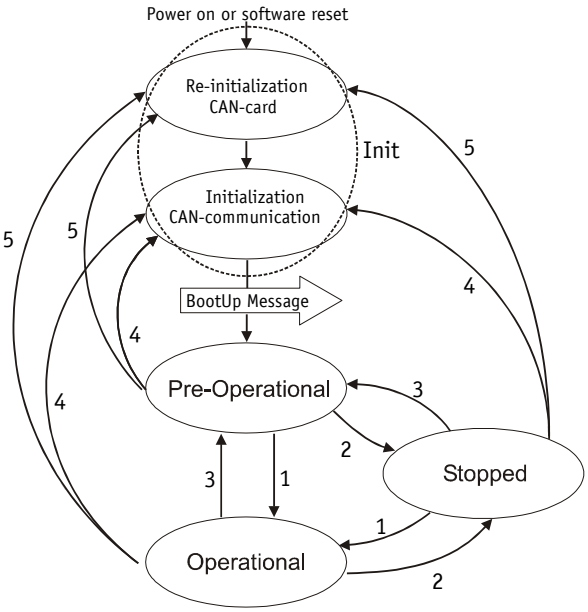

Fig. 2: NMT status diagram

4.2.1.1 NMT communication statuses

NMT Status INITIALIZATION

The unit is not involved in the bus actions in this state. All hardware and software components are initialised. This state is attained after switching on the device or after receipt of the command code 81h of the own or global addresses. After receiving the command code 82h, the display is also in the initialization status. However, only the hardware and software associated with CAN communication is reinitialized. The device automatically signifies completion of initialization via a boot-up message. After successful transmission of the boot-up message, the device will be in the "PRE-OPERATIONAL" status.

NMT Status PRE-OPERATIONAL

Parameterization data (SDO) can be exchanged in the Pre-Operational Mode. However, no process data (PDO) is transferred.

NMT Status OPERATIONAL

Exchange of process data is enabled as well.

NMT Status STOPPED

Communication is stopped except for Heartbeat and Node Guarding. Only NMT communication is enabled.

4.2.1.2 Switching between NMT communication states

Telegrams with the following structures are used for switching between the communications statuses:

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

Table 6: Switching between communication statuses

If transmitted as Node-ID x = 0, the message is intended for all bus subscribers.

4.2.2 Boot-Up

The COB-ID of the Boot-Up message consists of 700h and the Node-ID. The NMT-status "Initialization" is output as data content.

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

Table 7: Boot-Up message

4.2.3 SYNC object

CANopen makes it possible to simultaneously scan inputs and simultaneously set outputs. This is accomplished by the synchronization message (SYNC), a high-priority CAN message. The identifier of the Sync object can be set via object 1005h (see 1005h: COB-ID SYNC message).

4.3 Process data exchange

4.3.1 Transfer of Process Data Objects (PDO)

Process data objects (PDO) serve for quick process data exchange. A maximum of 8 bytes of user data can be transferred in a PDO. AP10T supports the Receive-PDO services RPDO1 and RPDO2 according to Draft Standard 301 as well as the Transmit-PDO services TPDO1 and TPDO2 according to Draft Standard 301 and Device Profile 406.

4.3.1.1 Receive-PDO (from Master to AP10T)

Using Receive-PDO transfer (RPDO), set points and control commands (see chapter 4.3.2: Control word) can be transmitted from the bus master to the display.

<table>
<tr><th rowspan="2">COB-ID</th><th colspan="8">Process data in binary code</th></tr>
<tr><th>Byte 0 (LSB)</th><th>Byte 1</th><th>Byte 2</th><th>Byte 3 (MSB)</th><th>Byte 4</th><th>Byte 5</th><th>Byte 6</th><th>Byte 7</th></tr>
<tr><td rowspan="2">RPDO1
200h + Node-ID</td><td colspan="4" rowspan="2">Target value 1 (indicated in the upper row)</td><td colspan="2">Data identifier equal to ASCII: Byte 4 and 5 of set point 1</td><td colspan="2" rowspan="2">5F0Ch: Control word (see chapter 4.3.2)</td></tr>
<tr><td colspan="2">Otherwise dummy 0x0000</td></tr>
<tr><td rowspan="2">RPDO2
300h + Node-ID</td><td colspan="4" rowspan="2">Target value 2 (indicated in the lower row)</td><td colspan="2">Data identifier equal to ASCII: Byte 4 and 5 of set point 2</td></tr>
<tr><td colspan="2">Otherwise dummy 0x0000</td></tr>
</table>

Table 8: RPDO message

The transfer behavior of RPDO1 is defined via objects 1400h and 1600h. RPDO2 is defined via objects 1401h and 1601h. A differentiation is made between Set point1 und Set point2. Set point1 is displayed in the upper row and Set point2 in the lower row.

4.3.1.2 Transmit PDO (from AP10T to the master)

PDO transfer from the display to the bus master (TPDO) can be initiated as a result of various events:

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

TPDO1 and TPDO2 are always formed from a status word (see chapter 4.3.3: Status word) and the current set points. Set point1 is delivered via TPDO1, Set point2 via TPDO2.
The transfer behavior of TPDO1 is determined via objects 1800h, 1A00h and 6200h and is assigned to asynchronous transfer. TPDO2 is defined via objects 1801h and 1A01h and serves for synchronous transfer.

The messages have the structure shown in Table 9, and mapping cannot be changed.

COB-ID	Process data in binary code							
	Byte 0 (LSB)	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5 (MSB)	Byte 6	Byte 7
TPDO1 180h + Node-ID	Target value 1 (displayed in the upper row)						5F19h: Status word (see chapter 4.3.3)	
TPDO2 280h + Node-ID	Target value 2 (displayed in the lower row)							

Table 9: TPDO message

Asynchronous data transfer (TPDO1)

If a TPDO1 is to be sent cyclically, then the cycle time must be entered into object 1800h, sub-index 5, in milliseconds. The TPDO1 will not be sent if the value 0 ms is written. The function is disabled. The minimum value to be set is 1 (=1 ms) Alternately, the value can also be written into the object 6200h which is permanently linked internally.

