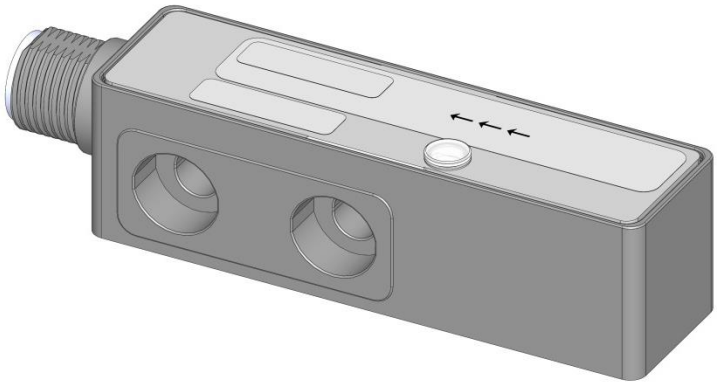
MSA501

Actuator with CANopen interface

User manual



330/18

Table of contents

1 General Information

1.1 Documentation

The following documents are associated with this product:

- Data sheet; it describes the technical data, the dimensions, the pin assignment, the accessories and the order key.
- Mounting instructions; they describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.
- User manual; for commissioning the sensor and integrating it 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 found at http://www.siko-global.com/p/msa501

1.2 Definitions

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

2 Intended use

The sensor collects the distance information of the coded MBA501 magnetic tape. By means of the CANopen protocol, the sensor can be configured and read out via the CAN interface. For instance, a superordinate control unit can read the absolute position value with a resolution of 10 µm (or 5 µm, resp.).

On the upper side of the sensor there are 3 LEDs (yellow, red, green), which indicate error or status information for diagnostic purposes.

If the sensor is lifted from the tape, an error will be detected and 0 will be output as the position value and the yellow LED will flash 1x.

2.1 Switching on the supply voltage

MSA501 initializes after being switched on. During initialization, the LEDs light up one after the other and the configuration parameters are loaded from the non-volatile memory to the random memory of the controller.

The sensor will work with its default values as long as no changes have been made to it. With parameters changed, the sensor will work with the changed data, which must be stored if they are intended to be used after power off/on.
After completing the initialization procedure, the sensor sends a specific NMT command, the boot-up message, which informs the system about the availability of the sensor. The MSA501 is now in the pre-operational mode. In this state, the sensor can be parameterized via SDO commands in accordance with the requirements of the application. This applies to the configuration parameters of the sensor unit as well as to the way it makes available to the system its position values (asynchronous or synchronous data transmission).

3 Operating elements

3.1 General Information

In its standard version, the sensor has a bus terminator, which can be energized via an SDO object (see chapter 5.6.2.25 5F09h: Bus terminator (not available with SP01 + SP03)). The SP01 +SP03 variant features an 8-pole DIP switch, which enables the adjustment of bus terminator, node ID and baud rate. The sensor has 3 LEDs with yellow, green and red colors.

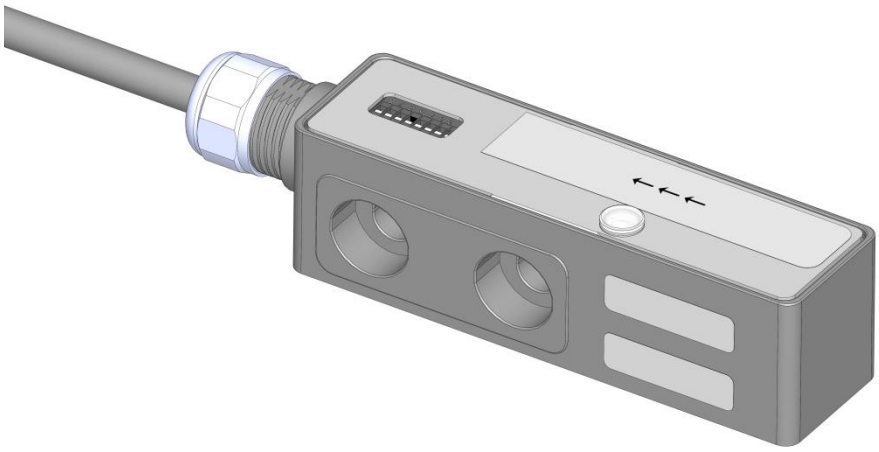


Fig. 1: Operating elements

3.2 LEDs

The device has 3 LEDs for diagnostic and status purposes,

- A yellow LED for device-specific states
- A green LED indicating the NMT status (CAN Run LED)
- A red LED for CAN error states (CAN Err LED)

Device-specific diagnosis

The yellow LED is lit while the device is operating. It starts flashing when an error occurs. The error states are differentiated by the number of LED flashes. The signal is repeated after a pause of 600 ms. If multiple error states occur simultaneously, then the individual flash signals add to form a sequence (e.g. yellow LED flashes 5x -> Sensor/tape reading distance error state + velocity check).

Error state	Number of flashes
Sensor/tape reading distance	1x
Plausibility of absolute value	2x
Velocity check (v > 5 m/s)	4x
Sensor-tape alignment	8x

Table 1: device-specific status LED

CAN diagnosis:

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

LED state	Description
On	LED is permanently on
Off	LED is permanently off
Blinking	LED flashes at a frequency of 2.5 Hz (200 ms on/off)
Single Flash	LED is 200 ms on, 1000 ms off
Double Flash	LED is 200 ms on, 200 ms off, 200 ms on, 1000 ms off

Table 2: CAN LED statuses acc. to CiA DS-303

CAN Run LED:

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

Table 3: CAN Run LED

CAN Err LED:

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

Error states	LED state
Bus off	On

Table 4: CAN Err LED

3.3 DIP switch (applies only to SP01 + SP03)

The device has an 8-pole DIP switch, which enables a bus resistor to be energized and the bus node ID and baud rate to be configured. If the DIP switches are at the position "Use from memory", then the node ID and baud rate can be changed per CAN bus via object 5F0Ah: Node-ID and baud rate Bus CAN. The switch position is scanned once during the startup process. The adoption of a node ID or baud rate bus reset later occurs only after re-initialization (see chapter 5.2.1 Network management (NMT) services).

