
User manual

Absolute Position Indicator

with **CANopen** - interface
and Firmware-Softwareversion 01

AP04S





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1. General Information

This user manual is valid for the absolute position indicator AP04S with firmware version H1.01 or higher and is intended to provide the necessary information for handling this device.

The **Installation Instruction AP04S** contains important information on warranty, safety, mechanical assembly, electrical connection as well as commissioning of the AP04S. Please read that information carefully as well.

The present **User Manual** will provide a detailed description of the functionality of the CANopen interface.

The communication options via RS485 are described in the **Additional to the Installation Instruction AP04S RS485**.

Definitions



This symbol precedes passages in the text that should be read particularly carefully to ensure flawless use of the device and to exclude dangers.



This symbol provides important information for proper handling of the display. Disregard of these hints may result in failures of functioning of the display or its environment.



This symbol indicates instructions for actions.

| | |
|---------------|--|
| CAL | CAN Application Layer. Application layer (layer 7) in the CAN communication model |
| CAN | Controller Area Network |
| CiA | CAN in Automation. International Association of Users and Producers of CAN products. |
| COB | Communication Object. Transport unit in the CAN network (CAN message). Data is sent within a COB via the network. |
| COB ID | COB-Identifier. Unambiguous identification of a CAN message. The identifier determines the priority of the COB on the network. |
| ID | Identifier, see COB ID |
| LSB | Least significant bit/byte |
| MSB | Most significant bit/byte |
| NMT | Network Management. Service element of CAL, responsible for initialization, configuration and error handling on the network. |
| PDO | Process Data Object. Object for exchanging process data. |
| RTR | Remote Transmission Request; data request telegram |
| SDO | Service Data Object; communication object that enables the master to access the object directory of a node. |

SYNC Synchronization telegram. Bus stations respond to the SYNC command by sending their process values.

Figures if not explicitly stated otherwise, decimal values are given as figures without an extension (e. g. 1234), binary values are marked after the figure with a **b** (e. g. 19011b), hexadecimal values with an **h** (e. g. 280h).

Intended use



Together with an external sensor, the electronic position indicator AP04S constitutes a high-precision measurement system. The position indicator serves exclusively for processing and output of position values, processing and providing measured values as electronic output signals for an upstream control as well as for the display of target values and positioning aids. The AP04S must be used for such purposes exclusively.

- Conversion or alteration of the device not approved by SIKO is forbidden for safety reasons.
- Refrain from any operation that may compromise safety with the device.

The AP04S product family

At present, the product family of absolute indicators consists of the following 2 types:

- **AP04 and AP04S with RS485 interface**
- **AP04 and AP04S with CAN interface (CANopen)**

AP04S must be operated together with the hollow shaft sensor GS04. Although designed with a bus interface, the position indicator is very compact.

The AP04S functions with the following communication protocols:

- **CAN (CANopen interface)**
- **SN3 (RS485 with SIKONETZ3 protocol)**
- **SN4 (RS485 with SIKONETZ4 protocol)**
- **SN5 (RS485 with SIKONETZ5 protocol)**
- **SSP (RS485 with Service Standard protocol)**

2. Brief description

In general

The present device is an absolute position indicator with a plug connector for a hollow shaft sensor GS04 intended for shaft mounting. Set point and actual value are displayed via the 2-line LC display. In case of non-conformance of actual value and set point a direction indication (arrow) is shown. The direction of the arrow indicates into which direction the shaft should be rotated in order to arrive at the set point. The user can set the threshold of deviation where the arrows will be shown. Additionally, various visualization tasks can be realized by means of two coloured LEDs (green and red).

The device parameters can be adjusted by means of 3 keys. The set point can be changed and individual device parameters adjusted via the integrated CAN bus interface.

Scanning is magnetically incremental. In the currentless state, scanning and saving of changes of the position value are battery-supported. The battery can be replaced. The battery symbol on the display will blink when the battery voltage falls below a critical level. If the battery voltage falls below a minimum level, the symbol will glow permanently.

If no sensor is connected (only RS485) or if the sensor is lifted from the band, an error will be detected and the position value displayed with a blinking "Error". This condition will also be retained beyond failure of power supply. The error must be corrected by zeroing (see key functions) after having checked the sensor connection or sensor position, respectively.

Display and interface are active with external power supply only.

Display

2 lines of each 5 7-segment readings




4 special characters: "<", ">", incremental measure symbol ; Battery symbol 

Displayable number range:
-99999 bis 99999



If this number range is exceeded, the "FULL" message will be displayed. However, the value is available for transmission via interface.


If the value to be displayed falls below -19999, the negative arithmetic sign will not be indicated permanently. Indication of the highest-value figure will alternate cyclically with the arithmetic sign.

Keyboard


The AP04S has the ,  - and  keys, which serve for device parameter adjustment.

 - Key

By pressing the  key, the incremental measurement function is switched on or off. During this action, the incremental measurement symbol  is shown or hidden on the display. For this purpose, the incremental measurement function must be enabled.


During configuration, the current value can be changed by means of the  key.

 - Key


If the  key is pressed for more than 5 s, then the current position value is zeroed after releasing the key. For doing this, zeroing must be enabled.

Position value = 0 + calibration value + offset value.

"rESEt" blinks in the lower line of the display during the 5 s delay period. After expiry of the delay period and as long as the button is still being pressed, "rESEt" will be displayed permanently until the button is released.

During configuration the  key serves for acknowledging the current value and switching over to the next parameter.

 - Key

By pressing the  key, the set bus address ("1" in the example) and baud rate (250 kbit/s) will be displayed.





E. g.:

| | |
|----|-----|
| Id | 1 |
| | 250 |

When actived during more than 15 s, AP04S will switch to configuration mode.

Display will then show the first configuration menu point.

Battery buffering

The battery makes possible the detection of currentless displacement. Battery life is approx. 5 to 8 years depending on the duration of battery operation (including storage) and frequency of currentless adjustments. Battery voltage is checked at intervals of approx. 5 min. If battery voltage drops below a specified value, the battery symbol  will blink on the display. The battery is nearly empty. If the battery voltage continues to drop,  will be displayed permanently. The battery should be replaced as soon as the battery symbol appears on the display. The battery can be replaced by the SIKO distribution partners or at the SIKO main factory. For battery replacement it is mandatory to follow the instructions of the ***Installation Instruction***.

3. Start-up

Prior to starting up the display the following work should be performed:

- Correct assembly (see AP04S installation instruction)
- Correct mounting and connection of hollow shaft sensor (see sensor installation instruction)
- Correct connection of the supply and bus lines (see AP04S installation instruction)
- Setting of the Node ID (must be present in the system only once)
- Setting of the CAN baud rate valid for the system
- Setting of additional configuration parameters if necessary

Switching on the supply voltage

The AP04S will be initialized after switching on the supply voltage.

During initialization, a display and LED test is carried out and the configuration parameters are loaded from the non-volatile memory to the main memory 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. The AP04S functions with the data last parameterized.

After completing the initialization procedure, the AP04S with CAN interface sends a specific NMT command, the **Boot-Up Message**, which informs the system about the availability of the display. The AP04S 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).



If no boot-up message can be sent because the baud rate was set wrongly, the AP04S will be reinitialized completely (warm start) and will try again to send the message. This becomes visible by a repeated display test. If no bus is connected, the AP04S will also try permanently to send the boot-up message but will only be reinitialized after a defined number of failed attempts.

Display

In the first line, the current position value is always shown.

The second line indicates the operational mode (see also section "Network Management Services (NMT)". In (NMT)". In the operational mode the valid target value is displayed. If no valid target value has been received, the display will indicate "- - - -" (see section "

Transmission of process data"). The display of the target value can be deactivated via object 5F0B.

Configuration

Parameter list

For a detailed description of the parameters refer to section "Detailed description of objects".


| Parameter | Value range | Default | Meaning / Note | Object |
|------------|-------------------------------|---------|---|-----------------|
| Id | 1 ... 127 | 1 | bus address | 5F0Ah |
| baud | 125, 250, 500, 1000 | 250 | baud rate in kbit/s | - |
| OFFSt | -9999 ... +9999 | 0 | offset value | 2001h |
| F0SEt | 0, 1 | 1 | zeroing enable | 2003h |
| FCEt | 0, 1 | 1 | incremental measurement enable | 2004h |
| ExHbtimer | 0 ... 65535 | 300 | expected heartbeat cycle time | 5F09h |
| Hidetarget | 0, 1 | 0 | hiding of target value | 5F0Bh |
| InPOS | -9999 ... +9999 | 5 | deviation window from target to actual value | 5F10h |
| dEZ | 0, 0.0, 0.00, 0.000, 0.0000 | 0 | display of decimals | 5F11h |
| dISPL | 0, 180 | 0 | display orientation | 5F12h |
| GrEEEn | 0 (OFF), 1 (ON) | 1 | green LED is lighted when target window reached | 5F12h |
| rEd | 0 (OFF), 1 (ON) | 1 | red LED is lighted when position outside the target window | 5F12h |
| FLASh | 0 (OFF), 1 (ON) | 0 | LED blinks when switched on | 5F12h |
| dIV | 1, 10, 100, 1000 | 1 | display divisor | 5F13h |
| Loop | -9999 ... +9999 | 0 | loop reversal point (in display unit) | 5F14h |
| LPdIr | dIr, POS, nEG | dIr | positioning direction for loop | 5F15h |
| ExHbSource | 0, 1 | 1 | trigger source of ext. heartbeat | 5F18h |
| LPHYS | 0 ... 99999 | 0 | hysteresis for detection of reversal of sense of rotation | 5F1Ah |
| dIr | POS, nEG | POS | counting direction (ascending values with sensor movement towards the sensor cable) | 6000h |
| APU | 0 ... 59999 | 720 | indication per revolution | 6001h |
| CAL | -9999 ... +9999 | 0 | calibration value | 6003h |
| CodE | 0 ... 99999 00100 11100 | 0 | for SIKO-internal test purposes / diagnosis trimming travel load factory settings | - - 1011h |





Configuration via keyboard

In the configuration mode, Id and baud rate can be set via keyboard. The functions of the "Code" parameter can be called up as well. All other parameters are configured via interface.

