User manual

Actuator
with CANopen interface

AG05

1 General Information

1.1 Symbols and their meaning

1.2 Documentation

The following documents are associated with this document:

• The Product data sheet describes the technical data, the dimensions, the pin assignment, the accessories and the order key.

• The installation instructions describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.

• The User manual for actuator commissioning and integration into a fieldbus system.

You can also download these documents at
http://www.siko.de/service/downloads/ausgewaehlte-downloads/details/ag05/.

2 Block Diagram

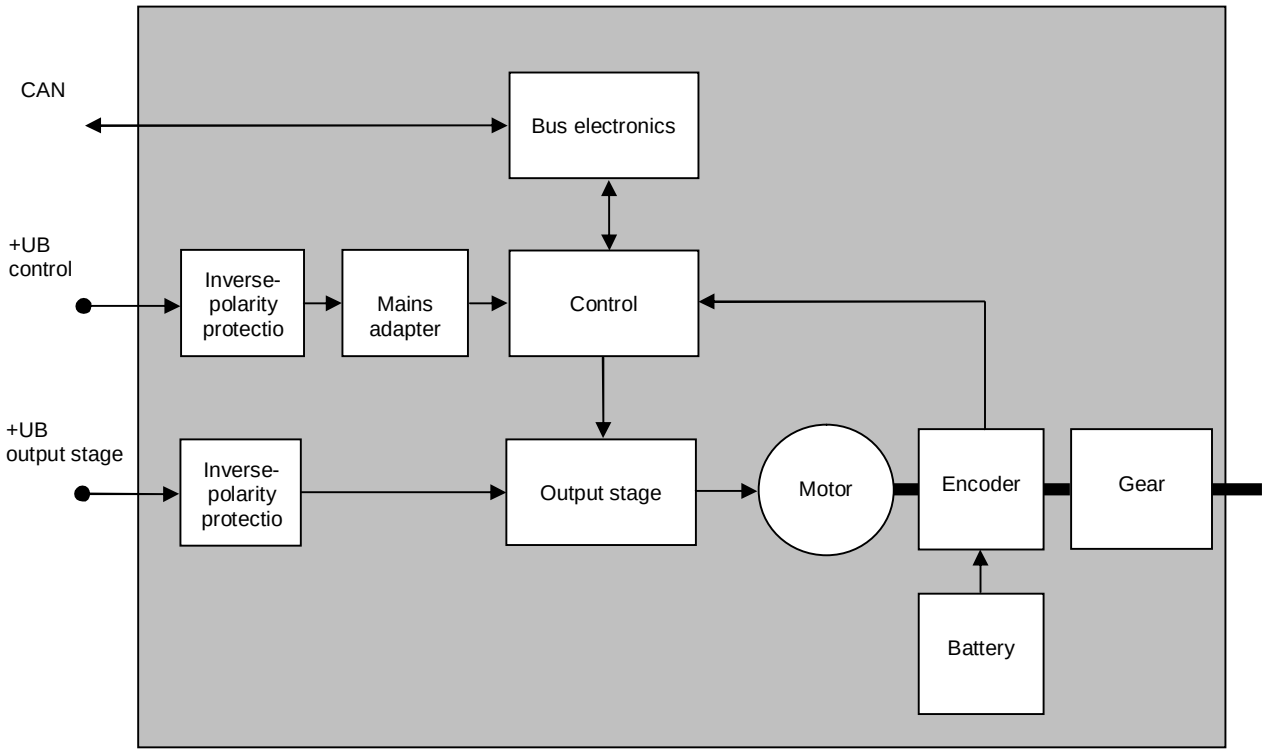

Fig. 1: Block diagram

3 Display and Control Keys

3.1 General

The actuator has a two-line display with special characters and three control keys. The keys serve for actuator parameterization and control. Two LEDs (1, 2) inform about the actuator's operating state.