Switch no.	1	2	3	4	5	6	7	8
Meaning	Bus baud rate			Node-ID (address)				Bus termination

Table 5: DIP switch

DIP switch			Bus baud rate
1	2	3	
0	0	0	Use baud rate from memory
0	0	1	50k kBaud
0	1	0	100 kBaud
0	1	1	125 kBaud
1	0	0	250 kBaud
1	0	1	500 kBaud
1	1	0	1M Baud
1	1	1	Use baud rate from memory

Table 6: DIP switch for bus baud rate

DIP switches				Node-ID (Address)
4	5	6	7	
0d	0d	0d	0d	Use address from memory
0d	0d	0d	1d	1d (1h)
0d	0d	1d	0d	2d (2h)
0d	0d	1d	1d	3d (3h)
0d	1d	0d	0d	4d (4h)
0d	1d	0d	1d	5d (5h)
0d	1d	1d	0d	6d (6h)
0d	1d	1d	1d	7d (7h)
1d	0d	0d	0d	8d (8h)

DIP switches				Node-ID (Address)
4	5	6	7	
1d	0d	0d	1d	9d (9h)
1d	0d	1d	0d	10d (Ah)
1d	0d	1d	1d	11d (Bh)
1d	1d	0d	0d	12d (Ch)
1d	1d	0d	1d	13d (Dh)
1d	1d	1d	0d	14d (Eh)
1d	1d	1d	1d	15d (Fh)

Tabelle 7: DIP switches Node-ID

4 Functional description

4.1 Measuring range

The numbers given below refer to an absolute resolution of 0.005 mm; divide the numerical values into half for an absolute resolution of 0.01 mm!

Representation of numerical values:

The numerical value output by the MSA501 sensor via the interface is always a multiple of the resolution set.

Example:

Value output by the sensor = 340603; set resolution = 0.005 mm

-> position value = 340603 * 0,005 mm = 1703,015 mm

With a resolution set to 0.01 mm, the above output value corresponds to a position value of 3406,030 mm.

Tape coding:

The absolute coding of MBA501 enables a maximum measuring range of 10240 mm (=2048000 * 0,005 mm).

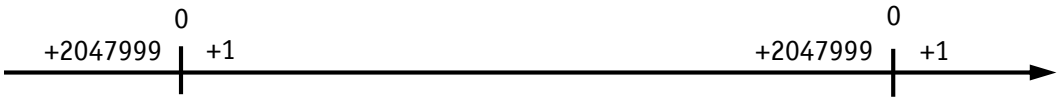


Fig. 2: Tape coding

Position value:

In order to avoid jumps around the maximum value at position 0, this maximum value is limited to 10000 mm (=2000000 * 0,005 mm). Thus, a range up to -240 mm (= -48000 * 0.005 mm) is possible in negative travel direction

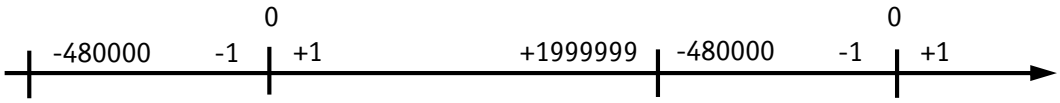


Fig. 3: Position value

Variable boundary:

In case the measurement range is to be extended in negative direction, there exists the possibility of programming a positive value as a boundary via interface,

e.g.: Boundary = 6000 mm (measurement range = -4240 mm ... +6000 mm;
-4240 mm / 0.005 mm = 848000; +6000 mm / 0.005 mm = +1200000)

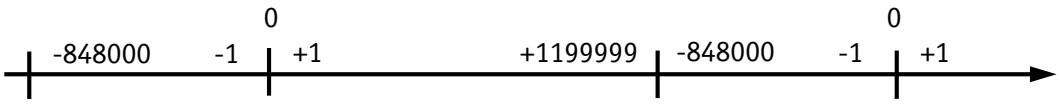


Fig. 4: Variable boundary:

Counting direction:

The sensor delivers ascending numerical values when the sensor is moved in the plug outlet direction. This feature can be changed via object 6000h: Operating Parameters (descending numerical values when the sensor is moved in the plug outlet direction).

4.2 Calibration

The MSA501 features an absolute measurement system, i.e. the information of the position value is represented in the scale (MBA501 magnetic tape) as an absolute value. Calibration can be performed at any position on the magnetic tape.

Position value = measured value + calibration value
The measured value is set to zero when calibrating.

At the actual sensor position, the value “position value = 0 + calibration value” is output from then on. With calibration, the actual position value is replaced by the set calibration value and stored non-volatilely.

Two steps are required for executing calibration:

1. Write calibration value (see *Object* 6003h: Preset value (Calibration value))
2. Execute calibration (reset) (see object 5115h: Calibrate encoder value)

The following equation is applied in case of calibration:

Position value = 0 + calibration value

4.3 Reset to factory settings

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

Access	Coding		Settings are restored for
CANopen (See object 1011h: Restore Parameter)	1011h "load"	Sub-index 1	All parameters
		Sub-index 2	Only bus parameters
		Sub-index 3	Only CiA DS-406 parameters
		Sub-index 4	Only manufacturer-specific parameters

Table 8: Access to factory settings

5 Communication via CAN bus (CANopen)

The CANopen communication profile CiA DS-301 V4.2, the Device profile for Encoders CiA DS-406 V3.2 as well as the indicator specification CiA DS-303 Part 3 V1.4.0 for CAN diagnosis form the basis for the MSA501 CAN. The MSA501 supports device class C1 and partly C2. The details required for a better understanding of the operation are included in this documentation. If more in-depth information is required, we recommend the applicable technical literature on CAN or CANopen.