On the 1st line of the display, the parameter will be shown and on the 2nd line the respective value will be displayed.

Using the  key, the current value (e. g. "baud" "250" -> "500") can be changed, in case of multi-digit numbers ("Code") at the blinking position.

The  key serves for switching to the next digit in case of multi-digit numbers.

By pressing the  key, the set value is acknowledged and saved non-volatily. If no key is pressed, the configuration mode will be exited after approx. 30 s without saving the latest value displayed, i. e. the original value will be maintained.

Configuration via CAN interface

Except for the baud rate all parameters can be configured via the CAN interface. For a detailed description of all parameter objects refer to section "6 Directory of objects".

Sending the position value

Before the display can send its position value, the AP04S must be switched to the **Operational Mode** via the **Node Start** NMT command.

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 1h | 0h ... 1Fh (0 ... 31) |

If the Node ID of the display is indicated as the node number, then only this display will start. If the value 0 is transmitted for the node number, then all devices connected to the bus will start.

Now the display can transmit its position value as specified via PDO1 or PDO2, respectively.

Synchronous transmission

The device supports this type of transmission with its factory setting.

If the AP04S receives a SYNC telegram in the operational mode, the display will respond with the position value plus the status byte. For a more detailed description of transmission refer to section "Transmission of process data".

To make possible synchronous transmission of the position value, the PDO2 must be enabled (bit31 of the COB ID PDO2 to 0 = default). Furthermore, a value between 1 and 240 (= F0h) must be written in object 1801h, sub-index 2 (1 = default).

Another possibility of transmitting the PDO2 consists in the response to a RTR. To this purpose, the value 253 (= FDh) must be written to object 1801h, sub-index 2.



Asynchronous (cyclic) transmission

PDO1 is responsible for this type of transmission. The position value (plus status byte) is cyclically sent in accordance with the time parameterized in object 1800h, sub-index 5.

Stopping Transmission of the Position Value

General:

To stop data transmission from the display, the display can be switched back to the **Stopped Mode** or to the **Pre-Operational Mode**:

Stop Mode command

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 2h | 0h ... 1Fh (0 ... 31) |

Pre-Operational Mode command

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 80h | 0h ... 1Fh (0 ... 31) |

All devices connected to the bus are addressed via node address 0.

Synchronous transmission:

Naturally, there is no synchronous transmission if no SYNC telegram is received or no RTR is obtained.

Asynchronous transmission:

Asynchronous, i. e. timer-controlled transmission is suppressed if the timer value is set to 0 (see object 1800h).

4. General information on the CAN bus

Originally, the CAN bus (CAN: Controller Area Network) was developed by Bosch and Intel for fast and low-cost data transmission in the car industry. Today it is also used in industrial automation. The CAN bus is a field bus, which enables communication of devices, actuators and sensors of different manufacturers. The standards are defined by the Association CAN in Automation (CiA).

CAN bus features

- Bus medium is a shielded twisted pair cable.
- The CAN bus is a multi-master bus, i. e. several CAN stations can request the bus at the same time. The message with the highest priority (determined by the identifier) prevails.
- Data rate up to 1bit/s permissible (with 40 m network range).
- Closed network on both sides.



- Theoretically, up to 127 stations possible on one bus; however, practically only up to 32 stations due to the driver.
- Message-oriented communication: The message is marked with a message identification (identifier). By means of the identifier, all bus stations check whether the message is relevant for each of them.
- All bus station receive each message at the same time. Therefore, synchronization is possible.
- The identifier determines the priority of the message. The lower the value of the identifier, the higher is the priority of the message. This enables fast transmission of important messages via the bus.
- High transmission safety thanks to various error identification mechanisms, which complement each other.
- Localization of faulty or disabled bus stations. The CAN protocol includes function monitoring of bus stations. The functionality of the latter will be limited or disconnected from the network if they are faulty.

CANopen

The CANopen profile was developed on the basis of the layer 7 specification CAL (CAN Application Layer) under the direction of the Steinbeis Transferzentrum für Automatisierung (Transfer centre for automation). Compared to CAL, only the functions appropriate for this use are included in CANopen. Thus, CANopen is a subset of CAL optimized for the application and enables a simplified system design as well as the use of simplified devices. CANopen has been optimized for fast data exchange in real-time systems.

The organization CAN in Automation (CiA) is responsible for the applicable standards of the respective profiles.

The position indicator AP04S with CANopen interface fulfils the conditions specified in the "CANopen Application Layer and Communication Profile" (CiA Draft Standard 301, version 4.02) and in the "CANopen Device profile for encoders" (CiA Draft Standard 406, version 3.1) (CAN 2.0A).

CANopen enables:

- easy access to all device and communication parameters,
- synchronisation of several devices,
- automatic configuration of networks
- cyclic and event-triggered data traffic

CANopen consists of four communication objects (COB) with different features:

- Process Data Objects (PDOs) for real-time data.
- Service Data Objects (SDOs) for parameter and program transfer,
- Network Management (NMT),
- Predefined objects (for synchronization, emergency message)

The description of the device functionality via an object directory is the central element of the CANopen standard. The object directory is subdivided into an area containing general information on the device (device identification, manufacturer's name, etc.) and communication parameters, and an area describing the specific device functionality.

An entry ("object") of the object directory is identified via a 16bit index and an 8b bit sub-index. By means of these entries, the "application objects" of a device (e. g. position value with encoders) are made accessible in a standardized form via the network.

The functionality and features of a CANopen device can be described in the ASCII format as a standardized "Electronic Data Sheet" (**EDS**).

The EDS file (CANopen configuration file) of the AP04S can be downloaded from the homepage of SIKO GmbH (www.siko-global.com/p/ap04s).

The encoder device profile (CiA Draft Standard 406)

This profile describes a manufacturer-independent and binding specification of the interface for rotary encoders. The profile defines which CANopen functions are used and how they are to be used. This standard enables the creation of an open and manufacturer-independent bus system.

The device profile is divided into two object classes:

- Standard class C1 describes all basic functions, which the encoder must contain,
- The extended class C2 contains a wide range of additional functions that must either be supported by these encoders (mandatory) or are optional. Thus, devices of the C2 class contain all the C1 and C2 mandatory functions as well as – manufacturer-dependent – additional, optional functions.

Additionally, an addressing range is defined in the profile for assignment of special proprietary functions.

The AP04S supports class C2.

5. Data transfer according to the CANopen communication model

The communication model underlying CANopen provides two types of communication mechanisms:

- Unconfirmed transfer of data having a length of max. 8 bytes (**Process Data Objects, PDOs**). These data is transferred with high priority (low COB identifier). PDOs are broadcast messages and provide their data to all addressees on the bus at the same time.
- Confirmed transfer also of longer data sets (parameters) between two stations with direct access to the entries of the addressee's object directory (**Service Data Objects, SDOs**). As a rule, these parameters are transferred acyclically (e. g. only once when the system is started) and have, therefore, low priority (= high COB identifier).



The priority of the message objects is determined via the COB identifier.

CANopen message structure



For easier management of the identifiers, CANopen uses the "Pre-Defined Connection Set". Here, all identifiers are defined in the object directory with standard values. However, the customer has the possibility of changing these identifiers via SDO access to meet his requirements. However, only 11 bit identifiers are supported (CAN 2.0A).

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 |

Hint: Thus, a maximum of 127 different node numbers can be set (node number 0 is illegal!).

Hint: Only a maximum of 31 bus stations is permitted!



The function code informs about the type of message and its priority. The higher the value of the identifier, the lower the priority.


Function code

The following function codes have been defined in the "Pre-defined Connection Set" (only the function codes used by the AP04S are represented):

| Object | Function code | Resulting COB ID | assigned communication parameter for index |
|------------------------|---------------|-----------------------|--|
| NMT | 0000b | 0 | - |
| SYNC | 0001b | 128 (80h) | 1005h |
| EMERGENCY | 0001b | 128 (80h) + Node-ID | 1014h |
| PDO1 (tx) ¹ | 0011b | 384 (180h) + Node-ID | 1800h |
| PDO1 (rx) ¹ | 0100b | 512 (200h) + Node-ID | 1400h |
| PDO2 (tx) ¹ | 0101b | 640 (280h) + Node-ID | 1801h |
| PDO2 (rx) ¹ | 0110b | 768 (300h) + Node-ID | 1401h |
| SDO (tx) ¹ | 1011b | 1408 (580h) + Node-ID | 1200h |
| SDO (rx) ¹ | 1100b | 1536 (600h) + Node-ID | 1200h |
| HEARTBEAT | 1110b | 1792 (700h) + Node-ID | 1017h |

¹ (tx) and (rx) seen from the position indicator

Node number (node ID)

The 7bit node number is set on the AP04S via configuration and displayed upon pressing the  key during operation.