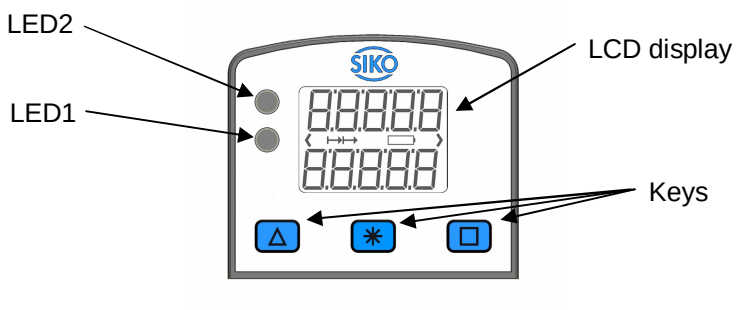

Fig. 2: Control elements

3.2 LCD display

With supply voltage applied to the control, the actual value is displayed in the first line and the set point value with factory settings in the second line.
The value displayed in the 2nd line can be adjusted via parameters.

3.3 LED displays

LED	Colour	State	Description
LED1	green	on	Actuator is within the programmed position window. Supply voltage of the output stage is applied.
		blinking	Actuator is within the programmed position window. Supply voltage of the output stage is missing.
		off	Actuator is outside the programmed position window.
	red	on	Actuator is outside the programmed position window. Supply voltage of the output stage is applied.
		blinking	Actuator is outside the programmed position window. Supply voltage of the output stage is missing.
		off	Actuator is within the programmed position window.
LED2	orange	blinking 2,5 Hz	NMT state: 'PRE-OPERATIONAL'
		on	NMT state: 'OPERATIONAL'
		blinking pulse-duty factor 1:5	
		off	NMT state: 'STOPPED'

Table 1: LED displays

4 Functional Description

4.1 Control of the drive

The drive can be controlled manually (stand-alone) and completely parameterized via the keys.
In bus operation you can disable drive control via the keys.

4.1.1 Value input

Enter values via the △ key and the ⊡ key. Confirm entered values by pressing the ✳ key.

⊡ decimal place selection key

△ Value input key

NOTICE	With value input via the keys, the display range is limited to -19999 … 99999. When entering values beyond this range via CAN interface, "FULL" will be displayed when you select the parameter.

4.1.2 Value selection

For some parameters you can select values from a list.
Direct value input is not possible.

You can select a value from the list via the △ key. Confirm the value by pressing the ✳ key.

4.1.3 Operating modes

The following operating modes are distinguished: positioning mode and speed mode.
In the positioning mode there is the additional option of travelling in the inching mode.

4.1.3.1 Positioning mode

In the positioning mode, positioning to the specified set point is executed by means of a ramp function (*see Fig. 3*), calculated on the basis of the actual position as well as the programmed controller parameters P (proportional factor), I (integral factor), D (differential factor), acceleration and speed.

Upon activation of the travel order, the actuator accelerates to the specified speed with the acceleration programmed. The value of deceleration to the set point is defined by the parameter 'a-Pos' as well.

If the actual position is within the programmed window, this will be signalled by LED1, in the system status word and in the SIKONETZ5 status word.
You can define the behaviour of the actuator upon reaching the programmed window.

Changing controller parameters during a positioning process does not influence the current positioning operation.