5.1 Telegram structure

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

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

SOF:

(Start of Frame) start bit of the telegram

Identifier (COB-ID):

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

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

Thus, the 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	Functional code				Node number (Node ID)						
Assignment	x	x	x	x	0	0	x	x	x	x	X

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

Object	Functional code	Resulting COB-ID	Object	Page
Network management (NMT)	0000b	0	-	12
SYNC message	0001b	128d (80h)	1005h	27
Emergency message	0001b	128d (80h) + Node-ID	1014h	34
TPD01	0011b	384d (180h) + Node-ID	1800h	37
TPD02	0101b	640d (280h) + Node-ID	1801h	38
SDO (tx)	1011b	1408d (580h) + Node-ID	1200h	36
SDO (rx)	1100b	1536d (600h) + Node-ID	1200h	36
Heartbeat message	1110b	1792d (700h) + Node-ID	-	23
Node Guard message	1110b	1792d (700h) + Node-ID	-	22

Table 9: Overview of COB identifiers

Changes to COB IDs are only possible in the PRE-OPERATIONAL NMT status. First, the COB ID must be switched invalid via bit 31 = 1b before it can be changed and reactivated.
The COB ID of the Sync object is an exception, where bit 30 must be = 0b to enable the COB ID to be changed. As bit 30 cannot be set to 1b in the MSA501, the COB ID could be changed at any time.

The node number (Node ID) (see also object 5F0Ah: Node-ID and baud rate Bus CAN) is assigned once in every bus system with configuration of the master on MSA501. The node numbers range from 1 to 127. Node ID = 0 is reserved and must not be used.

The adoption of a node ID or baud rate which was reset occurs only after re-initialization (see chapter 5.2.1: Network management (NMT) services).

Ex works, the MSA501 is delivered with node number 1 (1h).

Control field:

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

Data field:

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

CRC:

contains bits for error detection.

ACK/EOF:

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

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

5.2 Node control

5.2.1 Network management (NMT) services

The master configures, manages and monitors network nodes via the NMT service. The device is always in one of the four communication states “INITIALISATION”, “PRE-OPERATIONAL”, “OPERATIONAL” or “STOPPED” (see Fig.. 5)

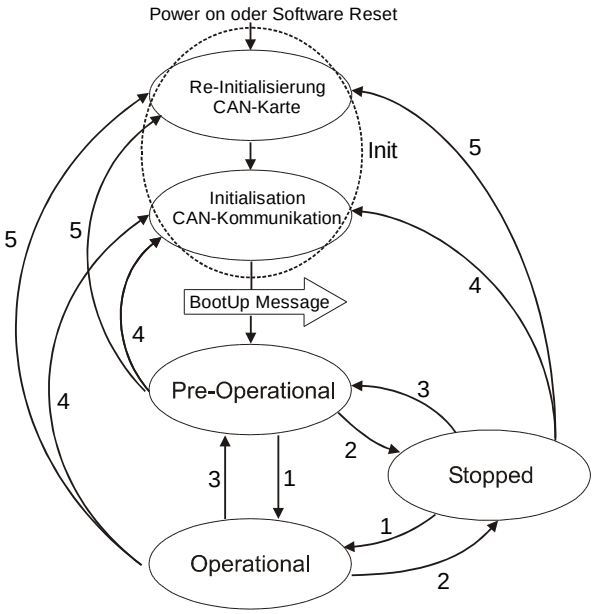


Fig.. 5: NMT Status diagram

5.2.1.1 NMT communication states

NMT Status INITIALISATION

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

NMT Status PRE-OPERATIONAL

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

NMT Status OPERATIONAL

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

NMT Status STOPPED

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

5.2.1.2 Toggling between the NMT communication states

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

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

Table 10: Toggling between communication states

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

5.2.2 Boot-Up

The COB ID of the boot-up message is made up of 700h and the node ID. The “Initialisation” NMT status is output as data content.

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

Table 11: Boot-Up message

5.2.3 SYNC object

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

5.3 Process data exchange

5.3.1 Transfer of process data objects (PDO)

Process data objects (PDO) serve for fast exchange of process data. A maximum of 8 bytes of user data can be transferred in a PDO. The MSA501 supports the Transmit PDO services TPDO1 and TPDO2 according to CiA DS-301 and CiA DS-406. The data content can be adjusted individually via variable mapping.

5.3.1.1 Transmit PDO (from the MSA501 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 response to a SYNC telegram
- as a response to an RTR message

When delivered, TPDO1 and TPDO2 are generated from the position value and the velocity value. The transfer behavior of TPDO1 is determined via the objects 1800h, 1A00h and 6200h and is assigned to asynchronous transmission. TPDO2 is defined via the objects 1801h and 1A01h and serves synchronous transmission.

The structure of the messages is shown in Table 12, with variable and changeable mapping (see chapter 5.3.1.2 Variable TPDO mapping).

COB-ID	**Process data in binary code**					
	Byte 0 (LSB)	**Byte 1**	**Byte 2**	**Byte 3 (MSB)**	**Byte 4 (LSB)**	**Byte 5 (MSB)**
TPDO1 180h + Node-ID	Position value				Velocity value	
TPDO2 280h + Node-ID						

Table 12: TPDO message

Asynchronous data transmission (TPDO1)

If a TPDO1 is to be sent cyclically, then the cycle time must be entered in milliseconds into object 1800h, sub-index 05h. The TPDO1 will not be sent if the value 0 ms is written. The function is disabled. The minimum value to be set is 1 (= 1 ms). Alternately, the value can also be written into the permanently internally linked object 6200h.

Synchronous data transfer (TPDO2)

As delivered, the device responds to every SYNC message received with the output of the TPDO2 message. 1h is entered for synchronous transmission in object 1801h, sub-index 02h. If a value n between 1d and 240d (= F0h) is entered, the device will respond to every nth SYNC message.

RTR

Queries can be sent via RTR (see chapter 5.1: Telegram s, control field) to TPDO1 and TDPO2.