Synchronous data transfer (TPDO2)

The device is factory set to reply by output of the TPDO2 message when receiving a SYNC message. Thus it is set to the synchronous transfer type. 1 is entered in object 1801h, sub-index 2. The device responds to every n SYNC message if a value n between 1 and 240 (=F0h) has been entered.

RTR

Queries can be sent to TPDO1 and TPDO2 via RTR (see chapter 4.1: Telegram setup, Control field).

4.3.2 Control word

The control word consists of 16 bits and is mapped in the object 5F0Ch: Control word. This object is received with both Receive PDOs.

Control word															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB			High Byte					Low Byte							LSB

The following table lists the designations of the individual bits of the control word and their meanings.

Bit	Meaning	Value = 0	Value = 1
0	reserved	ever 0	-
1	reserved	ever 0	-
2	validity of Set point1	invalid	valid
3	display range	standard	extended
4	reserved	ever 0	-
5	reserved	ever 0	-
6	acknowledgement of Set point2	not acknowledged	acknowledged
7	data identifier	number	ASCII
8	Guarding Bit	is taken over	is taken over
9	validity of Set point2	invalid	valid
10	acknowledgement of Set point1	not acknowledged	acknowledged
11	LED1 green left	Off	On
12	LED3 green right	Off	On
13	LED4 red right	Off	On
14	LED2 red left	Off	On
15	LED blinking	Off	On

Table 10: Control word

4.3.3 Status word

The status word indicates the current status of AP10T. It consists of 16 bits and is mapped in the object 5F19h: Status word as well as in the two Transmit-PDOs.

Status word															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB			High Byte					Low Byte							LSB

The following table lists the designations of the individual bits of the status word and their meanings.

Bit	Meaning	Value = 0	Value = 1
0	front key	not actuated	actuated
1	reserved	ever 0	-
2	validity of Set point1	invalid	valid
3	acknowledgement of Set point2	not acknowledged	acknowledged

Bit	Meaning	Value = 0	Value = 1
4	reserved	ever 0	-
5	acknowledgement of Set point1	not acknowledged	acknowledged
6	reserved	ever 0	-
7	reserved	ever 0	-
8	Guarding Bit	is output	is output
9	data identifier	number	ASCII-String
10	validity of Set point2	invalid	valid
11	reserved	ever 0	-
12	reserved	ever 0	-
13	← key	not actuated	actuated
14	✱ key	not actuated	actuated
15	↑ key	not actuated	actuated

Table 11: Status word

4.4 Parameter data exchange

4.4.1 Transfer of Service data objects (SDO)

Service data objects serve mainly for device configuration via the directory of objects.

SDOs are exchanged between two participants exclusively via expedited Request/Response. User data is sent already with the initialization message. The identifier is set to 11 bits and cannot be changed.

Two SDO services are available:

- SDO (rx) (master → AP10T): 600h + Node-ID
- SDO (tx) (AP10T → master): 580h + Node-ID

These SDO identifiers cannot be changed!

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	index		sub-index	service data (parameters)			

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 AP10T:

Command byte		Type	Function
Write Request	23h	SDO (rx), Initiate Download Request, expedited	Send parameter to AP10T (all 4 data bytes valid)

Command byte		Type	Function
Write Request	2Bh	SDO (rx), Initiate Download Request, expedited	Send parameter to AP10T (2 bytes from 4 data bytes valid)
Write Request	2Fh	SDO (rx), Initiate Download Request, expedited	Send parameter to AP10T (1 byte from 4 data bytes valid)
Write Response	60h	SDO (tx), Initiate Download Response	Acknowledgement of data acquisition to master
Read Request	40h	SDO (rx), Initiate Upload Request	Request parameter from AP10T
Read Response	43h	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (all four data bytes are valid)
Read Response	4Bh	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (2 bytes from 4 data bytes valid)
Read Response	4Fh	SDO (tx), Initiate Upload Response, expedited	Report parameter to master (1 byte from 4 data bytes valid)
Error Response	80h	SDO (tx), Abort Domain Transfer	AP10T reports error code to master

Table 12: Command coding

Index, bytes 1 and 2:

The index (object number) is entered in user data byte 2 (low byte) and in in 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.

Service data (Parameter), byte 4-7:

In the service data area, the value of the parameter is entered in left-aligned Intel notation. Byte 4 = low-Byte ... Byte 7 = high Byte.

4.4.2 Error Response

An error report (Abort) is returned to the master in case of invalid access.
The error codes are described in the CANopen profile (DS 301) or in the encoder profile (DSP 406), respectively. The following table shows the error codes used:

Error code	Description
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.

Error code	Description
08000022h	Parameters cannot be transferred to application or stored due to the current device status.
08000024h	no data available

Table 13: Error code

4.4.3 Examples of SDO access

Example of reading SDO parameters:

Read the number of decimal places stored in object 5F11h of the objects directory from the AP10T with device address 1.

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

Command: 40h
Index: 5F11h
Sub-index: 00h
The current value is 2 = 02h

Request by the master from the slave with Node ID 1:

COB-ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	40h	03h	60h	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 LB	Index HB	Sub-index	Data 0	Data 1	Data 2	Data 3
581h	4Fh (1 byte valid)	11h	5Fh	00h	02h	x	x	X

Example of writing SDO parameters:

Change the display orientation stored with 1 byte in object 5F12h, sub-index 1 of the objects directory in the AP10T with device address 1.

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

Command: Write 1 byte: 2Fh
Index: 5F12h
Sub-index: 01h
The new value shall be 1 = 01h (corresponds to orientation = 180°).