Node number 0 is reserved and must not be changed by any node. Therefore, resulting node numbers are in the range of 1 ... 127. Any freshly set node number is only taken over after the next reset/power-on of the encoder.

Ex works, the position indicator is delivered with node number 1.



Transmission of process data

The four PDO services, PDO1 (tx), PDO1 (rx), PDO2 (tx) and PDO2 (rx), are available.

From the AP04S to the bus master (position value + status byte)

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 response to a SYNC telegram
- as a response to a RTR telegram

Both PDOs provide the current position as well as a status byte of the display and are determined via objects 1800h, 1801h, 1A00h, 1A01h, 2800h, 2801h and 6200h.

With the AP04S, TPDO1 is assigned to asynchronous and TPDO2 to synchronous process data transfer. As a standard, TPDO2 is enabled after each power-on of the encoder and must be disabled on request via SDO.

Request of the position value via RTR telegram is also only possible via TPDO2.

The TPDO message has the following structure:

| COB ID | Process data in binary code | | | | |
|------------------------|---|--------|--------|--------|---|
| 11bits | Byte 0 (LSB) | Byte 1 | Byte 2 | Byte 3 | Byte 4 (MSB) |
| TPDO1: 180h+Node-ID | Position value in two's complement representation see object 6004h | | | | Status byte see object 5F19h |
| TPDO2: 280h+Node-ID | | | | | |

Synchronous data transfer (factory setting)

The AP04S is delivered with this type of transmission preset and the AP04S responds to a SYNC telegram received by sending the TPDO message.

In the special version 01 the object 5F09h (ext. heartbeat timer) is additionally active. This means that with factory setting the AP04S expects a SYNC telegram at an interval of max. 300 ms. Otherwise the operational mode will be exited.

The validity of the transmitted target value is acknowledged with the additional control byte. The data received is interpreted as a valid target value only if the control byte has a value > 0.

To be able to send process data synchronously, a value between 1 and 240 (= F0h) must be written in object 1801h, sub-index 2.

In synchronous operation, the PDO2 is requested by a master via the SYNC telegram (SYNC-COB ID = 80h).

If the PDO2 is to be requested via an RTR telegram, then the value 253 (= FDh) must be written in object 1801h, sub-index 2.

Asynchronous data transfer

If a PDO is to be sent cyclically, then the cycle time must be entered into object 1800h, sub-index 5, in milliseconds. The PDO1 will not be sent if the value 0ms is written. The function is disabled. The minimum value to be set is 1 (= 1 ms).

From bus master to AP04S (target value)

By means of PDO transmission from the bus master to the AP04S (RPDO), the target value can be transferred to the display. The following PDOs are accepted.

| COB ID | Process data in binary code | | | |
|------------------------|---|--------|--------|--------------|
| 11Bit | Byte 0 (LSB) | Byte 1 | Byte 2 | Byte 3 (MSB) |
| RPDO1: 200h+Node-ID | Target value in 2-complement representation | | | |
| RPDO2: 300h+Node-ID | | | | |

Transfer of the SDO data (parameterization)

The object directory of the position indicator can be accessed via an SDO message. All device parameters are stored in this object directory under standardized addresses (indexes) and can be written to and read by means of SDOs. SDOs are exclusively exchanged in the expedited request/response process between two subscribers.

Two SDO services are available:



- SDO (tx) (AP04S → Master): **580h** + Node-ID
- SDO (rx) (Master → AP04S): **600h** + Node-ID

The SDO identifiers cannot be changed!

SDO messages are set up as follows:

| COB ID | Command | Index | | Sub-index | Service data (parameters) | | | |
|---------------|-----------------------|--------------|--------------|-----------|---------------------------|--------|--------|--------------|
| SDO + Node-ID | Byte 0 (read / write) | Byte 1 (LSB) | Byte 2 (MSB) | Byte 3 | Byte 4 (LSB) | Byte 5 | Byte 6 | Byte 7 (MSB) |

For the meaning of index, sub-index and data please refer to *chapter*, "6 Directory of objects".

The command byte specifies the length of the service data (parameters). In the case of the AP04S the following command bytes are valid:

| Command byte | Type | Function |
|--------------|--|--|
| 23h | SDO (rx), Initiate Download Request, expedited | Send parameter to AP04S (data length = 4bytes) |
| 2Bh | SDO (rx), Initiate Download Request, expedited | Send parameter to AP04S (2Bytes from 4 Datenbytes valid) |
| 2Fh | SDO (rx), Initiate Download Request, expedited | Send parameter to AP04S (1Bytes from 4 Datenbytes valid) |

| Command byte | Type | Function |
|--------------|--|---|
| 60h | SDO (tx), Initiate Download Response | Acknowledgement of data acquisition to master |
| 40h | SDO (rx), Initiate Upload Request | Request parameter from AP04S |
| 42h | SDO (tx), Initiate Upload Response, expedited, unspecified number of bytes | Parameter to master (data length = 4bytes) |
| 80h | SDO (tx), Abort Domain Transfer | AP04S reports error code to master |



- An error message (command 80h) replaces the normal response in case of a fault.
- The error message includes communication protocol errors as well as object directory access errors (e. g. write attempt on read-only object, wrong index, etc.).

The error codes are described in the CANopen profile (DS 301) or in the encoder profile (DSP 406), respectively. The table below shows the error codes used in the AP04S:

| 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. |
| 06070010h | Wrong data type, incorrect data length. |
| 06090011h | Sub-index does not exist. |
| 06090030h | Wrong value range of selected parameter. |
| 06090036h | Maximum value smaller than minimum value. |
| 08000020h | Parameters cannot be transferred to application or stored. |
| 08000022h | Parameters cannot be transferred to application or stored due to the current device status. |

SDO examples:

Request of value by a master with a slave → Operating Status (object 6500h):

| COB ID | Command | Index L | Index H | Sub-index | Data 0 | Data 1 | Data 2 | Data 3 |
|----------------|---------|---------|---------|-----------|--------|--------|--------|--------|
| 600h + Node-ID | 40h | 00h | 65h | 00h | x | x | x | x |

Response to the request by the slave:

| COB ID | Command | Index L | Index H | Sub-index | Data 0 | Data 1 | Data 2 | Data 3 |
|----------------|---------|---------|---------|-----------|--------|--------|--------|--------|
| 580h + Node-ID | 42h | 00h | 65h | 00h | a | b | c | d |

Writing a value from master to a slave → object 1800, sub-index 5 (Event Timer):

| COB ID | Command | Index L | Index H | Sub-index | Data 0 | Data 1 | Data 2 | Data 3 |
|----------------|---------|---------|---------|-----------|--------|--------|--------|--------|
| 600h + Node-ID | 23h | 00h | 18h | 05h | E8h | 03h | 00h | 00h |

Response from slave to writing the value:

| COB ID | Command | Index L | Index H | Sub-index | Data 0 | Data 1 | Data 2 | Data 3 |
|----------------|---------|---------|---------|-----------|--------|--------|--------|--------|
| 600h + Node-ID | 60h | 00h | 18h | 05h | 00h | 00h | 00h | 00h |

Emergency Service

Internal device errors or bus problems trigger an emergency message. The corresponding telegram is set up as follows:

| COB ID | Byte 0 | Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
|---------------|------------|--------|----------------|-----------------------|--------|-------------------------|--------|--------|
| 80h + Node-ID | Error Code | | Error Register | Alarms (object 6503h) | | Warnings (object 6505h) | | 00h |



If value "11h" is in the error register, the meaning of bytes 3 – 6 in the emergency telegram will be changed. The value "11h" indicates errors that have occurred during transfer of data on the CAN bus (see description "Error codes"). The encoder has changed to the "Error Passive" state.

With diminished interference on the CAN bus the encoder returns automatically to the normal state designated "Error active". Otherwise, if interference continues to increase, the encoder will change to the "bus off" state with subsequent restart characterized by a "boot-up message" and an additional "emergency message" (byte3 and byte4 = 0).

Emergency message in the case of bus errors:

| COB ID | Byte 0 | Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
|---------------|------------|--------|----------------|------------------------|-----------------------|--------|--------|--------|
| 80h + Node-ID | Error Code | | Error Register | Transmit Error Counter | Receive Error Counter | 00h | 00h | 00h |

As with the SDO error messages, pre-defined error messages are assigned to the EMERGENCY object as well. A subset of these error codes described in the CAN Application Layer DS301 is used by the AP04S. They are described in the table below:

Byte 0 ... Byte 1: Error Code

| Error Codes | Description |
|-------------|--------------------------------------|
| 0000h | No error |
| 8120h | Encoder is in the Error Passive Mode |
| 8140h | Recovered from Bus Off |

Byte 2: Error Register

| Bit Nr. | Description |
|---------|---|
| 0 | Set bit indicates general error condition; bit is set with every error occurring |
| 4 | Communication error; is set when a CANbus communication error occurs (acknowledgement, form, CRC and stuff error) |
| 8 | Manufacturer-specific instrumental error (battery dead, sensor error) |

Byte 3 ... Byte 4: Alarms

| Bit Nr. | Description |
|---------|---|
| 0 | Position value invalid if bit set (= 1) |
| 14 | Battery warning (critical charge condition) |
| 15 | Battery alarm (battery dead) |

Byte 5 ... Byte 6: Warnings

| Bit Nr. | Description |
|---------|-------------------------|
| 4 | Battery status critical |

Byte 7: not used

Network Management Services (NMT)

The network management can be subdivided into two groups:

- NMT service for device control; serves for initializing, starting and stopping of the encoder,
- NMT service connection monitoring ("heartbeat").