5.3.1.2 Variable TPDO mapping

By changing objects 1A00h and 1A01h you can specify the data content to be transferred in the TPDOs. The maximum of 8 data bytes can be mapped in a TPDO.

Procedure of changing the TPDO mappings:

1. The device must be in the Pre-Operational NMT status.
2. By setting the COB-ID Valid bit to 1, the corresponding TPDO will be disabled.
3. Mapping is disabled by writing sub-index 00h to 0h.
4. Mapping is changed by writing into the desired sub-indexes the desired objects and the data length.
5. In order to enable mapping, the maximally used sub-index must be entered in sub-index 00h.
6. The TPDO is reactivated by deleting the Valid bit of COB-ID on 0.

Example of changing a TPDO1 mapping:

Default setting:

Node ID: 1h

TPDO1: COB-ID 00000181h

Mapping:

1A00.0h 2

1A00.1h 60040020h (position value object 6004h, sub-index 00h, 32bit)

1A00.2h 60300110h (speed object 6030h, sub-index 01h, 16bit)

Desired mapping:

1A00.0h 3

1A00.1h 60040020h (position value object 6004h, sub-index 00h, 32bit)

1A00.2h 51220108h (Sys Register object 5122h, sub-index 01h, 8bit)

1A00.3h 51220208h (Flag 0 Register object 5122h, sub-index02h, 8bit)

1. User dataThe device must be in the Pre-Operational NMT status.
2. Disable TPDO1 via COB-ID = 80000181h.

COB-ID	User data							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
601h	23h	00h	18h	01h	81h	01h	00h	80h

3. Disable current mapping via 1A00.0h = 0.

COB-ID	User data							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
601h	23h	00h	1Ah	00h	00h	00h	00h	00h

4. Execute desired changes on mapping

COB-ID	Nutzdaten							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
601h	23h	00h	1Ah	01h	20h	00h	04h	60h
601h	23h	00h	1Ah	02h	08h	01h	22h	51h
601h	23h	00h	1Ah	03h	08h	02h	22h	51h

5. Enable mapping via 1A00.0h = 3.

COB-ID	User data							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
601h	23h	00h	1Ah	00h	03h	00h	00h	00h

6. Enable TPDO1 via COB-ID = 00000181h.

COB-ID	User data							
	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
601h	23h	00h	18h	01h	81h	01h	00h	00h

5.4 Parameter data exchange

5.4.1 Transmission of Service Data Objects (SDO)

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

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

Two SDO services are available:

- SDO (rx) (Master → MSA501): 600h + Node-ID
- SDO (tx) (MSA501 → Master): 580h + Node-ID

These SDO identifiers cannot be changed!

5.4.1.1 Expedited Request/Response

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

SDO messages are set up as follows:

COB-ID	User data in the Binärcode							
	Byte 0 read / write	**Byte 1 LSB**	**Byte 2 MSB**	**Byte 3**	**Byte 4 LSB**	**Byte 5**	**Byte 6**	**Byte 7 (MSB)**
SDO rx/tx + Node-ID	Command-byte	Index		Subindex	User data (Parameter)			

Command byte, byte 0:

The command byte determines the type of access and the number of valid data bytes. The following command bytes are valid for the MSA501:

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

Table 13: Command coding

Index, bytes 1 and 2:

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

Sub-index, Byte 3:

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

User data (parameters), byte 4-7:

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

5.4.1.2 Normal Request/Response

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

For the MSA501 this is only the case with reading of the object 1008h: Manufacturer Device Name.

The initialization message has the following structure:

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

The segment message has the following structure:

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

Initialization and segment message: Command byte, byte 0:

The command byte determines the type of access and the number of valid data bytes. The following command bytes are valid for the MSA501:

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

Table 14: Command coding

Initialization message : Index, Bytes 1 and 2:

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

Initialization message : Subindex, Byte 3:

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

Initialization message : User data (Parameter), Byte 4-7:

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

Segment message : User data (Parameter), Byte 1-7:

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

5.4.1.3 Error Response in SDO exchange

With invalid access, an error message (Abort) is returned to the master.
The error codes are described in the CANopen profile (CiA DS-301) or in the encoder profile (CiA DS- 406), respectively. The table below shows the error codes used:

Error code	Description
05030000h	Toggle bit unequal in Normal Transfer of Request/Response.
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.
06040041h	Object cannot be mapped to PDO.
06040042h	The number and lengths of the objects to be mapped exceed PDO length
06090011h	Sub-index does not exist
06090030h	Wrong value range of selected parameter.
08000020h	Parameters cannot be transferred to application or stored.
08000022h	Parameters cannot be transferred to application or stored due to the current device status.
08000024h	No data available

Table 15: Error codes

5.4.1.4 SDO examples

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

The calibration value stored in object 6003 of the directory of objects is to be read from the slave with device address 1h.

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

Command 40h
Index: 6003h
Sub-index: 00h
The current value is 510d = 01FEh

Request of master from slave with node ID 1h:

COB-ID	User data							
	Command	Index L	Index H	Subindex	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	Subindex	Data 0	Data 1	Data 2	Data 3
581h	43h (4 Bytes gültig)	03h	60h	00h	FEh	01h	00h	00h

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

The calibration value stored with 2 bytes in object 6002 of the directory of objects is to be changed in the slave with device address 1h.

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

Command: 2 bytes are to be written 2Bh
Index: 6200h
Subindex: 00h
The new value shall be 4500d = 1194h

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

COB-ID	User data							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
601h	2Bh (2 Bytes gültig)	00h	62h	00h	94h	11h	00h	00h

Response to the command by the slave:

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

COB-ID	User data							
	Command	Index L	Index H	Subindex	Data 0	Data 1	Data 2	Data 3
581h	60h	00h	62h	00h	00h	00h	00h	00h

Example of reading SDO parameters with normal Request/Response:

The manufacturer device name stored in object 1008h of the directory of objects is to be read from the MSA501 with device address 1h.