Write a value from master to slave with Node ID 1:

COB-ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	2Fh (1 byte valid)	12h	5Fh	01h	01h	00h	00h	00h

Response of the slave to the command:

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

COB-ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
581h	60h	14h	5Fh	00h	00h	00h	00h	00h

4.5 Node monitoring

4.5.1 Emergency Service (EMCY)

The status of the bus subscriber is transferred via high-priority emergency messages in case of error. These messages have a data length of 8 bytes and contain information on the error.

The emergency message is transferred as soon as a serious communication error occurred or was corrected. The cause of error is stored in the error buffer (see object 1003h: Pre-defined Error Field). An emergency object is sent only once per error event. Removal of a cause of error is signified by sending an emergency message with Error Code 0000h (No Error). If multiple errors exist and one cause of an error has been corrected, then Error Code 0000h is output as well; however, the persisting error condition is indicated in the Error Register.

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 error removed	0x0000
Bus Status changed over to the Error Passive Mode	0x8120
Recovered from Bus Off	0x8140

Table 14: Emergency Error Code

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

4.5.2 Node Guarding

Node Guarding is available for failure monitoring of the CANopen network. During guarding, the master transmits remote frames (RTR, remote transmit request, request message) on the guarding identifiers of the nodes to be monitored. They respond with the Guarding message, which contains the current NMT status of the node as well as a toggle bit whose value must change with every message. If NMT status or toggle bit do not correspond with the value expected by the master or if there is no response, then the master assumes a node error.

Via objects 100Ch (Guard Time) 100Dh (Life Time Factor), the time interval (Life-Time) is set within which the NMT master expects to receive a message. The time interval "Life time" is calculated from the cycle time "Guard time" multiplied with the factor "Life Time Factor". If the NMT master receives no response to its RTR frame within the "Life-Time", it can react with appropriate measures. After switching on, Node Guarding is activating by the master sending the first RTR frame to the slave. If the value of either object (100Ch or 100Dh) is set to 0, Node Guarding will be deactivated.

The node's response to the master's RTR frame is formed as follows:

Identifier	Byte 0	
700h + Node-ID	Bit 7: toggle Bit	Bit 6 ... 0: NMT status

Toggle Bit:

The toggle bit must alternate between two subsequent responses of the unit. After activation of the Guarding protocol, the toggle bit must have the value 0 with the first response.

NMT status:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

The identifier of the heartbeat protocol is permanently set to 700h + Node-ID and cannot be changed. Sending of a Node Guard message is possible in the "OPERATIONAL", "PREOPERATIONAL" or "STOPPED" NMT statuses.

4.5.3 Heartbeat

The master monitors the status of the slave device via the Heartbeat protocol. While doing this, the unit sends cyclically its NMT status. The AP10T is a heartbeat producer, it does not receive nor process heartbeat protocols. The cycle time of the heartbeat message is set via object 1017h. The heartbeat protocol is inactivated if the cycle time is 0.

The heartbeat message consists of the COB-ID and an additional byte, which is used to store the current NMT status.

COB-ID	Byte 0
700h + Node-ID	NMT status

NMT status:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

The identifier of the heartbeat protocol is permanently set to 700h + Node-ID and cannot be changed. Sending of a Node Guard message is possible in the "OPERATIONAL", "PREOPERATIONAL" or "STOPPED" NMT statuses.

4.5.4 External heartbeat

In addition to the function described under Heartbeat, the NMT status can be controlled via the external heartbeat. In this case, a value corresponding to an interval in ms is entered in object 5F09h sub-index 1. If the devices receives no external heartbeat message during this interval, the display will switch over to Pre-Operational status. The type of message to be interpreted as external heartbeat is set in object 5F09h sub-index 2. The value 0 means that the timer is triggered when receiving an RPDO (set point). With value 1, the timer is triggered when receiving a SYNC (see object 5F09h: External Heartbeat timer and external Heartbeat source).

4.5.5 Guarding Bit

There is a guarding bit in the control word, which serves for monitoring communication or the NMT state of the device, respectively. When receiving the control word, the content of this bit will be copied into the guarding bit of the status word and output with the next TPDO. Thus, by shifting the bit in the control word, the superordinate control can verify without additional data traffic that process data exchange is in operation. This function is especially helpful when a gateway (converter from CANOpen to superordinate fieldbus) is used.

4.6 Auto-Functions

4.6.1 Auto-Baud

This function facilitates first commissioning of the devices in the plant. The baud rate is factory-set to "Auto Baud". AP10T "overhears" the bus and does not transmit messages. To enable the instrument's autonomous recognition and adjustment of the prevalent bus baud rate, communication must take place on the CAN bus. If the device recognizes a faultless message with the internally set baud rate it will be adopted as a valid baud rate, CAN initialization finished and a boot-up message sent. If no message is detected till expiry of the dwell time, then the next valid baud rate is set and checked for communication. The search for a baud rate is not stopped until a valid baud rate has been found. If the baud rate is to be adopted permanently, it must be saved upon command (see chapter 4.7.2.11: 1010h: Store Parameter).

The Auto Baud function can be activated or deactivated during parameterization (see chapter 3.6: Parameterization of the set point display) and the desired baud rate directly set.

4.6.2 Auto-ID

This function facilitates first commissioning of the devices in the plant. The node numbers can be assigned by the superordinate control or by pressing the relevant button on the device concerned.

The Node ID 7Dh (125d) is factory-set. After finishing initialization, every device sends a boot-up message and switches over to the "PRE-OPERATIONAL" status. Now, the CAN master must send to the bus subscriber(s) with the current Node-ID 7Dh an SDO message to object 5F0Ah sub-index 2 with the new Node ID to be set and await an SDO reply.