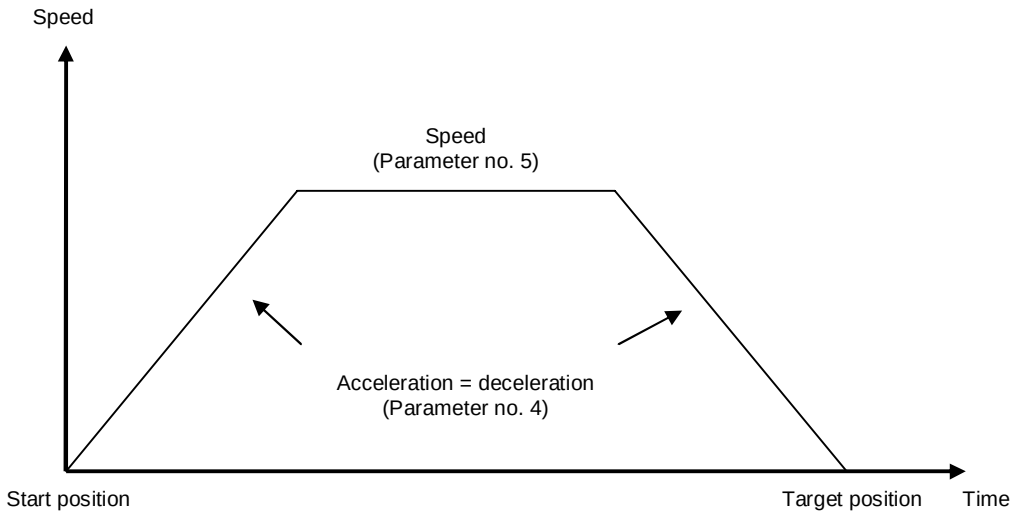

Fig. 3: Ramp travel, direct positioning mode

4.1.3.1.1 Loop positioning

If the actuator is operated on a spindle or an additional gear, the spindle or external gear backlash can be compensated by means of loop positioning. In this case, travelling to the target value is always from the same direction. This direction of approach can be defined.

Example:
The direction from which every target position shall be driven to is positive.

- Case 1 ⇒ new position is greater than actual position:

Direct travel to the target position

- Case 2 ⇒ new position is smaller than actual position:

The actuator drives beyond the target position by the loop length; afterwards, the set point is approached in positive direction.

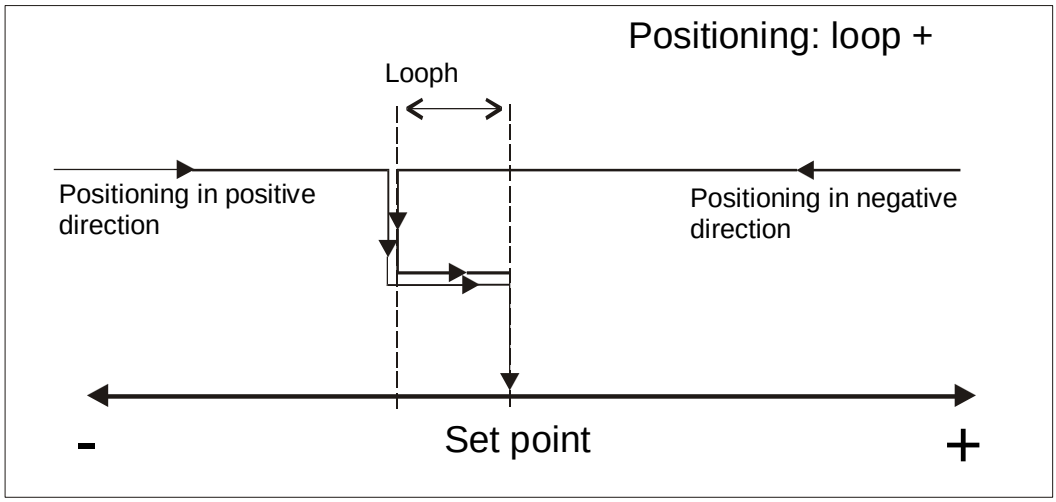

Fig. 4: Positioning Loop+

4.1.3.2 Inching operation

Inching operation is enabled in the 'positioning mode' only. You can program via parameters acceleration as well as speed in the inching mode.

NOTICE	Ein Ausgleich der Spindelspieles (Schleifenpositionierung) erfolgt in dieser Betriebsart nicht

4.1.3.2.1 Inching mode 1

The drive travels once from the current actual position by the position 'Delta Tipp' depending on the mathematical sign of the value entered.

'Delta Tipp' < 0: negative travel direction
'Delta Tipp' > 0: positive travel direction

NOTICE	If the 'Spindle pitch' parameter is programmed to zero, then the travelling way occurs by increments. If 'Spindle pitch' is unequal zero, then the information of the 'Delta Tipp' parameter refers to the travel distance in 1/100 mm.

Reaching of the target position will be signalled accordingly.