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

Command: 40h
index: 1008h
sub-index: 00h

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

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

Response to the request by the slave:

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

COB-ID	User data							
	Command	Index LB	Index HB	Subindex	Data 0	Data 1	Data 2	Data 3
581h	41h	08h	10h	00h	06h	00h	00h	00h

Number of expected user data bytes: 6

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

COB-ID	User data							
	Command	**Index L**	**Index H**	**Subindex**	**Data 0**	**Data 1**	**Data 2**	**Data 3**
601h	60h	08h	10h	00h	x	x	x	x

Response to the request by the slave

COB-ID	User data							
	Command	**Data 0**	**Data 1**	**Data 2**	**Data 3**	**Data 4**	**Data 5**	**Data -?**
581h	03h	4Dh	53h	41h	35h	30h	31h	00h

4Dh 53h 41h 35h 30h 31h = "MSA501"

5.5 Node monitoring

5.5.1 Emergency Service (EMCY)

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

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

Identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
11/ 29 Bit	Emergency Error Code		Error Register (Objekt 1001h)	Manufacturer-specific error field (not used)				

Emergency Error Code:

Error description	Error Code
Cause of the error removed	0000h
Bus status changed over to the error passive mode	8120h
recovered from Bus Off	8140h
Manufacturer-specific Tape-sensor	FF10h
Manufacturer-specific Velocity error	FF12h
Manufacturer-specific Plausibility error	FF13h
Manufacturer-specific Alignment activated?	FF14h
Manufacturer-specific Faulty values detected	FF15h
Manufacturer-specific Check sum error	FF16h
Manufacturer-specific Read/write error EEPROM	FF17h

Table 16: Emergency Error Code

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

5.5.2 Node Guarding

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

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

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

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

Toggle Bit:

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

NMT-Zustand:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

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

Note:

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

5.5.3 Heartbeat

The master monitors the state of the slave device via Heartbeat protocol. While doing this, the device sends independently its NMT status cyclically. The MSA501 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 deactivated if the cycle time is 0h.

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

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

NMT-Zustand:

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

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

5.6 Directory of objects

5.6.1 Overview of objects

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

Name	Description	see page
1000h: Device Type	Device profile and encoder type	25
1001h: Error Register	Current error status of the device	26
1002h: Manufacturer Status Register	Contains the Transmit Error Counter and the Receive Error Counter	26
1003h: Pre-defined Error Field	The object stores the 8 error states that have occurred last	27
1005h: COB-ID SYNC-Nachricht	Setting of the COB ID of the SYNC object.	27
1008h: Manufacturer Device Name	Device name in ASCII notation	28
1009h: Manufacturer Hardware Version	Indicates the hardware version of the device	28
100Ah: Manufacturer Software Version	Indicates the software version of the device	28
100Ch: Guard Time	Parameter for Node Guarding	29
100Dh: Life Time Factor	Parameter for Node Guarding	29
1010h: Store Parameter	Object for non-volatile storage of the settings	29
1011h: Restore Parameter	Object for restoring the factory settings	32
1014h: COB-ID Emergency-Nachricht	COB ID of the Emergency object	34
1015h: Inhibit time EMCY	Delay time of the emergency message	34
1017h: Producer Heartbeat Time	Setting of the cycle time of the heartbeat timer	34
1018h: Identity Objekt	Contains the manufacturer number	35
1200h: Server SDO Parameter	SDO parameter	36
1800h: 1. Transmit PDO Parameter	Transmit PDO for asynchronous transfer (timer-controlled)	37
1801h: 2nd Transmit PDO Parameter	Transmit PDO for synchronous transfer	38
1A00h: 1. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO1	40
1A01h: 2. Transmit PDO Mapping Parameter	Describes the arrangement of the objects, which are mapped in TPDO2	40
5115h: Calibrate encoder value	Set the position value to the calibration value	41
5116h: Set the boundary	Setting of the boundary	42
5122h: Register	Reading various registers	42
5F09h: Bus terminator (not available with SP01 + SP03)	Bus termination	44

Name	Description	see page
5F0Ah: Node-ID and baud rate Bus CAN	Setting of Node ID and baud rate	42
6000h: Operating Parameters	Setting of scaling and sense of rotation	45
6003h: Preset value (Calibration value)	Setting the calibration value	46
6004h: Position value	position value (offset with calibration and offset value)	46
6005h: Resolution	Setting of the resolution	46
6030h: Velocity value	Velocity value	47
6200h: Zyklus Timer	Identical with object 1800h, sub-index 5	47
6500h: Operating Status	Output of scaling and sense of rotation	48
6501h: Measuring step	The physical number of measurement steps per revolution	48
6502h: Number of distinguishable revolutions	Number of revolutions the encoder is able to sense	49
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	Hourmeter (function is not supported)	49
6509h: Offset value	Encoder state at the time of calibration	50
650Ah: Module Identification	Indicates the Manufacturer-specific offset value as well as the smallest and largest transferable position value	50
650Bh: Serial number	Indicates the serial number	51

Table 17: Overview of objects

5.6.2 Object description

5.6.2.1 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	00080196h			
EEPROM	no			
Data content	Device profile number		Encoder type	
	Byte 0	Byte 1	Byte 2	Byte 3
	96h	01h	08h	00h

0196h (= 406d): CANopen Device Profile for Encoders

0008h: Absoluter Linear-Geber

5.6.2.2 1001h: Error Register

Object 1001h indicates the error state of the device.

Subindex	00h	
Description	Actually pending error state	
Access	ro	
PDO-Mapping	No	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	No	
Data content	Bit	Bedeutung
	0	set bit indicates the occurrence of any error condition
	4	set bit indicates communication error on the CAN bus (passive or bus-off)
	7	manufacturer-specific (sensor error)
	1-3, 5-6	Not used

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

5.6.2.3 1002h: Manufacturer Status Register

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

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

5.6.2.4 1003h: Pre-defined Error Field

In object 1003h, the 8 latest error states are archived (see chapter 5.5.1: Emergency Service (EMCY)).