"New ID" will be displayed on all devices that have the current Node-ID 7Dh. The user must press the ↑ key on the device intended to adopt the new Node ID. Subsequently, this device will send an SDO reply with the identifier 5FDh. The new Node-ID is taken over and stored in the EEPROM. The initialization phase is run again and a boot-up message sent with the new Node-ID. All other devices do not react. Afterwards, the control execute a reset of all nodes for example in order to find out whether there are still devices in the bus with Node-ID 7Dh. If so, the procedure may be repeated until all devices have received the desired Node-ID. The Auto-ID function is aborted in the AP10T when an illegal value was sent for the new ID. SDO Abort messages will be returned in this case.

Use of this function is optional. The node numbers can also be set via parameterization (see chapter 3.6: Parameterization of the set point display).

COB-ID	Byte 0	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3	Byte 4 (LSB)	Byte 5	Byte 6	Byte 7 (MSB)
67Dh	2Fh	0Ah	5Fh	02h	New Node-ID	x	x	x

Table 15: Auto-ID: SDO-message from the master

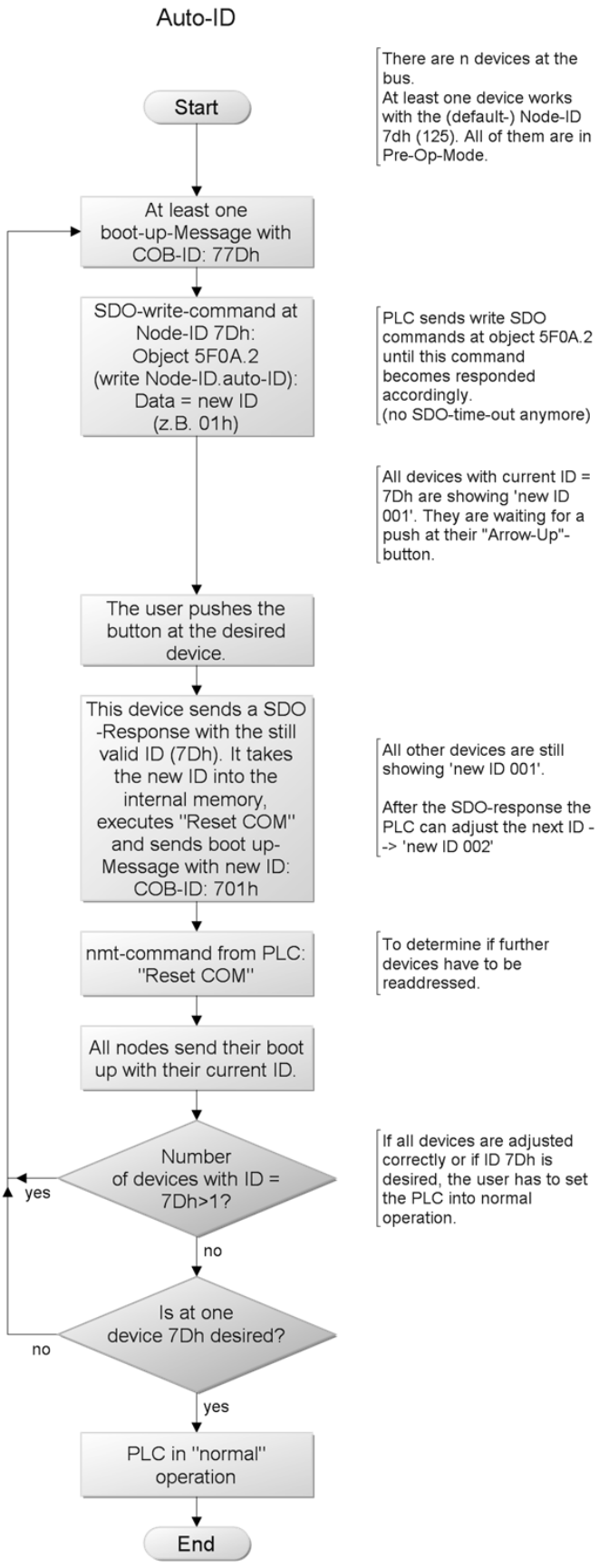

Fig. 3: Auto-ID function

4.7 Directory of objects

4.7.1 Overview of objects

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

Name	Description	see page
1000h: Device Type	Device profile and encoder type.	27
1001h: Error Register	Current error status of the device.	27
1002h: Manufacturer Status Register	Contains the Receive Error Counter and the Transmit Error Counter.	28
1003h: Pre-defined Error Field	The object stores the 8 error states that have occurred last.	28
1005h: COB-ID SYNC message	Setting of the COB ID of the SYNC object.	29
1008h: Manufacturer Device Name	Device name in ASCII characters	29
1009h: Manufacturer Hardware Version	Indicates the hardware version of the device.	30
100Ah: Manufacturer Software Version	Indicates the software version of the device.	30
100Ch: Guard Time	Parameter for Node Guarding.	30
100Dh: Life Time Factor	Parameter for Node Guarding.	31
1010h: Store Parameter	Object for non-volatile storage of the settings.	31
1011h: Restore Parameter	Object for restoring the factory settings.	33
1014h: COB-ID Emergency Message	COB ID of the Emergency message.	35
1017h: Producer Heartbeat Time	Setting of the cycle time of the heartbeat timer.	36
1018h: Identity Object	Contains the manufacturer number assigned by CiA.	36
1200h: Server SDO Parameter	SDO parameter	37
1400h: 1. Receive PDO Parameter	Receive PDO1	38
1401h: 2. Receive PDO Parameter	Receive PDO2	39
1600h: 1. Receive PDO Mapping Parameter	Describes the arrangement of the objects mapped in RPDO1.	40
1601h: 2. Receive PDO Mapping Parameter	Describes the arrangement of the objects mapped in RPDO2.	41
1800h: 1. Transmit PDO Parameter	Transmit PDO for asynchronous transmission (timer-controlled).	42
1801h: 2. Transmit PDO Parameter	Transmit PDO for synchronous transmission.	44
1A00h: 1. Transmit PDO Mapping Parameter	Describes the arrangement of the objects mapped in TPDO1.	45
1A01h: 2. Transmit PDO Mapping Parameter	Describes the arrangement of the objects mapped in TPDO2.	46
2003h: ✳ key actuation enable	Setting whether calibration of the display is enabled via key operation.	47