Description of the NMT commands

The commands are transferred as unconfirmed objects (broadcast messages) and are set up as follows:

| COB ID | Byte 1 | Byte 2 |
|--------|--------------|-----------------------|
| 0h | Command byte | Node number (node ID) |

The COB ID for NMT commands is always zero (highest priority). The node ID is transferred in byte 2 of the NMT command.

The node number corresponds with the node ID of the desired station. With node number = 0, all bus stations are addressed.

Command byte

| Command byte | Description | State transition (see State diagram, fig. 1) |
|--------------|--|--|
| 01h | Start_Remote_Node; change from state "Pre-Operational" or "Stopped" to "Operational" | 1 |
| 02h | Stop_Remote_Node; change to state "Stopped" | 2 |
| 80h | Enter_PRE-OPERATIONAL_State; change to state "Pre-Operational" | 3 |
| 81h | Re-initialization of CAN connection | 4 |
| 82h | Reset AP04S (warm start) | 5 |

NMT status

After initializing, the encoder is in the "Pre-Operational" state. SDO parameters can be read and written in this state. To request PDOs, the encoder must first be switched to the "Operational" state.

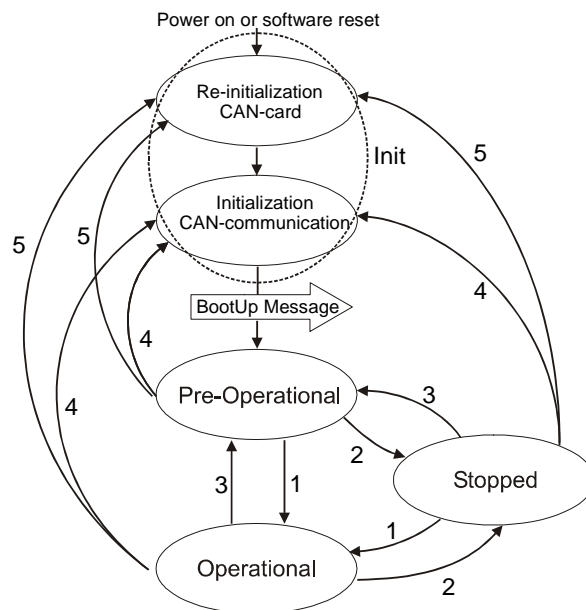


Fig. 1: CAN status diagram

The individual NMT states

Init:

After initialization, the encoder logs in at the CAN bus with a boot-up message. Afterwards, the encoder changes automatically to the "Pre-operational" state.

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

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



Pre-Operational Mode:

SDOs can be read and written in the Pre-Operational Mode.

Operational Mode:

In the operational mode, the encoder sends the PDOs requested. Additionally, SDOs can be read and written.

Stopped Mode:

Only NMT communication is possible in the Stopped Mode. No SDO parameters can be read or written.

State change

The following applies to all commands listed below: If node number 0h is sent, the command will apply to all nodes connected.

Start Remote Node (1)

With the "Start_Remote_Node" command, the encoder is set to the "Operational Mode" state.

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 1h | 0h ... 1Fh (0 ... 31) |

Stop Remote Node (2)

With the "Stop_Remote_Node" command, the encoder is set to the "Stopped" state.

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 2h | 0h ... 1Fh (0 ... 31) |

Enter_PRE-OPERATIONAL-Mode (3)

Change to the "Pre-Operational" state.

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 80h | 0h ... 1Fh (0 ... 31) |

Re-initialization of CAN parameters (4)

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 81h | 0h ... 1Fh (0 ... 31) |

Re-initialization of the CAN card (5)

| COB ID | Command byte | Node number |
|--------|--------------|-----------------------|
| 0h | 82h | 0h ... 1Fh (0 ... 31) |

Heartbeat

Two optional monitoring mechanisms are intended for ensuring proper functioning of the CANopen network nodes: Each network node can be monitored by a higher-order master via the so-called "Node Guard" or, alternatively, announce its ability to communicate by cyclic sending of a so-called „heartbeat“ message.

The "heartbeat" method is intended for the AP04S.

One or several network subscribers can receive this message and, thus, monitor the assigned subscriber.

In object 1017h, "Producer Heartbeat Time", the time of the heartbeat interval can be deposited. The value 0 disables heartbeat.

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 states:

- 0: Boot-Up
- 4: Stopped
- 5: Operational
- 127: Pre-Operational

6. Directory of objects

In the object directory of a CANopen device, all features and parameters of this device are deposited.



Specific parameters of the objects directory are deposited in a power-failure-safe memory of the encoder and are copied into the main memory during power-on or re-initialization.

Access to the directory of objects is via the SDO services described in section "Transfer of the SDO data (parameterization)".

The object directory is subdivided into three separate areas:

- standard objects applicable to all CANopen instruments, 1h ... 1FFFh, (CiA DS 301)
- manufacturer-specific objects, 2000h ... 5FFFh
- device-specific objects, 6000h ... BFFFh, (CiA DS 406)

The address (index) pointing to each entry in the object directory is also standardized in the profiles except for the manufacturer-specific area. This fact ensures that all instruments always provide the functions described in the profile (standard and optional functions) under the same index. This is a precondition of an open system and of exchangeability of the instruments.

The entries of the object directory are addressed by a 16-bit index. Each index can be further subdivided by a sub-index.

Overview of objects

| Index | Name | Description | see page |
|-------|---------------------------------------|--|----------|
| 1000h | Device Type | indicates the device profile and the encoder type | 24 |
| 1001h | Error Register | indicates error states of the encoder | 25 |
| 1002h | Manufacturer Status Register | indicates the contents of the CAN bus-specific "TransmitErrorCounter" or "ReceiveErrorCounter", respectively | 25 |
| 1003h | Pre-Defined Error Field | the object stores the 8 error states that have occurred last | 25 |
| 1005h | COB ID SYNC message | setting of the COB ID of the SYNC object | 26 |
| 1008h | Manufacturer Device Name | short designation of the device type | 26 |
| 1009h | Manufacturer Hardware Version | hardware version of the encoder | 27 |
| 100Ah | Manufacturer Software Version | software version of the encoder | 27 |
| 1010h | Store Parameters | the object indicates non-volatile storage of parameters by the encoder with no user input | 27 |
| 1011h | Restore Parameters | this object allows loading of default values (factory setting) | 29 |
| 1014h | COB ID Emergency Object | COB ID of the Emergency object | 29 |
| 1017h | Producer Heartbeat Time | setting of the cycle time of the heartbeat timer | 30 |
| 1018h | Identity Objekt | contains the manufacturer number and device variant assigned by CiA | 30 |
| 1200h | Server SDO Parameter | SDO parameter | 31 |
| 1400h | Receive PDO1 Communication Parameter | receive PDO for asynchronous operating mode | 31 |
| 1401h | Receive PDO2 Communication Parameter | receive PDO for synchronous operating mode | 32 |
| 1600h | Receive PDO1 Mapping Parameter | | 32 |
| 1601h | Receive PDO2 Mapping Parameter | | 33 |
| 1800h | Transmit PDO1 Communication Parameter | transmit PDO for the asynchronous operation mode (timer-controlled) | 34 |
| 1801h | Transmit PDO2 Communication Parameter | transmit PDO for the synchronous operation mode, including output of the position value via RTR | 35 |
| 1A00h | Transmit PDO1 Mapping Parameter | | 35 |
| 1A01h | Transmit PDO2 Mapping Parameter | | 36 |

| Index | Name | Description | see page |
|-------|--|---|----------|
| 2001h | Manufacturer Offset | manufacturer-specific offset value (is added to the position value encoder-internally) | 36 |
| 2002h | Zero encoder | set position value to value 0 (position value = 0 + Manufacturer offset + pre-set value) | 37 |
| 2003h | Enable for zeroing | indicates whether zeroing via key actuation is enabled | 37 |
| 2004h | Enable for incremental measurement | indicates whether setting the position value as an incremental measurement via key actuation is enabled | 38 |
| 5F09h | External heartbeat timer | expected heartbeat cycle time | 38 |
| 5F0Ah | Node-ID | Node ID, ! Change only active after re-initialization | 38 |
| 5F0Ch | Control byte | Controls the validity of the target value and the LEDs | 39 |
| 5F10h | Target window | max. deviation from target value, if actual value within the window: target value achieved | 39 |
| 5F11h | Decimal places | number of decimal places | 39 |
| 5F12h | Display orientation and LED | 0° or 180° function of the LEDs | 40 |
| 5F13h | Display divisor | | 40 |
| 5F14h | Loop width | width of the loop | 41 |
| 5F15h | Loop direction | direction from which travel to target value must be started | 41 |
| 5F16h | Read target value | read current target value; read access; write access only via PDO | 42 |
| 5F18h | Trigger source of ext. heartbeat | signal which triggers external heartbeat | 42 |
| 5F19h | Device status | is attached to position value in PDO | 43 |
| 5F1Ah | Hysteresis reversal of sense of rotation | Parameter for loop positioning | 43 |
| 6000h | Operating Parameters | Setting the counting direction and scaling function | 44 |
| 6001h | Measuring units per Revolution | parameterization of the resolution in steps / revolution of the encoder | 44 |
| 6002h | Total measuring range in measuring units | parameterization of the total measuring range of the encoder | 45 |
| 6003h | Preset Value | parameterization of a pre-set (calibration) value | 45 |
| 6004h | Position Value | position value (offset with pre-set and manufacturer offset value) | 45 |
| 6200h | Cycle Timer PDO1 | value in ms, identical with object 1800h, sub-index 5 | 46 |
| 6500h | Operating Status | indicates the counting direction and scaling function currently set | 46 |