- the entry under sub-index 0 indicates the number of errors saved.
- The latest error state is always stored in sub-index 01h. Previous error messages “slip onwards” in their position by one sub-index.
- The whole error list is deleted by writing the value 0 in sub-index 00h.
- The entries in the error list have the format described in chapter 5.5.1: Emergency Service (EMCY).

Subindex	00h
Description	number of error messages stored
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

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

5.6.2.5 1005h: COB-ID SYNC-Nachricht

Durch das Objekt 1005h wird die COB-ID des SYNC-Objekts eingestellt.

Subindex	00h	
Description	Defines the COB ID of the synchronization object (SYNC)	
Access	rw (writable in the “Pre-Operational” state only see chapter 5.1)	
PDO-Mapping	no	
Data type	UNSIGNED 32	
Default	80h	
EEPROM	yes	
Data content	Bit 31	not defined
	Bit 30	0: The device generates no SYNC message
	Bit 29	0: 11Bit-Identifier (CAN 2.0A) 1: 29Bit-Identifier (CAN 2.0B)
	Bit 28 ... 11	0: falls Bit 29 = 0 X: Bits 28 – 11 des SYNC-COB-ID, falls Bit 29 = 1
	Bit 10 ... 0	X: Bits 10 – 0 des SYNC-COB-ID

5.6.2.6 1008h: Manufacturer Device Name

Object 1008h indicates the device name. Since the latter comprises 6 data bytes, normal transfer is required for reading the SDO (see chapter 5.4.1.2: Normal Request/Response).

Subindex	00h						
Description	Device name in ASCII notation						
Access	Const						
PDO-Mapping	no						
Data type	Visible_String						
Default	MSA501						
EEPROM	no						
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	4Dh ("M")	53h ("S")	41h ("A")	35h ("5")	30h ("0")	31h ("1")	00h ("0")

5.6.2.7 1009h: Manufacturer Hardware Version

Object 1009h indicates the hardware version.

Subindex	00h			
Description	Hardwareversion in ASCII-Zeichen			
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")

5.6.2.8 100Ah: Manufacturer Software Version

Object 100Ah indicates the software version of the device.

Subindex	00h			
Description	Software version in ASCII notation			
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")	31h ("0")	30h ("0")	30h ("1")

5.6.2.9 100Ch: Guard Time

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

Subindex	00h
Description	Guard Time
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes

5.6.2.10 100Dh: Life Time Factor

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

Subindex	00h
Description	Life Time Factor
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 8
Default	0h
EEPROM	yes

5.6.2.11 1010h: Store Parameter

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

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

Subindex	01h			
Description	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, reserviert		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

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

Subindex	03h			
Description	Save only application parameters (1000h-1FFFh, CiA DS-406)			
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, reserviert		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

Subindex	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, reserviert		
	Bit 1	0: Device does not independently store parameters		
	Bit 0	1: Device stores parameters after command		

5.6.2.12 1011h: Restore Parameter

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

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

Subindex	01h			
Description	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, reserviert		
	Bit 0	1: Device permits loading of default parameters.		

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

Subindex	03h			
Description	Set only application parameters to factory settings (6000h-9FFFh, CiA DS-406)			
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, reserviert		
	Bit 0	1: Device permits loading of default parameters.		

Subindex	04h			
Description	Set only manufacturer-specific parameters to factory settings (2000h-5FFFh)			
Access	rw			
PDO-Mapping	no			
Data type	UNSIGNED 32			
Default	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, reserviert		
	Bit 0	1: Device permits loading of default parameters.		

5.6.2.13 1014h: COB-ID Emergency-Nachricht

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

Subindex	00h	
Description	Definiert die COB-ID des Emergency Objekts (EMCY)	
Access	rw (writable in the "Pre-Operational" state only see chapter 5.1: Telegrams)	
PDO-Mapping	no	
Data type	UNSIGNED 32	
Default	80h + Node-ID	
EEPROM	yes	
Data content	Bit 31	0: EMCY object exists / is valid 1: EMCY object does not exists / is invalid
	Bit 30	Always 0b
	Bit 29	0: 11Bit-Identifier (CAN 2.0A) 1: 29Bit-Identifier (CAN 2.0B)
	Bit 28 ... 11	0: falls Bit 29 = 0b X: Bits 28 – 11 des EMCY-COB-ID, falls Bit 29 = 1b
	Bit 10 ... 0	X: Bits 10 – 0 des EMCY -COB-ID

5.6.2.14 1015h: Inhibit time EMCY

The delay time of the emergency message in 100 µs is indicated through object 1015h.

Subindex	00h
Description	Defines the delay time of the emergency message
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0d ... 65535d (0h ... FFFFh); the numerical value corresponds to a multiple of 100 µs. Value 0 disables the service.

5.6.2.15 1017h: Producer Heartbeat Time

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

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

5.6.2.16 1018h: Identity Objekt

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

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

Subindex	01h
Description	The manufacturer identification number (vendor ID) for the company SIKO GmbH allocated by the CiA
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 32
Default	195h
EEPROM	no

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

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

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

5.6.2.17 1200h: Server SDO Parameter

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

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

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

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

5.6.2.18 1800h: 1. Transmit PDO Parameter

TPDO1 is used for asynchronous PDO transmission according to CiA DS-406.
The communication parameters for TPDO1 are set via object 1800h.

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

Subindex	01h
Description	COB ID of the PDO1
Access	rw (writable in the “Pre-Operational” state only see chapter 5.1)
PDO-Mapping	no
Data type	UNSIGNED 32
Default	180h + Node-ID
EEPROM	yes

Subindex	02h	
Description	Transmission Type	
Access	rw	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	FEh (254d)	
EEPROM	yes	
Data content	FEh (254d) FFh (255d)	PDO has asynchronous characteristics (PDO is sent depending on the “Event Timer”).
	FDh (253d)	Device responds only to RTR request if RTR Bit 30 is enabled in the COB-ID.