The following conditions must be met for enabling the start of inching modes 1 and 2:

- The actuator must not be switched to error
- No active travel job
- Supply voltage of the output stage is applied

NOTICE	If the actual position is outside the programmed limiting values, then travelling from this position in the respective direction is possible by means of inching mode 1 or 2!

4.1.3.2.2 Inching mode 2

The actuator travels from the current position as long as the relevant command is active. You can influence the inching speed via two parameters and it will be calculated in the actuator as illustrated in the example below:

v - Tipp (*Parameter no. 9*) = 10 rpm (can only be changed in the idle state)

Offset inching 2 (*Parameter no. 30*) = 85% (can be changed during inching operation)

The resulting inching speed in this example will be:

Inching speed = v - Tipp * Offset inching 2 = 10 rpm * 85% = **9 rpm**

The results are always rounded to integers.
The minimum speed is 1 rpm.

4.1.3.3 Rotational speed mode

With the set point enabled, the actuator when in the rotational speed mode accelerates to the target speed and maintains this speed until the set point is disabled or a different target speed specified.
The speed is adjusted immediately to the new value when the rotational target speed is changed.
The arithmetical sign of the set point determines the travel direction in the rotational speed mode.

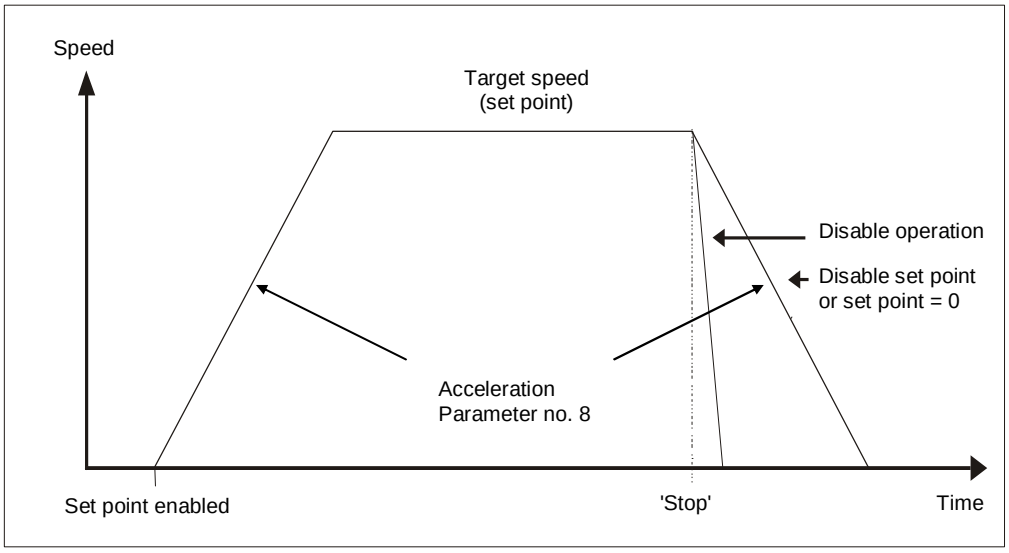

Fig. 5: Ramp rotational speed mode

The following conditions must be met for enabling the start of the rotational speed mode:

- The actuator must not be switched to error
- No active travel job
- Supply voltage of the output stage is applied

NOTICE	Limits 1 + 2 are inactivated in this operational mode.

4.1.4 Current limiting

The actuator is equipped with adjustable current limiting, which serves primarily for protecting the actuator against overload.

With the default value set, the nominal speed indicated on the product data sheet is achieved.

Actuator overload results in limiting the motor current to the set value.
As a consequence, the actuator cannot maintain the speed set, the contouring error increases.
With the contouring error exceeding the contouring error limit the actuator will enter the state of error: contouring error.

NOTICE	The actual motor current cannot be stated by measuring the supply current. With cycled output stages, the supply current does not correspond to the motor current. The actual motor current can be read out via the interface or indicated on the display.

4.2 Manual control (stand-alone operation)

4.2.1 Start inching mode 2

After applying supply voltage, the actuator will be on the uppermost level of the menu structure (default/delivery state). Positioning mode is active.