Name	Description	see page
2004h: ↑ key actuation enable	Setting whether setting of the incremental function is enabled via key operation.	47
2005h: Configuration enable via keyboard and delay of start of configuration	Setting whether configuration is enabled via key operation. Delay of start of configuration.	48
5000h: Diagnosis of CAN bus errors	Informs about CAN bus error events.	49
5F09h: External Heartbeat timer and external Heartbeat source	Cycle time and trigger source of the external heartbeat.	49
5F0Ah: Node-ID, Auto-ID and Baud rate Bus CAN	Setting of Node-ID baud rate.	50
5F0Bh: Display in the 2nd row	Setting of the display in the 2nd row.	52
5F0Ch: Control word	Control word	52
5F11h: Decimal places	Number of decimal places.	52
5F12h: Display orientation and LEDs	Setting of the display orientation and LED functionality.	53
5F16h: Read target value	Read current target value; write access only via PDO.	55
5F19h: Status word	Output of the device status.	56
5F1Bh: Sensor type and operating mode	Reading of the sensor type.	57
5F1Ch: Acknowledgement settings	Setting of the key to be used as acknowledgement key.	57
6200h: Cycle Timer	Identical with object 1800h, sub-index 5.	58
6503h: Alarms	Indication of error states.	58
6504h: Supported Alarms	Indicates which alarm messages are supported.	58
6505h: Warnings	Indication of warnings.	59
6506h: Supported Warnings	Indicates which warnings are supported.	59
6507h: Profile and Software Version	Indicates the version number of the device profile used and the version number of the encoder's firmware.	59
6508h: Operating Time	Counter of operating hours (function is not supported)	60
650Bh: Serial Number	Outputs the value FFFFFFFFh (function is not supported).	60

Table 16: Overview of objects

4.7.2 Description of objects

4.7.2.1 1000h: Device Type

Object 1000h indicates the device profile number.

Sub-index	00h			
Description	Information on device profile and device type			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	00000196h			
EEPROM	no			
Data content	Device profile number		Encoder type	
	Byte 0	Byte 1	Byte 2	Byte 3
	96h	01h	05h	00h

0196h (= 406): CANopen Device Profile for Encoders, Version 3.02

0000h: AP10T is not an encoder.

4.7.2.2 1001h: Error Register

Object 1001h indicates the error state of the device.

Sub-index	00h	
Description	pending error state	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	0x00	
EEPROM	no	
Data content	Bit	Meaning
	0	set bit indicates the occurrence of any error condition
	4	set bit indicates communication error on the CAN bus (Acknowledgement-, Form-, CRC- and Stuffbit)
	7	manufacturer-specific (battery or sensor error)
	1-3, 5-6	not used

Faults and errors are signalled at the time of their occurrence by an emergency message.

4.7.2.3 1002h: Manufacturer Status Register

The object 1002h shows the counter readings of "Transmit Error Counter" and "Receive Error Counter". 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	0x0000			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	Receive Error Counter	Transmit Error Counter		

4.7.2.4 1003h: Pre-defined Error Field

The 8 error states that occurred last are archived in object (see chapter 4.5.1: Emergency Service (EMCY)).

- The entry under sub-index 0 indicates the number of stored errors.
- The latest error state is always stored in sub-index 1. Previous error messages are each shifted one sub-index position farther.
- The whole error list is deleted by writing the value 0 at sub-index 0.
- The entries in the error list have the format described in chapter 4.5.1: Emergency Service (EMCY).

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

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

4.7.2.5 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 4.1)	
PDO mapping	no	
Data type	UNSIGNED 32	
Default	80h	
EEPROM	yes	
Data content	Bit 31	not defined
	Bit 30	0: unit generates no SYNC message
	Bit 29	0: 11bit identifier (CAN 2.0A) 1: 29bit 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

4.7.2.6 1008h: Manufacturer Device Name

Object 1008h indicates the device name.

Sub-index	00h			
Description	Device name as ASCII characters			
Access	Const			
PDO mapping	no			
Data type	Visible_String			
Default	AP10T			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	41h ("A")	50h ("P")	31h ("1")	30h ("0")

4.7.2.7 1009h: Manufacturer Hardware Version

Object 1009h indicates the hardware version.

Sub-index	00h			
Description	Hardware version as ASCII characters			
Access	Const			
PDO mapping	no			
Data type	Visible_String			
Default	V001			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	56h ("V")	30h ("0")	30h ("0")	31h ("1")

4.7.2.8 100Ah: Manufacturer Software Version

Object 100Ah indicates the software version of the device.

Sub-index	00h			
Description	Software version as ASCII characters			
Access	Const			
PDO mapping	no			
Data type	Visible_String			
Default	V100			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	56h ("V")	31h ("1")	30h ("0")	30h ("0")

4.7.2.9 100Ch: Guard Time

The object 100Ch indicates the cycle time set in the master for Node Guarding (see chapter 4.5.2: Node Guarding). The cycle time is indicated in milliseconds. The value "0" 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

4.7.2.10 100Dh: Life Time Factor

The object 100Dh indicates the Life Time Factor set in the master for Node Guarding (see chapter 4.5.2: Node Guarding). The value "0" 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

4.7.2.11 1010h: Store Parameter

With this objects, parameter are transferred into the EEPROM in order to be available in case of voltage failure. Different parameter groups are saved depending on the sub-index selected for access. The string "save" as data content must also be sent.