| Index | Name | Description | see page |
|-------|---------------------------------------|---|----------|
| 6501h | Resolution | indicates the maximum resolution in increments | 47 |
| 6502h | Number of distinguishable Revolutions | indicates the maximum possible number of revolutions (1 revolution for linear systems) | 47 |
| 6503h | Alarms | indication of error states | 47 |
| 6504h | Supported Alarms | indicates which alarm messages are supported | 48 |
| 6505h | Warnings | indication of warnings | 48 |
| 6506h | Supported Warnings | indicates which warnings are supported | 48 |
| 6507h | Profile and Software Version | indicates the version number of the device profile used and the version number of the encoder's firmware | 49 |
| 6508h | Operating Time | outputs the value FFFFFFFFh (function is not supported) | 49 |
| 6509h | Offset Value | corresponds with the encoder's zero point value | 49 |
| 650Ah | Module Identification | device-specific parameters (Manufacturer offset, Manufacturer min position value, Manufacturer max position value) can be represented via sub-indexes | 50 |
| 650Bh | Serial Number | outputs the value FFFFFFFFh (function is not supported) | 50 |

Detailed description of objects

Object 1000h (Device Type)

| | | | | |
|---------------------|---|--------|--------------|--------|
| Sub-index | 00h | | | |
| Description | Information on device type and device profile | | | |
| Access | ro | | | |
| Data type | UNSIGNED 32 | | | |
| EEPROM | no | | | |
| Default | 00080196h | | | |
| Data content | Device profile number | | Encoder type | |
| | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
| | 96h | 01h | 03h | 00h |

0196h (= 406): CANopen Device Profile for Encoders, Version 3.01

0003h: Single-turn angle encoder, absolute, with battery-buffered electronic revolution counter



Object 1001h (Error Register)

| | | |
|---------------------|--|---|
| Sub-index | 00h | |
| Description | Device errors occurring are indicated here | |
| Access | ro | |
| Data type | UNSIGNED 8 | |
| EEPROM | no | |
| Default | 0 | |
| 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 | Battery status or sensor error |
| | 1-3, 5, 6 | not used |

Object 1002h (Manufacturer Status Register)

| | | | | |
|---------------------|--|------------------------|--------|--------|
| Sub-index | 00h | | | |
| Description | The counts of the registers "Transmit Error Counter" and "Receive Error Counter" can be read via this object. The contents of these registers provide information on the transmit faults present at the mounting site of the encoder. | | | |
| Access | ro | | | |
| Data type | UNSIGNED 32 | | | |
| EEPROM | no | | | |
| Default | 0 | | | |
| Data content | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
| | Receive Error Counter | Transmit Error Counter | - | - |

For details on the above-mentioned counters refer to the relevant CAN bus publications.

Object 1003h (Pre-defined Error Field)

- the object stores the 8 error states that have occurred last.
- the entry under sub-index 0 indicates the number of errors saved.
- each newly error state added is stored under sub-index 1. Previous error messages "slip" in their position by one digit.
- 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, "Emergency Service".



| | |
|--------------------|---|
| Sub-index | 00h |
| Description | number of the error messages stored |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 0 |
| Value range | 0 – 8 |

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

Object 1005h (COB ID SYNC message)

| | | |
|---------------------|---|--|
| Sub-index | 00h | |
| Description | Defines the COB ID of the synchronization object (SYNC) | |
| Access | rw (writable in the "Pre-Operational" state only) | |
| Data type | UNSIGNED 32 | |
| EEPROM | yes | |
| Default | 80h | |
| Data content | Bit 31 | not defined |
| | Bit 30 | 0: encoder generates no SYNC message 1: encodes generates SYNC messages |
| | Bit 29 | 0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B) ! not supported ! |
| | Bit 28 ... 11 | 0: if bit 29 = 0 |
| | Bit 10 ... 0 | X: bits 10 – 0 of the SYNC-COB-ID |

Object 1008h (Manufacturer Device Name)

| | | | | |
|---------------------|------------------------------------|-----------|-----------|-----------|
| Sub-index | 00h | | | |
| Description | short encoder designation in ASCII | | | |
| Access | const | | | |
| Data type | Visible_String | | | |
| EEPROM | no | | | |
| Default | AP4S | | | |
| Data content | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
| | 41h ('A') | 50h ('P') | 34h ('4') | 53h ('S') |



Object 1009h (Manufacturer Hardware Version)

| | | | | |
|---------------------|---------------------------|-----------|-----------|-----------|
| Sub-index | 00h | | | |
| Description | hardware version in ASCII | | | |
| Access | const | | | |
| Data type | Visible_String | | | |
| EEPROM | no | | | |
| Default | "V100" | | | |
| Data content | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
| | 56h ('V') | 31h ('1') | 30h ('0') | 30h ('0') |

Object 100Ah (Manufacturer Software Version)

| | | | | |
|---------------------|---------------------------|-----------|-----------|-----------|
| Sub-index | 00h | | | |
| Description | software version in ASCII | | | |
| Access | const | | | |
| Data type | Visible_String | | | |
| EEPROM | no | | | |
| Default | "H101" | | | |
| Data content | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
| | 48h ('H') | 31h ('1') | 30h ('0') | 31h ('1') |

Object 1010h (Store Parameters)

This object serves only for information that the encoder automatically stores specific parameters in the EEPROM. The "Store Parameter" command is not required for parameter storage!

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | describes the number of entries present in sub-index 1 |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 1h |

| | | |
|---------------------|--|--|
| Sub-index | 01h | |
| Description | describes the behavior of the encoder, how parameters are stored in the EEPROM | |
| Access | ro | |
| Data type | UNSIGNED 32 | |
| EEPROM | no | |
| Default | 2h | |
| Data content | Bit 31-2 | 0 |
| | Bit 1 | 0: encoder does not store parameters automatically 1: encoder stores parameters automatically following write access to relevant object |
| | Bit 0 | 0: encoder does not store parameter by command 1: encoder stores parameter by command |

The following table represents the parameters, which are stored non-volatily in the EEPROM:

| Objekt | Sub-index | Description | Default value |
|--------|-----------|------------------------------------|---------------------|
| 1005h | 0h | SYNC-ID | 80h |
| 1014h | 0h | EMCY-ID | 80h + Node-ID |
| 1017h | 0h | Producer Heartbeat Time | 0h |
| 1400h | 1h | RPDO1-ID | 40000200h + Node-ID |
| 1401h | 1h | RPDO2-ID | 40000300h + Node-ID |
| 1800h | 1h | TPDO1-ID | 40000180h + Node-ID |
| 1800h | 5h | PDO1 Event Timer | 0h |
| 1801h | 1h | PDO2-ID | 80000280h + Node-ID |
| 1801h | 2h | PDO2 Transmission Type | 1h |
| 2001h | 0h | Manufacturer Offset | 0h |
| 2003h | 0h | Enable for zeroing | 1h |
| 2004h | 0h | Enable for incremental measurement | 1h |
| 5F09h | 0h | External heartbeat timer | 0h |
| 5F0Ah | 0h | Node-ID | 1h |
| 5F10h | 0h | Target window | 5h |
| 5F11h | 0h | Decimal places | 0h |
| 5F12h | 0h | Display orientation / LED | 300h |
| 5F13h | 0h | Display divisor | 0h |
| 5F14h | 0h | Loop reversal point | 0h |
| 5F15h | 0h | Loop direction | 0h |
| 5F18h | 0h | External heartbeat source | 0h |
| 5F1Bh | 0h | Free factor | 0h |
| 6000h | 0h | Operating Status | 0h |
| 6002h | 0h | Total measurement range | +/-65535999 |
| 6003h | 0h | Preset value | 0h |
| 6005h | 0h | Resolution | 0h |
| 6200h | 0h | PDO1 Event Timer | see object 1800-5 |



Object 1011h (Restore Default Parameters)

This object serves for setting the encoder to its default values. To be protected against unintended loading of the default values, the string "load" must be written in sub-index 1h:

| COB ID | Command | Index Low | Index High | Sub-index | Data 0 (LSB) | Data 1 | Data 2 | Data 3 (MSB) |
|------------------|---------|-----------|------------|-----------|--------------|-----------|-----------|--------------|
| 600h+ Node-ID | 23h | 11h | 10h | 01h | 'l' (6Ch) | 'o' (6Fh) | 'a' (61h) | 'd' (64h) |

The write access to the respective sub-indexes results in the values represented below:

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

| | | | | | |
|---------------------|---|----------|---|-------|--|
| Sub-index | 01h | | | | |
| Description | All default values are loaded (except Node-ID and baud rate) | | | | |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) | | | | |
| Data type | UNSIGNED 32 | | | | |
| EEPROM | no | | | | |
| Default | 1h | | | | |
| Data content | <table border="1"> <tbody> <tr> <td>Bit 31-1</td> <td>0</td> </tr> <tr> <td>Bit 0</td> <td>0: Encoder does not permit loading of default parameters. 1: Encoder permits loading of default parameters.</td> </tr> </tbody> </table> | Bit 31-1 | 0 | Bit 0 | 0: Encoder does not permit loading of default parameters. 1: Encoder permits loading of default parameters. |
| Bit 31-1 | 0 | | | | |
| Bit 0 | 0: Encoder does not permit loading of default parameters. 1: Encoder permits loading of default parameters. | | | | |

Object 1014h (COB ID Emergency Object)

| | | | | | | | | | | | |
|---------------------|---|--------|--|--------|----------|--------|--|---------------|------------------|--------------|-----------------------------------|
| Sub-index | 00h | | | | | | | | | | |
| Description | Defines the COB ID of the Emergency object (EMCY) | | | | | | | | | | |
| Access | rw (writable in the "Pre-Operational" state only) | | | | | | | | | | |
| Data type | UNSIGNED 32 | | | | | | | | | | |
| EEPROM | yes | | | | | | | | | | |
| Default | 80h + Node-ID | | | | | | | | | | |
| Data content | <table border="1"> <tbody> <tr> <td>Bit 31</td> <td>0: EMCY object exists / is valid 1: EMCY object does not exist / is invalid</td> </tr> <tr> <td>Bit 30</td> <td>always 0</td> </tr> <tr> <td>Bit 29</td> <td>0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B) ! not supported !</td> </tr> <tr> <td>Bit 28 ... 11</td> <td>0: if bit 29 = 0</td> </tr> <tr> <td>Bit 10 ... 0</td> <td>X: bits 10 – 0 of the EMCY-COB ID</td> </tr> </tbody> </table> | Bit 31 | 0: EMCY object exists / is valid 1: EMCY object does not exist / is invalid | Bit 30 | always 0 | Bit 29 | 0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B) ! not supported ! | Bit 28 ... 11 | 0: if bit 29 = 0 | Bit 10 ... 0 | X: bits 10 – 0 of the EMCY-COB ID |
| Bit 31 | 0: EMCY object exists / is valid 1: EMCY object does not exist / is invalid | | | | | | | | | | |
| Bit 30 | always 0 | | | | | | | | | | |
| Bit 29 | 0: 11bits identifier (CAN 2.0A) 1: 29bits identifier (CAN 2.0B) ! not supported ! | | | | | | | | | | |
| Bit 28 ... 11 | 0: if bit 29 = 0 | | | | | | | | | | |
| Bit 10 ... 0 | X: bits 10 – 0 of the EMCY-COB ID | | | | | | | | | | |



Object 1017h (Producer Heartbeat Time)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | defines the cycle time of the heartbeat monitoring service |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 16 |
| EEPROM | yes |
| Default | 0h |
| Value range | 10 ... 65535 (Ah ... FFFFh); the numerical value corresponds to a multiple of 1 ms. Value 0 disables the service. Values in the range of 1 ... 9 trigger an error message! |

Object 1018h (Identity Object)

| | |
|--------------------|-------------------|
| Sub-index | 00h |
| Description | number of entries |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | the manufacturer identification number (vendor ID) for the company SIKO GmbH allocated by the CiA (see www.can-cia.org) |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 195h |

| | | | | | | | | | |
|---------------------|---|-----------|--------|--------|--------|-----------|-----------|-----------|-----|
| Sub-index | 02h | | | | | | | | |
| Description | indicates the display version ASCII-coded | | | | | | | | |
| Access | ro | | | | | | | | |
| Data type | UNSIGNED 32 | | | | | | | | |
| EEPROM | no | | | | | | | | |
| Default | "CAN" | | | | | | | | |
| Data content | <table border="1"> <tr> <td>Byte 0</td> <td>Byte 1</td> <td>Byte 2</td> <td>Byte 3</td> </tr> <tr> <td>43h ('C')</td> <td>41h ('A')</td> <td>4Eh ('N')</td> <td>00h</td> </tr> </table> | Byte 0 | Byte 1 | Byte 2 | Byte 3 | 43h ('C') | 41h ('A') | 4Eh ('N') | 00h |
| Byte 0 | Byte 1 | Byte 2 | Byte 3 | | | | | | |
| 43h ('C') | 41h ('A') | 4Eh ('N') | 00h | | | | | | |



Object 1200h (Server SDO Parameter)

| | |
|--------------------|-----------------------------|
| Sub-index | 00h |
| Description | largest sub-index supported |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|------------------------------|
| Sub-index | 01h |
| Description | COB ID Client -> Server (rx) |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 00000600h + Node-ID |

| | |
|--------------------|------------------------------|
| Sub-index | 02h |
| Description | COB ID Server -> Client (tx) |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 00000580h + Node-ID |

Object 1400h (Receive PDO1 parameter, asynchronous operational mode)

| | |
|--------------------|-----------------------------|
| Sub-index | 00h |
| Description | largest sub-index supported |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|--|
| Sub-index | 01h |
| Description | COB ID of RPDO1 |
| Access | rw |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 40000200h + Node-ID Bit30 = 1: RTR for this PDO not released, bit is always set |



| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Transmission Type |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | FFh (255) cannot be changed, update with PDO receipt |

Object 1401h (Receive PDO2 parameter, synchronous operational mode)

| | |
|--------------------|-----------------------------|
| Sub-index | 00h |
| Description | largest sub-index supported |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|--|
| Sub-index | 01h |
| Description | COB ID of RPDO2 |
| Access | rw |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 40000300h + Node-ID Bit30 = 1: RTR for this PDO not released, bit is always set |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Transmission Type |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | FFh (255) cannot be changed, update with PDO receipt |

Object 1600h (Receive PDO1 Mapping Parameter)

| | |
|--------------------|--------------------------|
| Sub-index | 00h |
| Description | number of objects mapped |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |



| | |
|--------------------|---|
| Sub-index | 01h |
| Description | Describes the 1 st portion of the PDO1 message (data bytes 0 to 3) |
| Access | const |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 5F160020h (object 5F16h, 32bit) |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Describes the 2 nd portion of the PDO1 message (data byte 4) |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 5F0C0008h (object 5F0Ch, 8bit) |

Object 1601h (Receive PDO2 Mapping Parameter)

| | |
|--------------------|--------------------------|
| Sub-index | 00h |
| Description | number of objects mapped |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 1h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | Describes the 1 st portion of the PDO2 message (data bytes 0 to 3) |
| Access | const |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 5F160020h (object 5F16h, 32bit) |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Describes the 2 nd portion of the PDO2 message (data byte 4) |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 5F0C0008h (object 5F0Ch, 8bit) |

Object 1800h (Transmit PDO1 parameter, asynchronous operation mode)

| | |
|--------------------|-----------------------------|
| Sub-index | 00h |
| Description | largest sub-index supported |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 5h |

| | |
|--------------------|--|
| Sub-index | 01h |
| Description | COB ID of PDO1 |
| Access | rw (writable in the "Pre-Operational" state only) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 40000180h + Node-ID Bit30 = 1: RTR for this PDO not released, bit is always set |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Transmission Type |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | FEh (254) PDO has asynchronous characteristics (PDOs are sent depending on the "Event Timer"). This value cannot be changed! |

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

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

| | |
|--------------------|---|
| Sub-index | 05h |
| Description | Event Timer |
| Access | rw (writable in the "Pre-Operational" state only) |
| Data type | UNSIGNED 16 |
| EEPROM | yes |
| Value range | 0 ... 65535 (1h ... FFFFh); the numerical value corresponds to a multiple of 1 ms. The service is disabled by writing the value 0. The content of this object is identical with object 6200h. |

Object 1801h (Transmit PDO2 parameter, synchronous operation mode)

| | |
|--------------------|-----------------------------|
| Sub-index | 00h |
| Description | largest sub-index supported |
| Access | ro |
| Datentyp | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | COB ID of PDO2 |
| Access | rw (writable in the "Pre-Operational" state only) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 00000280h + Node-ID |

| | |
|--------------------|--|
| Sub-index | 02h |
| Description | Transmission Type |
| Access | rw (writable in the "Pre-Operational" state only) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 1h PDO has synchronous characteristics |
| Value range | 1h ... F0h (240) the PDO will be sent following every SYNC command FDh (253): encoder responds to RTR request |

Object 1A00h (Transmit PDO1 Mapping Parameter)

| | |
|--------------------|--------------------------|
| Sub-index | 00h |
| Description | number of objects mapped |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | Describes the 1 st portion of the PDO1 message (data bytes 0 to 3) |
| Access | const |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 60040020h (object 6004h, 32bit) position value |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Describes the 2 nd portion of the PDO1 message (data byte 4) |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 5F190008h (object 5F19h, 8bit) AP04S status |