Pressing the △ key starts left-hand motion (inching operation 2).

Pressing the □ key starts right-hand motion (inching operation 2).

Releasing the respective key stops travel movement.

Pressing the ✳ key starts the parameterization/programming mode.

4.2.2 Specifying the set point and starting the travel order

4.2.2.1 Example: Starting positioning order to position 500

Preconditions:
The display is at the uppermost level of the menu structure (basic state).
Operating mode: Positioning mode
Key functions: enabled

0 0	Initial state: normal display First press the ✳ key, then the □ key and hold down together.
tArgt 3	The key enable time is counted down.
tArgt 00000	After expiry of the key enable time, the input field is released The first decimal place is active. Press the □ key twice to change the active decimal place.
tArgt 00000	The third decimal place is active. Press the △ key 5 times.
tArgt 00500	Value 500 will be displayed. Confirm by pressing the ✳ key to start positioning.

4.2.2.2 Example: Starting positioning order to position -500

Preconditions:
The display is at the uppermost level of the menu structure (basic state).
Operating mode: Positioning mode
Key functions: enabled

NOTICE	For negative values to be entered, set first the value and only afterwards the arithmetical sign. The value 0 cannot be entered.

0 0	Initial state: normal display First press the ✳ key, then the □ key and hold down together.
tArgt 3	The key enable time is counted down.
tArgt 00000	After expiry of the key enable time, the input field is released The first decimal place is active and blinks. Press the □ key twice to change the active decimal place.
tArgt 00000	The third decimal place is active and blinks. Press the △ key 5 times for entering the value.
tArgt 00500	Value 500 will be displayed. Press the □ key twice to change the active decimal place.
tArgt 00500	The fifth decimal place is active and blinks. Press the △ key 11 times for setting the arithmetical sign.
tArgt -0500	Value -500 will be displayed. Confirm by pressing the ✳ key to start positioning.