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

Subindex	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 save parameters autonomously		
	Bit 0	1: unit stores parameter by command		

Sub-index	02h			
Description	save only communication parameters (1000h-1FFFh, DS301)			
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 save parameters autonomously		
	Bit 0	1: unit stores parameter by command		

Sub-index	03h			
Description	save only application parameters (6000h-9FFFh, DS406)			
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 save parameters autonomously		
	Bit 0	1: unit stores parameter by 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 save parameters autonomously		
	Bit 0	1: unit stores parameter by command		

4.7.2.12 1011h: Restore Parameter

The object 1011h restores the factory settings of the device depending on the selection. The string "load" must be sent as data content and reset executed afterwards. If the restored parameters must be available permanently, they must be saved via object 1010h: Store Parameter.

Sub-index	00h
Description	indicates the largest supported sub-index
Access	ro
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: unit permits loading of default parameters		

Sub-index	02h			
Description	reset only communication 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: unit permits loading of default parameters		

Sub-index	03h			
Description	reset only application 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: unit permits loading of default parameters		

Sub-index	04h			
Description	reset only manufacturer-specific 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: unit permits loading of default parameters		

4.7.2.13 1014h: COB-ID Emergency Message

The COB-ID of the Emergency object is set via object 1014h (see chapter 4.5.1: Emergency Service (EMCY)).

Sub-index	00h	
Description	Defines the COB ID of the Emergency object (EMCY)	
Access	rw (writable in the "Pre-Operational" state only see chapter 4.1: Telegram setup)	
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	ever 0
	Bit 29	0: 11bit identifier (CAN 2.0A) 1: 29bit identifier (CAN 2.0B)
	Bit 28 ... 11	0: if bit 29 = 0 X: bits 28 – 11 of the EMCY-COB-ID, if bit 29 = 1
	Bit 10 ... 0	X: bits 10 – 0 of the EMCY -COB-ID

4.7.2.14 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	0
EEPROM	yes
Data content	0, 10 ... 65535 (0h, Ah ... FFFFh); the numerical value corresponds to a multiple of 1 ms. The value 0 deactivates the service.

4.7.2.15 1018h: Identity Object

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

Sub-index	00h
Description	indicates the largest sub-index supported
Access	ro
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	195h
EEPROM	no

Sub-index	02h
Description	Product Code (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	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

Sub-index	04h
Description	Serial Number (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	FFFF FFFFh
EEPROM	no

4.7.2.16 1200h: Server SDO Parameter

The COB IDs for the Default Server SDO are indicated via object 1200h. The COB-IDs cannot be changed.

Sub-index	00h
Description	indicates the largest sub-index supported
Access	ro
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

4.7.2.17 1400h: 1. Receive PDO Parameter

The communication parameters of the first Receive PDO (RPDO1) are set via object 1400h.

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

Sub-index	01h
Description	COB-ID des PDO1
Access	rw (writable in the "Pre-Operational" state only see chapter 4.1: Telegram setup)
PDO mapping	no
Data type	UNSIGNED 32
Default	200h + Node-ID
EEPROM	yes

Sub-index	02h
Description	Transmission Type
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	FFh
EEPROM	yes
Data content	0h ... F0h, FEh, FFh

Sub-index	03h
Description	Inhibit time (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

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

Sub-index	05h
Description	Event timer (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

4.7.2.18 1401h: 2. Receive PDO Parameter

The communication parameters of the second Receive-PDOs (RPDO2) are set via object 1401h.

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

Sub-index	01h
Description	COB-ID of the PDO2
Access	rw (writable in the "Pre-Operational" state only see chapter 4.1)
PDO mapping	no
Data type	UNSIGNED 32
Default	300h + Node-ID
EEPROM	yes

Sub-index	02h
Description	Transmission Type
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	FFh
EEPROM	yes
Data content	0h ... F0h, FEh, FFh

Sub-index	03h
Description	Inhibit time (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

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

Sub-index	05h
Description	Event timer (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

4.7.2.19 1600h: 1. Receive PDO Mapping Parameter

Object 1600h determines the objects that are mapped on the first Receive PDO (RPDO1).

Sub-index	00h
Description	number of objects mapped
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	no

Sub-index	01h
Description	1st object of the PD01 message (Data byte 0 until 3)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F160320 (Set point object 5F16h, Sub-index 0x03, 32bit)
EEPROM	no

Sub-index	02h
Description	2nd object of the PD01 message (Data byte 4+5)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F160410 (Set point object 5F16h, Sub-index 0x04, 16bit)
EEPROM	no

Sub-index	03h
Description	3rd object of the PD01 message (Data byte 6+7)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F0C0010 (Control word object 5F0Ch, Sub-index 0x00, 16bit)
EEPROM	no

4.7.2.20 1601h: 2. Receive PDO Mapping Parameter

Object 1601h determines the objects that are mapped on the second Receive PDO (RPD02).

Sub-index	00h
Description	number of objects mapped
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	3h
EEPROM	no

Sub-index	01h
Description	1st object of the PDO2 message (Data byte 0 until 3)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F160120 (Set point object 5F16h, Sub-index 0x01, 32bit)
EEPROM	no

Sub-index	02h
Description	2nd object of the PDO2 message (Data byte 4+5)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F160210 (Set point object 5F16h, Sub-index 0x02, 16bit)
EEPROM	no

Sub-index	03h
Description	3rd object of the PDO2 message (Data byte 6+7)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0x5F0C0010 (Control word object 5F0Ch, Sub-index 0x00, 16bit)
EEPROM	no

4.7.2.21 1800h: 1. Transmit PDO Parameter

According to DS406, TPDO1 is used for asynchronous PDO transmission.
The communication parameters are set for TPDO1 via object 1800h.

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

Sub-index	01h
Description	COB-ID des PDO1
Access	rw (writable in the "Pre-Operational" state only see chapter 4.1)
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	FEh (254)	
EEPROM	yes	
Data content	FEh (254) FFh (255)	PDO has asynchronous characteristics (PDO is sent depending on the "Event Timer").
	FDh (253)	Device responds to RTR-request only if RTR Bit 30 is enabled in the COB-ID.