Object 1A01h (Transmit PDO2 Mapping Parameter)

| | |
|--------------------|--------------------------|
| Sub-index | 00h |
| Description | number of objects mapped |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 2h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | Describes the 1 st portion of the PDO2 message (data bytes 0 to 3) |
| Access | const |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 60040020h (object 6004h, 32bit) position value |

| | |
|--------------------|---|
| Sub-index | 02h |
| Description | Describes the 2 nd portion of the PDO2 message (data byte 4) |
| Access | const |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 5F190008h (object 5F19h, 8bit) AP04S status |

Object 2001h (Manufacturer Offset)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The offset enables the shifting of a scaled value range. The offset value is added to the position value in the encoder. Positive as well as negative values are permitted. Position value = measured value + calibration value + offset value |
| Access | rw |
| Data type | SIGNED 32 |
| EEPROM | yes |
| Default | 0h |

| | |
|--------------------|---|
| Value range | <p>The minimum or maximum values to be entered depend on the values entered in object 650Ah, sub-index 2 or sub-index 3, respectively. The latter depend on the parameterized value of the total of measuring steps:</p> <p>lower_limit = - 1/2 total of measuring steps = -5242880, upper_limit = 1/2 total of measuring steps – 1 = 5242779 -5242880 < offset < 5242779</p> |
|--------------------|---|

Object 2002h (Zeroing of encoder value)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The object enables "zeroing" of the measured value. Position value = measured value + calibration value + offset value |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | no |
| Value range | 0 ... 1; writing the value 1 on sub-index 0 sets the position value to 0. After renewed zeroing the figure 1 will be output in case of read access. |

Example:




Measured value = 214 calibration value = 400, offset value = 0,
results in position value = 614 (see object 6004h)

| COB ID | Com- mand | Index Low | Index High | Sub- index | Data 0 (LSB) | Data 1 | Data 2 | Data 3 (MSB) |
|---------------|--------------|--------------|---------------|---------------|-----------------|--------|--------|-----------------|
| 600h+ Node-ID | 23h | 02h | 20h | 00h | 01h | 00h | 00h | 00h |




Measured value = 0
results in position value = 400

This function does not depend on zeroing enable via keyboard (object 2003h)

Object 2003h (Enable zeroing of encoder value via keyboard)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Zeroing via  key is enabled with this object. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 1 |
| Value range | 0: Zeroing via  key disabled 1: Zeroing via  key enabled |

Object 2004h (Incremental measurement enable)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Switching on incremental measurement function via  key is enabled with this object. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 1 |
| Value range | 0: Incremental measurement function via  key disabled 1: Incremental measurement function via  key enabled |

Object 5F09h (External Heartbeat Timer)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | If a value > 0 is entered here, the AP04S will expect an event to occur in this interval (see object 5F18h). If no such event occurs, the AP04S will change to the „Pre-operational“ state. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 16 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 65535 (0h ... FFFFh); the numerical value corresponds to a multiple of 1 ms. The function is disabled by writing the value 0. |

Object 5F0Ah (Node-ID)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | Node-ID of AP04S |
| Access | rw (writable in the "Preoperational" and "Operational" states) The ID set here will become valid only after re-initialization of communication or power-up. |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 0h |
| Value range | 1 ... 127 (1h ... 7Fh) |



Object 5F0Ch (control byte)

| | | |
|--------------------|--|--|
| Sub-index | 00h | |
| Description | control byte | |
| Access | wo (writable in the "Pre-Operational" and "Operational" states) write access only via PDO | |
| Data type | UNSIGNED 8 | |
| EEPROM | no | |
| Default | 0h | |
| Value range | 0 ... 48 (0h ... 30h) | |
| Coding | bit 0 | 0: target value invalid 1: target value valid |
| | bit 1 | 0: LEDs constant 1: LEDs blinking when ON |
| | bit 2 bit 3 | reserved reserved |
| | bit 4 | 0: LED green OFF 1: LED green ON independent of target window (only valid when object 5F12h bit 0 = bit 1 = 0) (will be reflected from object 5F12h to bit 4) |
| | bit 5 | 0: LED red OFF 1: LED red ON independent of target window (only valid when object 5F12h bit 0 = bit 1 = 0) (will be reflected from object 5F12h to bit 5) |
| | bit 6 bit 7 | not used not used |

Object 5F10h (Target window)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | max. valid deviation from target value, if actual value is within the window: target value achieved |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 5h |
| Value range | 0 ... 4.294.967.296 (0h ... FFFFFFFh) |

Object 5F11h (Decimal places)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Number of decimal places |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 4 (0h ... 4h) |



Object 5F12h (Display orientation and LED)

| | | | | |
|---------------------|---|--------|----------|----------------|
| Sub-index | 00h | | | |
| Description | Display orientation 0° or 180° additionally LED functionality | | | |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) | | | |
| Data type | UNSIGNED 32 | | | |
| EEPROM | Basic functions yes | | | |
| Default | 0h | | | |
| Value range | 0; 14516 (38B4h) | | | |
| Data content | Reserved for future use | | LED | Display |
| | Byte 3 | Byte 2 | Byte 1 | Byte 0 |
| | 00h | 00h | 0 ... 56 | 0 or 180 (B4h) |

| | | |
|---------------|-----------------|--|
| Coding | Byte 0: Display | 0h: 0° B4h: 180° |
| | Byte 1: LED | bit 0 = 0: LED green OFF bit 0 = 1: LED green ON when position in target window bit 1 = 0: LED red OFF bit 1 = 1: LED red ON when position outside target window bit 3 = 1: LEDs blink when ON bit 4 = 1: LED green ON independent of target window (only valid if bit 0 = bit 1 = 0) (will be reflected out of control byte bit 4) bit 5 = 1: LED red ON independent of target window (only valid if bit 0 = bit 1 = 0) (will be reflected out of control byte bit 5) Only bits 0 ... 3 are saved non-volatily bit 6 = 0: not used bit 7 = 0: not used |

Object 5F13h (Display divisor)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Display divisor (ADI) |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 1h |
| Value range | 0 ... 3 (0h ... 3h) 0: Indication of the position value: "10000" 1: Indication of the position value: "1000" 2: Indication of the position value: "100" 3: Indication of the position value: "10" |

Object 5F14h (Loop width)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Loop width; the target value will be exceeded by this value in case of loop travel. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 4.294.967.296 (0h ... FFFFFFFh) |

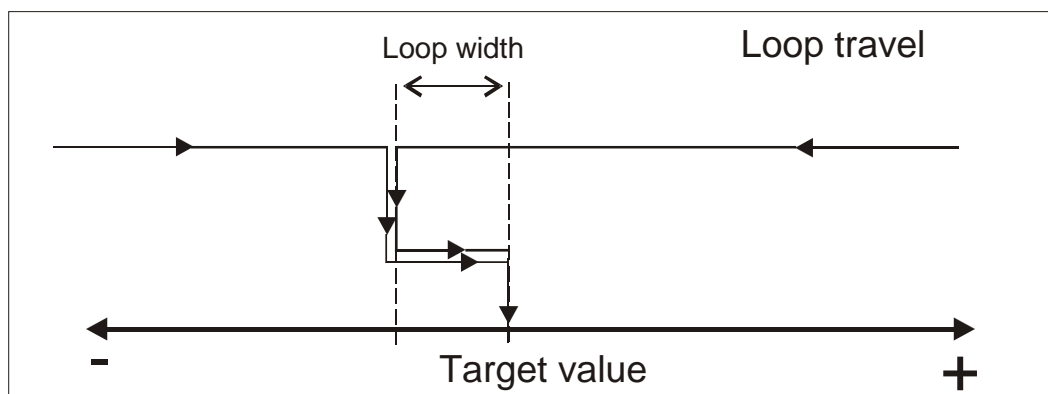
Description of loop travel, see object 5F15h loop travel.

Object 5F15h (Loop direction)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Loop direction; travelling to the target value is always in this direction. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states") |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 524944h |
| Value range | 0h ... 524944h 0h: direct (write) 2Bh: = ASCII "+" in positive counting direction 2Dh: = ASCII "-" in negative counting direction 524944h: =ASCII "DIR" direct (response to read) |

If the AP04S is operated on a spindle, then the spindle play can be compensated by means of loop positioning.

In this case, travelling to the target value is always from the same direction.



Example:

Loop width = 100 (Object 5F14h = 100)

The direction from which every target position shall be driven to is: *Negative* (Object 5F15h = "-")

Hysteresis of reversal of sense of rotation = 10

current position value = 1000

- Case 1 ➔ new target value = 1500

direct travel to target position

- Case 2 ➔ new target value = 500

The positioning aid (arrows) of AP04S requires that the target position (500) will be exceeded by the loop width (object 5F14h). Upon reaching the loop target position (400 = target position – loop width), the positioning arrows will be reversed and travel to the target position 500 is enabled. If, on the way between target loop position and target position, reversal of the sense of rotation > hysteresis (object 5F1A) is detected, a new loop travel will be initiated.

In the example:

Movement between target loop position (400) and target position (500)

Given an actual position of = 453; movement back to position 442 => hysteresis is exceeded, a new travel to target loop position (400) is requested.

Object 5F16h (Read target value)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | Read target value |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) write access only via PDO |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 0h |
| Value range | 0 ... 4.294.967.296 (0h ... FFFFFFFh) |

Any attempt at writing on this object via SDO will result in an error message (error code: 06010000h).