Subindex	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)

Subindex	05h
Description	Event timer für TPDO1 hard-wired (CiA DS-406) mit 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 0h. The content of this object is identical with object 6200h. If the value is changed with the timer running, the change will be applied only with the next timer operation.

Subindex	06h (is not used, access attempt generates error message)

5.6.2.19 1801h: 2nd Transmit PDO Parameter

TPDO2 is used for synchronous PDO transmission according to CiA DS-406.
The communication parameters for TPDO2 are set via object 1801h.

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

Subindex	01h
Description	COB-ID des PDO2
Access	rw (writable in the “Pre-Operational” state only see chapter 5.1)
PDO-Mapping	no
Data type	UNSIGNED 32
Default	280h + Node-ID
EEPROM	yes

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

Subindex	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

Subindex	04h (is not used, access attempt generates error message)

Subindex	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

Subindex	06h (is not used, access attempt generates error message)

5.6.2.20 1A00h: 1. Transmit PDO Mapping Parameter

Object 1A00h determines the objects that are mapped on the first Transmit PDO (TPDO1) (see chapter 5.3.1.2: Variable TPDO mapping).

Subindex	00h
Description	number of objects mapped
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes

Subindex	01h
Description	1st object of the PDO1 message (Datenbyte 0 bis 3)
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 32
Default	60040020h (position value object 6004h, Subindex 00h, 32bit)
EEPROM	yes

Subindex	02h
Description	2nd object of the PDO1 message (Datenbyte 4 + 5)
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 16
Default	60300110h (Speed Objekt 6030h, Subindex 01h, 16bit)
EEPROM	yes

5.6.2.21 1A01h: 2. Transmit PDO Mapping Parameter

Object 1A01h determines the objects that are mapped in the second Transmit PDO (TPDO2) (see chapter 5.3.1.2: Variable TPDO mapping).

Subindex	00h
Description	number of objects mapped
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	yes

Subindex	01h
Description	1st object of the PDO2 message (data byte 0+1)
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 32
Default	60040020h (Position data Objekt 6004h, Subindex 00h, 32bit)
EEPROM	yes

Subindex	02h
Description	2nd object of the PDO2 message (data byte 2 to 5)
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 32
Default	60300110h (speed object 6030h, sub-index 01h, 16bit)
EEPROM	yes

5.6.2.22 5115h: Calibrate encoder value

With object 5115h, calibration can be executed or it informs whether calibration is executed.

Subindex	00h	
Description	This object enables “zeroing” of the measured value. This serves for setting the position value to the object 6003h: Preset value (Calibration value) written calibration value. Position value = measured value + calibration value	
Access	rw	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	yes	
Data content	Object 5115h Read:	
	0, 1	In case of a read access, 0h is returned when no zeroing is ongoing. 1h is returned with ongoing calibration.
	Objekt 5115h Write:	
	1	Writing of the value 1h sets the position value to the calibration value.

5.6.2.23 5116h: Set the boundary

With Object 5116h the boundary can be set (see chapter 4.1: Measuring range).

Subindex	00h
Description	In case the measurement range is to be extended in negative direction, there exists the possibility of programming a positive value as a boundary.
Access	rw
PDO-Mapping	no
Data type	SIGNED 32
Default	0h
EEPROM	yes
Data content	-2047999d...2047999d (FFE0C001h...001F3FFFh)

5.6.2.24 5122h: Register

With Object 5122h can be readout the register.

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

Subindex	01h	
Description	Read Sys Register	
Access	ro	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	no	
Data content	Bit 7	A Read/write EEPROM error has occurred
	Bit 6	Check sum error has occurred
	Bit 5	Verify-Error (faulty values in the EEPROM)
	Bit 4	Sensor-tape alignment is executed
	Bit 3	Not used
	Bit 2	Velocity check (v > 5 m/s) has struck
	Bit 1	Plausibility of the absolute value is not given
	Bit 0	Sensor/tape reading distance error

Subindex	02h	
Description	Flag 0 Register	
Access	ro	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	20h	
EEPROM	no	
Data content	Bit 7, 6	Not used
	Bit 5	Fine value of filtering: 0 = OFF; 1 = ON
	Bit 4...2	Not used
	Bit 1	Counting direction : 0 = Up; 1 = Down
	Bit 0	Resolution: 0 = 10µm; 1 = 5µm

Subindex	03h	
Description	Flag 1 Register	
Access	ro	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	43h	
EEPROM	no	
Data content	Bit 7	External Reset (/MCLR) Pin bit
	Bit 6	Software Reset (Instruction) Flag bit
	Bit 5	Software Enable/Disable of WDT bit
	Bit 4	Watchdog Timer Time-out Flag bit
	Bit 3	Wake-up from Sleep Flag bit
	Bit 2	Wake-up from Idle Flag bit
	Bit 1	Brown-out Reset Flag bit
	Bit 0	Power-on Reset Flag bit

Subindex	04h	
Description	Flag 2 Register	
Access	ro	
PDO-Mapping	no	
Data type	UNSIGNED 8	
Default	0h	
EEPROM	no	
Data content	Bit 7	Trap Reset Flag bit
	Bit 6	Illegal Opcode or Uninitialized W Access Reset Flag bit
	Bit 5...2	Not used
	Bit 1	Configuration Mismatch Flag bit
	Bit 0	Voltage Regulator Standby During Sleep bit

5.6.2.25 5F09h: Bus terminator (not available with SP01 + SP03)

An internal bus terminator can be energized by object 5F09h.

Subindex	00h
Description	Connection of the internal bus termination
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 8
Default	2h
EEPROM	no

5.6.2.26 5F0Ah: Node-ID and baud rate Bus CAN

Node ID and bus baud rate can be set via object 5F0Ah if the DIP switches (only available with SP01 + SP03) are set to "Use memory" (see chapter 3.3: DIP switch). The adoption of a node ID or baud rate bus set later occurs only after re-initialization (siehe Kapitel 5.2.1Network management (NMT) services).