Sub-index	03h
Description	Inhibit time (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

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

Sub-index	05h
Description	event timer for TPDO1 hard-wired (DS406) with cyclic timer 6200h
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	The service is disabled by writing the value 0. The content of this object is identical with object 6200h. If the value is changed while the timer is running, then the change will take effect only with the next timer run.

Sub-index	06h (is not used, access attempt generates error message)

4.7.2.22 1801h: 2. Transmit PDO Parameter

According to DS406, TPDO2 is used for synchronous PDO transmission.
The communication parameters are set for TPDO2 via object 1801h.

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

Sub-index	01h
Description	COB-ID of the PDO2
Access	rw (writable in the "Pre-Operational" state only see chapter 4.1)
PDO mapping	no
Data type	UNSIGNED 32
Default	280h + Node-ID
EEPROM	yes

Sub-index	02h	
Description	Transmission Type	
Access	rw	
PDO mapping	no	
Data type	UNSIGNED 8	
Default	1h	
EEPROM	yes	
Data content	FEh (254) FFh (255)	PDO is sent after receipt of 1 ... 240 SYNC messages.
	FDh (253)	Device responds to RTR-request only if RTR Bit 30 is enabled in the COB-ID.

Sub-index	03h
Description	Inhibit time (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

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

Sub-index	05h
Description	Event timer (function is not supported, only compatibility entry for various configurators)
Access	ro
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	no

Sub-index	06h (is not used, access attempt generates error message)

4.7.2.23 1A00h: 1. Transmit PDO Mapping Parameter

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

Sub-index	00h
Description	number of objects mapped
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	no

Sub-index	01h
Description	1st object of the PDO1 message (Data byte 0 until 3)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F160320h (Set point object 5F16h, Sub-index 0x03, 32bit)
EEPROM	no

Sub-index	02h
Description	2nd object of the PDO1 message (Data byte 4+5)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F160410h (Set point object 5F16h, Sub-index 0x04, 16bit)
EEPROM	no

Sub-index	03h
Description	3rd object of the PDO1 message (Data byte 6+7)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F190010h (Status word object 5F19h, Sub-index 0x00, 16bit)
EEPROM	no

4.7.2.24 1A01h: 2. Transmit PDO Mapping Parameter

Object 1A01h determines the objects that are mapped on the second Receive PDOs (TPDO2).

Sub-index	00h
Description	number of objects mapped
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	no

Sub-index	01h
Description	1st object of the PDO2 message (Data byte 0 until 3)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F160120h (Set point object 5F16h, Sub-index 0x01, 32bit)
EEPROM	no

Sub-index	02h
Description	2nd object of the PDO2 message (Data byte 4+5)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F160210h (Set point object 5F16h, Sub-index 0x02, 16bit)
EEPROM	no

Sub-index	03h
Description	3rd object of the PDO2 message (Data byte 6+7)
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	5F190010h (Status word object 5F19h, Sub-index 0x00, 16bit)
EEPROM	no

4.7.2.25 2003h: ✳ key actuation enable

The object 2003h indicates whether the actuation of the ✳ key is enabled.

Sub-index	00h
Description	key enable
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	ja
Data content	0: actuation disabled 1: actuation enabled

4.7.2.26 2004h: ↑ key actuation enable

The object 2004h indicates whether the actuation of the ↑ key is enabled.

Sub-index	00h
Description	key enable
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: actuation disabled 1: actuation enabled

4.7.2.27 2005h: Configuration enable via keyboard and delay of start of configuration

Object 2005h indicates whether configuration via key actuation is enabled. The delay of start of configuration is set in sub-index 2 (key enable time).

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

Sub-index	01h
Description	key enable
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: disabled (is not supported) 1: enabled

Sub-index	02h
Description	delay of start of configuration (key enable time)
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	5h
EEPROM	yes
Data content	1 … 60 s

4.7.2.28 5000h: Diagnosis of CAN bus errors

A prioritized list of CAN bus errors occurring can be read via object 5000h.

Sub-index	00h			
Description	Indicates the CAN Bus errors Acknowledge, Form, CRC and Stuff Error sorted by frequency.			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	0h			
EEPROM	no			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	General Acknowledgement error	Form error	CRC error	Stuff error
	0, 1, 2, 3, 4	0, 1, 2, 3, 4	0, 1, 2, 3, 4	0, 1, 2, 3, 4

Explanation of the data content:

0: Error does not occur at all

4: Error occurs most frequently

4.7.2.29 5F09h: External Heartbeat timer and external Heartbeat source

Via object 5F09h, an external heartbeat timer and its trigger source can be set. This function serves for monitoring the connection of the device to the master via CAN bus.

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

Sub-index	01h
Description	With a value greater than zero entered here, an event depending on the external heartbeat source set in sub-index 2 is expected in this interval. If no such event is received, the device will return to the "Pre-Operational" status.
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0, 10 ... 65535 (Ah ... FFFFh); the numerical value corresponds to a multiple of 1 ms. The function is disabled by writing the value 0.

Sub-index	02h
Description	source that triggers the external heartbeat timer in sub-index 1
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0: Timer is triggered upon receipt of a PDO (set point) 1: Timer is triggered upon receipt of a SYNC

4.7.2.30 5F0Ah: Node-ID, Auto-ID and Baud rate Bus CAN

Via object 5F0Ah, Node-ID, Auto-ID (see chapter 4.6.2: Auto-ID) and the baud rate of the bus (see chapter 4.6.1: Auto-Baud) can be set.

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

Sub-index	01h
Description	Node-ID
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	7Dh (125)
EEPROM	yes
Data content	1 ... 7Fh

Sub-index	02h
Description	Node-ID for access via Auto-ID function
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	
EEPROM	yes
Data content	1 ... 7Fh

Sub-index	03h
Description	baud rate of the CAN bus
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0 (Auto baud)
EEPROM	yes
Data content	0: Auto baud 1: 125 kbaud 2: 250 kbaud 3: 500 kbaud 4: 800 kbaud 5: 1000 kbaud

4.7.2.31 5F0Bh: Display in the 2nd row

Via object 5F0Bh the display of the 2nd row of the display unit is controlled. The setting is not effective in the "Display" operating mode.