Object 5F18h (External Heartbeat source)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Event triggering an external heartbeat timer (object 5F09h) |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 1 0: Timer is triggered when receiving a PDO (target value) 1: Timer is triggered when receiving a sync |

Object 5F19h (AP04S status)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | The status byte informs about the current state of AP04S. |
| Access | ro (readable in the "Pre-Operational" and "Operational" PDO states only) |
| Data type | UNSIGNED 8 |
| EEPROM | yes |
| Default | 1h |
| Value range | 1h ... Eeh |

The bits of the status byte have the following meaning:

| Bit | Value = 0 | Value = 1 |
|-----|------------------------|---------------------|
| 0 | Not IN-POS | IN-POS |
| 1 | ACT. ≤ TARG | ACT. > TARG |
| 2 | Battery ok | Battery warning |
| 3 | incred. meas. = 0 | incred. meas. = set |
| 4 | ">" off | ">" on |
| 5 | "<" off | "<" on |
| 6 | battery critical or ok | flat battery |
| 7 | Sensor connected | error: no sensor |

Any attempt at writing on this object will result in an error message (error code: 06010000h).

Object 5F1Ah (Hysteresis of detection of reversal of sense of rotation)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | Hysteresis, within which detection of reversal of sense of rotation does not initiate new loop travel. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 4.294.967.296 (0h ... FFFFFFFFh) |

Explanation see Object 5F15h loop travel.

Object 6000h (Operating Parameters)

| | | | | | |
|-----------------------|--|-------------------|----------|----------|-------------------|
| Sub-index | 00h | | | | |
| Description | This object influences the encoder's sense of rotation and the scaling function. | | | | |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) | | | | |
| Data type | UNSIGNED 16 | | | | |
| EEPROM | yes | | | | |
| Default | 0h | | | | |
| Bit definition | | Bit 14 ... Bit 3: | Bit 2: | Bit 1: | Bit 0: |
| | Function | not used | Scaling | not used | Sense of rotation |
| | Bit = 0 | - | disabled | - | E (CCW) |
| | Bit = 1 | - | enabled | - | I (CW) |

Explanation of the functions:

I sense of rotation: ascending position values with clockwise (CW) encoder rotation (view at the display)

E sense of rotation: ascending position values with counter-clockwise (CCW) encoder rotation (view at the display)



Scaling disabled: The encoder works with preset readout per revolution or measuring units per revolution. Any attempt at changing the readout per revolution via object 6001h will result in an error message

Scaling enabled: The readout per revolution (object 6001h) can be parameterized.

Object 6001h, (Display per revolution, APU)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | This parameter sets the desired resolution per revolution. (max. 720 increments per revolution) |
| Access | rw (writable in the "Pre-Operational" and "Operational" states, if the "Scaling" bit [see object 6000h] is set) |
| Data type | UNSIGNED 32 |
| EEPROM | yes |
| Default | 720 |
| Value range | 1 ... FFFFFFFFh |

Example:

APU = 400, position = 0;

When the shaft is moved by one revolution, the new position will be 400



Object 6002h (Total Measuring Range [Total of measurement steps])

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | This parameter sets the total number of measuring steps. (number of countable revolutions multiplied with set APU) |
| Access | ro (readable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 5242320 |
| Value range | 7281 ... 4294967295 (FFFFFFFFh) |

Any attempt at writing on this object will result in an error message (error code: 06010002h).

Object 6003h (Preset value)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The position value of the encoder is set to this preset (calibration) value when zeroing. Position value = measured value + calibration value + offset value see object 6004h |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | SIGNED 32 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0 ... 4.294.967.296 (0h ... FFFFFFFFh) |

Object 6004h (Position value)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | This object provides the position value of the encoder offset with the scaling factors, preset and Manufacturer Offset. |
| Access | ro |
| Data type | SIGNED 32 |
| EEPROM | no |

The position value of the AP04S is calculated by using the following formula:

$$\text{Position value} = (\text{encoder value} - \text{encoder zeroing value}) * RF + \text{preset value} + \text{Manufacturer Offset}$$

Encoder value: absolute value sensed by the encoder sensor system,

Encoder zeroing value: absolute value at the time of zeroing,



RF: Calculation (scaling) factor = readout per revolution/ 720
 Preset value: see Object 6003h,
 Manufacturer Offset see Object 2001h

With the AP04S, the total measuring range is subdivided into a negative and positive value range:

-1/2 total measuring range ... 0 ... +1/2 (total measuring range – 1)

Therefore, the representation of the position value is in the 2-complement format in a signed 32 bits number.

Object 6200h (Cycle Timer)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Defines the cycle time with which the PDO1 is output. The value is fixed-linked (identical) with the value indicated under object 1800h, sub-index 5. The timer-controlled output is activated as soon as a cycle time was parameterized within the value range and the encoder switched over to the Operational Mode. |
| Access | rw (writable in the "Pre-Operational" and "Operational" states) |
| Data type | UNSIGNED 16 |
| EEPROM | yes |
| Default | 0h |
| Value range | 0: Cycle timer is disabled, 1 ... 65535: cycle time in ms |

Object 6500h (Operating Status)

| | |
|-----------------------|--|
| Sub-index | 00h |
| Description | The object indicates the settings programmed with object 6000h (counting direction, scaling enable). |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | counting direction yes; scaling enable no |
| Default | 0 |
| Bit definition | see object 6000h |



Object 6501h (SingleTurn resolution)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The object indicates the maximum possible encoder resolution. |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 720 |

Object 6502h (Number of distinguishable revolutions)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The object indicates the maximum possible number of encoder revolutions. (with linear systems: 1) |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | no |
| Default | 7281 |

Object 6503h (Alarms)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | In addition to the errors reported via the emergency messages, this object provides further, encoder-specific error messages. In the case of an error, the associated bit is set to 1. |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | no |
| Default | 0h |

Bitdefinition:

| Bit | Function | Value = 0 | Value = 1 |
|-----------|-----------------|--|---|
| 0 | position error | no error | position value invalid |
| 1 ... 11 | not used | - | - |
| 12 | battery warning | battery voltage OK | battery voltage near lowest tolerable value |
| 13 | battery error | battery OK or still in tolerable range | battery discharged |
| 14 ... 15 | not used | | |



Object 6504h (Supported Alarms)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The object indicates which alarm messages are supported. The relevant bits are set. |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | no |
| Default | 3001h |

Bit 0: position error
 Bit 12: battery warning
 Bit 13: battery alarm

Object 6505h (Warnings)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Warnings indicate that tolerances of internal encoder parameters have been exceeded. However, unlike with alarm messages, the position value can be valid in case of a warning. |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | no |
| Default | 0h |

Bit definition:

| Bit | Function | Value = 0 | Value = 1 |
|----------|-----------------|--------------------|---|
| 0 .. 3 | not used | - | - |
| 4 | battery warning | battery voltage OK | battery voltage near lowest tolerable value |
| 5 ... 15 | not used | - | - |

Object 6506h (Supported Warnings)

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | The object indicates which warnings are supported. |
| Access | ro |
| Data type | UNSIGNED 16 |
| EEPROM | no |
| Default | 0010h |

Bit 4: Battery warning is supported



Object 6507h (Profile and Software Version)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The object indicates the encoder profile used (CANopen Device profile for encoders) and the version number of the firmware state. |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | 00650301h |

Data content:

| Firmware Version | | Profile Version | |
|------------------|--------------|-----------------|--------------|
| Byte 3 (High) | Byte 2 (Low) | Byte 1 (High) | Byte 0 (Low) |
| 00h | 65h | 03h | 01h |

Object 6508h (Operating Time)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Operation time counter (not implemented in the AP04S) |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | FFFFFFFFh (shows that the function is not supported) |

Object 6509h (Encoder Zeroing Value)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | The difference between encoder value and the position value scaled and offset with preset and/or Manufacturer Offset is output via this object. |
| Access | ro |
| Data type | SIGNED 32 |
| EEPROM | yes |

$$\text{Encoder zeroing value} = \text{encoder value} - \frac{(\text{position value} - \text{preset value} - \text{manufacturer offset})}{\text{Scaling factor}}$$



Object 650Ah (Module Identification)

The Manufacturer Offset value (sub-index 1), the smallest (sub-index 2) and the largest (sub-index 3) position value can be read out via this object.

| | |
|--------------------|--|
| Sub-index | 00h |
| Description | contains the number of additional sub-indexes. |
| Access | ro |
| Data type | UNSIGNED 8 |
| EEPROM | no |
| Default | 3h |

| | |
|--------------------|---|
| Sub-index | 01h |
| Description | manufacturer-specific offset value (is added to the position value) see object 2001h |
| Access | ro |
| Data type | SIGNED 32 |
| EEPROM | yes |
| Default | 0h |

| | |
|--------------------|-------------------------------------|
| Sub-index | 02h |
| Description | minimum transferable position value |
| Access | ro |
| Data type | SIGNED 32 |
| EEPROM | no |
| Default | -5242880 |

| | |
|--------------------|-------------------------------------|
| Sub-index | 03h |
| Description | maximum transferable position value |
| Access | ro |
| Data type | SIGNED 32 |
| EEPROM | no |
| Default | 5242880 |

Object 650Bh (Serial Number)

| | |
|--------------------|---|
| Sub-index | 00h |
| Description | Provides the serial number of the encoder (not supported with the AP04S). |
| Access | ro |
| Data type | UNSIGNED 32 |
| EEPROM | no |
| Default | FFFFFFFFh (Function is not implemented) |