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

Subindex	01h
Description	Node-ID
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 8
Default	1h
EEPROM	yes
Data content	01h ... 7Fh

Subindex	02h
Description	Baud rate of the CAN bus
Access	rw
PDO-Mapping	No
Data type	UNSIGNED 8
Default	5h (500kBaud)
EEPROM	yes
Data content	1: 50 kBaud 2: 100 kBaud 3: 125 kBaud 4: 250 kBaud 5: 500 kBaud 6: 1000 kBaud

5.6.2.27 6000h: Operating Parameters

Settings of the operating parameters can be made through object 6000h.

Subindex	00h	
Description	Operating Parameters	
Access	rw	
PDO-Mapping	no	
Data type	UNSIGNED 16	
Default	4h	
EEPROM	yes	
Data content	Bit 15 ... 4	not used
	Bit 3	0: ascending position values when the sensor travels away from the sensor cable 1: ascending position values when the sensor travels towards the sensor cable
	Bit 2	1: Scaling enabled
	Bit 1	not used
	Bit 0	not used

Scaling: The encoder works with its set resolution which can be configured via object 6005h. The scaling function cannot be disabled.

5.6.2.28 6003h: Preset value (Calibration value)

Via object 6003h, the position value of the encoder can be set to a calibration value with calibration. Position value = measured value + calibration value (see chapter 4.2 Calibration)

Subindex	00h
Description	Calibration data
Access	rw
PDO-Mapping	no
Data type	SIGNED 32
Default	0h
EEPROM	yes
Data content	-2047999d ... 2047999d (FFE0C001h...001F3FFFh)

5.6.2.29 6004h: Position value

Object 6004h indicates the actual position value of the device.

Subindex	00h
Description	Position data
Access	ro
PDO-Mapping	yes
Data type	SIGNED 32
Default	0h
EEPROM	no

Position value = measured value + calibration value

5.6.2.30 6005h: Resolution and velocity step width

Resolution and velocity step width are defined via object 6005h.

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

Subindex	01h
Description	Resolution of the linear sensor. The parameter must be indicated as multiple of nm according to CiA DS-406.
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 32
Default	10000d (2710h)
EEPROM	yes
Data content	5000d (1388h) oder 10000d (2710h)

Subindex	02h
Description	Step width of the velocity of the linear sensor. The parameter must be indicated as multiple of 0.01 mm/s according to CiA DS-406.
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 32
Default	100d (64h)
EEPROM	yes
Data content	100d (64h)

5.6.2.31 6030h: Velocity value

Velocity can be read via object 6030h. The velocity step width is defined in object 6005.2h.

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

Subindex	01h
Description	Velocity value
Access	ro
PDO-Mapping	no
Data type	SIGNED 16
Default	0h
EEPROM	no

5.6.2.32 6200h: Zyklus Timer

Object 6200h sets a cycle time for the output of PDO1. This value is permanently linked to object 1800h: 1. Transmit PDO Parameter sub-index 05h. Timer-controlled output is active as soon as a valid cycle time has been entered and the device is operated in the operational mode. Value 0h disables the function.

Subindex	00h
Description	Zyklus Timer
Access	rw
PDO-Mapping	no
Data type	UNSIGNED 16
Default	0h
EEPROM	yes
Data content	0d ... 65535d (0h...FFFFh)

5.6.2.33 6500h: Operating Status

The object 6500h indicates the settings programmed with object 6000h.

Subindex	00h	
Description	Operating Status	
Access	ro	
PDO-Mapping	no	
Data type	UNSIGNED 16	
Default	4h	
EEPROM	no	
Data content	Bit 15 ... 4	not used
	Bit 3	0: positive counting direction 1: negative counting direction
	Bit 2	0: Scaling disabled 1: Scaling enabled
	Bit 1	not used
	Bit 0	not used

5.6.2.34 6501h: Measuring step

Object 6501h indicates the physical number of measurement steps.

Subindex	00h
Description	Physical resolution
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 32
Default	10000d (2710h)
EEPROM	no

5.6.2.35 6502h: Number of distinguishable revolutions

Object 6502h indicates the number of resolutions the encoder is able to sense.

Subindex	00h
Description	Total count of revolutions that can be sensed.
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 16
Default	1h
EEPROM	no

5.6.2.36 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.

Subindex	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)
	02h	03h	01h	00h

5.6.2.37 6508h: Operating Time

The operating hours can be indicated via object 6508h. This function is not supported.

Subindex	00h
Description	Hourmeter
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 32
Default	FFFFFFFFh
EEPROM	no

5.6.2.38 6509h: Offset value

The difference between the encoder value and the position value scaled and offset with the calibration value (preset value) is output via object 6509h.

Subindex	00h
Description	Encoder reading at the time of calibration
Access	ro
PDO-Mapping	no
Data type	SIGNED 32
Default	0h
EEPROM	yes

5.6.2.39 650Ah: Module Identification

Object 650Ah indicates the manufacturer-specific offset value as well as the smallest and largest transferable position value.

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

Subindex	01h
Description	Manufacturer-specific offset value
Access	ro
PDO-Mapping	no
Data type	SIGNED 32
Default	0h
EEPROM	no

Subindex	02h
Description	Smallest transferable position value
Access	ro
PDO-Mapping	no
Data type	SIGNED 32
Default	-24000d (FFFFA240h)
EEPROM	no

Subindex	03h
Description	Largest transferable position value
Access	ro
PDO-Mapping	no
Data type	SIGNED 32
Default	1000000d (000F4240h)
EEPROM	no

5.6.2.40 650Bh: Serial number

Object 650Bh provides the serial number of the encoder.

Subindex	00h
Description	Serial number
Access	ro
PDO-Mapping	no
Data type	UNSIGNED 32
Default	0h
EEPROM	yes