Sub-index	00h
Description	controls the display of the 2nd row of the display unit
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	no
Data content	0: Set point2 1: Off

4.7.2.32 5F0Ch: Control word

The control word can be read via object 5F0Ch. Write access is only via RPDO1 or RPDO2 (see chapter 4.3.2: Control word).

Sub-index	00h
Description	Control word
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	0h
EEPROM	no

4.7.2.33 5F11h: Decimal places

The object 5F11h indicates the number of decimal places.

Sub-index	00h
Description	number of decimal places
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0 ... 4

4.7.2.34 5F12h: Display orientation and LEDs

Settings of the display orientation and the LEDs can be made via object 5F12h. Furthermore the function of the display backlighting can be set (see chapter 3.3: LED display).

Sub-index	00h
Description	indicates the largest sub-index supported
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	9h
EEPROM	no

Sub-index	01h
Description	Display orientation
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0 = 0° 1 = 180° rotated

Sub-index	02h
Description	LED1 green left
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: acknowledgement-dependent

Sub-index	03h
Description	LED2 red left
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: acknowledgement-dependent

Sub-index	04h
Description	LED3 green right
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: acknowledgement-dependent

Sub-index	05h
Description	LED4 red right
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: acknowledgement-dependent

Sub-index	06h
Description	FLASH LED
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0: Off 1: On

Sub-index	07h
Description	backlight white
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: On

Sub-index	08h
Description	backlight red
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	0: Off 1: On

Sub-index	09h
Description	FLASH backlight
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0: Off 1: On

4.7.2.35 5F16h: Read target value

The current set points can be read via object 5F16h.

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

Sub-index	01h
Description	Set point2 (4 LSB Bytes)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Sub-index	02h
Description	Set point2 (2 MSB Bytes)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Sub-index	03h
Description	Set point1 (4 LSB Bytes)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 32
Default	0h
EEPROM	no

Sub-index	04h
Description	Set point1 (2 MSB Bytes)
Access	ro
PDO mapping	yes
Data type	UNSIGNED 32
Default	0h
EEPROM	no

4.7.2.36 5F19h: Status word

Object 5F19h informs about the current device status (see chapter 4.3.3: Status word).

Sub-index	00h
Description	The status word informs about the current device status.
Access	ro
PDO mapping	yes
Data type	UNSIGNED 16
Default	0h
EEPROM	no

4.7.2.37 5F1Bh: Sensor type and operating mode

The sensor type can be read via object 5F1Bh.

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

Sub-index	01h
Description	read sensor type
Access	ro
PDO mapping	no
Data type	UNSIGNED 8
Default	2h (internal sensor)
EEPROM	yes

4.7.2.38 5F1Ch: Acknowledgement settings

Object 5F1Ch serves for determining the key to be used as acknowledgement key. By pressing the relevant key, the previously received set points (set point1 and set point2) are acknowledged. If both values are unacknowledged, both values will be acknowledged via one keystroke.
The respective key actuation enable can be set as well.

Sub-index	00h
Description	acknowledgement settings
Access	rw
PDO mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes
Data content	0: ✳ - and front key 1: only front key 2: ↑ - and ← -key

4.7.2.39 6200h: Cycle Timer

Object 6200h sets a cycle time for the output of PDO1. This value is permanently linked to the object 1800h: 1. Transmit PDO Parameter sub-index 5. Timer-controlled output is active as soon as a valid cycle time has been entered and the device run in the Operational Mode. The value 0 deactivates the function.

Sub-index	00h
Description	Zyklus Timer
Access	rw
PDO mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0 ... 65535

4.7.2.40 6503h: Alarms

Object 6503h sends device-specific alarm messages in addition to the errors reported via the Emergency message. In the case of an error, the associated bit is set to 1.

Sub-index	00h	
Description	alarm messages	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 16	
Default	0h	
EEPROM	no	
Data content	Bit 15 ... 0	not used

4.7.2.41 6504h: Supported Alarms

This object 6504h indicates the alarm messages that are supported. The relevant bits are set.

Sub-index	00h	
Description	supported alarm messages	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 16	
Default	3001h	
EEPROM	no	
Data content	Bit 15 ... 0	not used

4.7.2.42 6505h: Warnings

The warning messages displayed via object 6505h indicate that tolerances of internal parameters have been exceeded.

Sub-index	00h	
Description	warnings	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 16	
Default	0h	
EEPROM	no	
Data content	Bit 15 ... 0	not used

4.7.2.43 6506h: Supported Warnings

Object 6506h indicates the warning messages that are supported.

Sub-index	00h	
Description	supported warning messages	
Access	ro	
PDO mapping	no	
Data type	UNSIGNED 16	
Default	0010h	
EEPROM	no	
Data content	Bit 15 ... 0	not used

4.7.2.44 6507h: Profile and Software Version

The object 6507h indicates the encoder profile used (CANopen Device profile for encoders) and the version number of the firmware state.

Sub-index	00h			
Description	Profile and software version			
Access	ro			
PDO mapping	no			
Data type	UNSIGNED 32			
Default	01000302h			
EEPROM	no			
	Profile version		Software version	
	Byte 0 (LSB)	Byte 1	Byte 2	Byte 3 (MSB)
	02	03	00	01

4.7.2.45 6508h: Operating Time

The operating hours are displayed via object 6508h. This function is not supported.

Sub-index	00h
Description	operating hours counter
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	0xFFFFFFFFh
EEPROM	no

4.7.2.46 650Bh: Serial Number

Object 650Bh outputs the serial number of the encoder. This function is not supported.

Sub-index	00h
Description	Serial number
Access	ro
PDO mapping	no
Data type	UNSIGNED 32
Default	FFFFFFFFh
EEPROM	no