4.3 Menu selection

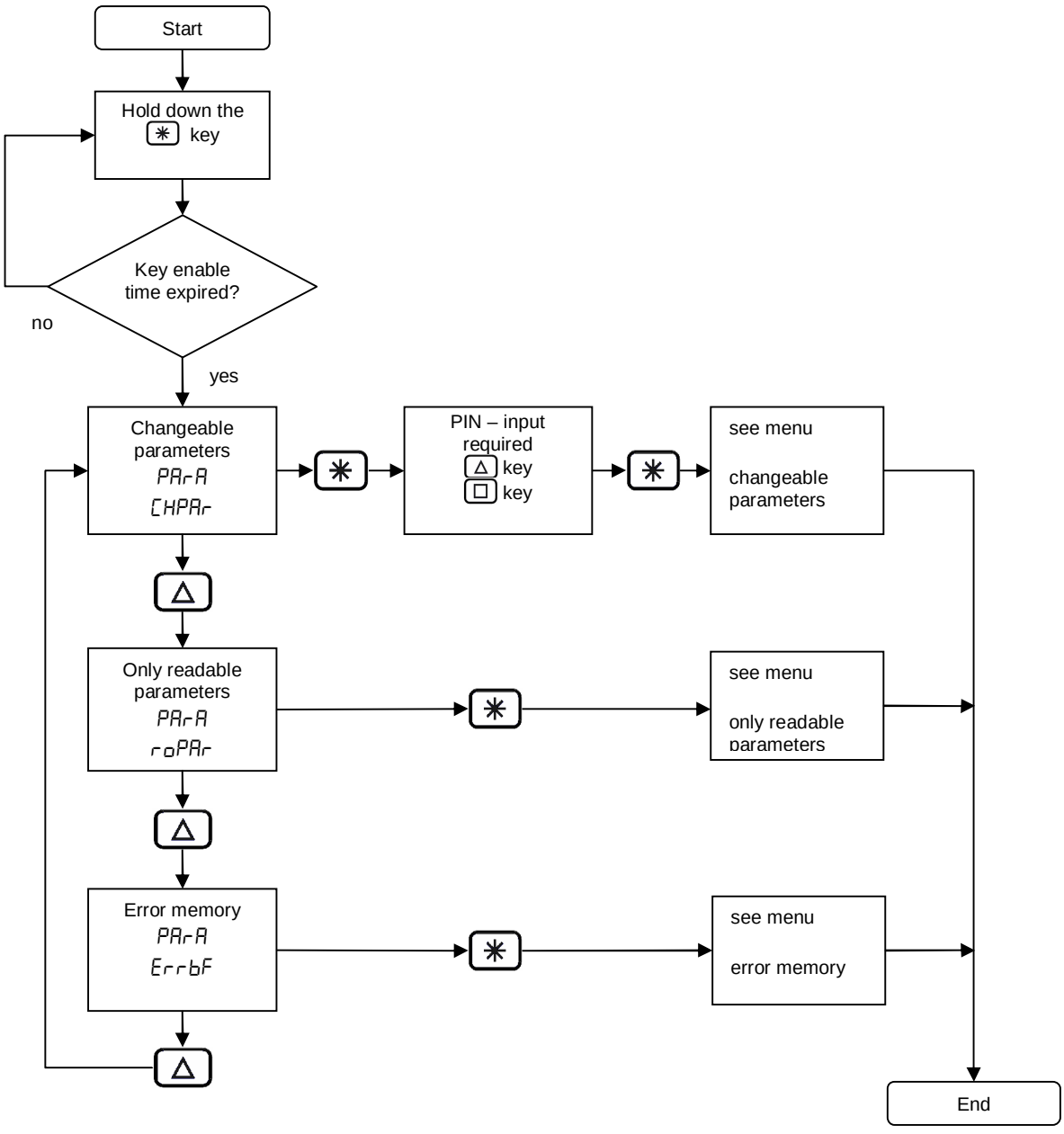

Fig. 6: Menu selection

4.3.1 Changeable parameters

The Changeable parameters menu is subdivided into further sub-menus:

Menu	Sub-menu	Description
PArA CHPAr	PArA bUS	Bus parameters
	PArA POSI t	Positioning
	PArA dru	Actuator
	PArA bound	Limiting values
	PArA U IS IO	Visualization
	PArA OPt IO	Options
	PArA Contr	Controller parameter
	PArA 9U It	Exit menu

Table 2: Changeable parameters menu overview

4.3.1.1 Bus parameters

Menu	PArA CHPAr	Sub-menu	PArA bUS

Parameter	Description
Id	Node address Value range: 1 - 127 *(see chapter 8: Parameter description ⇒ Parameter no.22)*
bAUd	Baud rate Selection: 1000: 1 Mbit/s 800: 800 kbit/s 500: 500 kbit/s 250: 250 kbit/s 125: 125 kbit/s 50: 50 kbit/s 20: 20 kbit/s *(see chapter 8: Parameter description ⇒ Parameter no.33)*

Table 3: Bus parameter menu

4.3.1.2 Positioning

Menu	PArA CHPAr	Sub-menu	PArA POS It

Parameter	Description
tAr9t	Pos window Value range: 0 - 1000 *(see chapter 8: Parameter description ⇒ Parameter no.10)*
P ItCH	Spindle pitch Value range: 0 - 99999 *(see chapter 8: Parameter description ⇒ Parameter no.13)*
d IU	Display divisor Selection: I: 1 I0: 10 I00: 100 I000: 1000 *(see chapter 8: Parameter description ⇒ Parameter no.43)*
CAL Ib	Calibration value Value range: -19999 … 99999 *(see chapter 8: Parameter description ⇒ Parameter no.14)*
LOAdP	Selection: no: no calibration CAL Ib: Execute calibration
OFFSt	Offset Value range: -19999 … 99999 *(see chapter 8: Parameter description ⇒ Parameter no.32)*
rotAt	Sense of rotation Selection: Cr: i sense of rotation (cw) CCr: e sense of rotation (ccw) *(see chapter 8: Parameter description ⇒ Parameter no.18)*
POtyP	Pos Type Selection: d Ir: direct POS: loop + nE9: sloop - *(see chapter 8: Parameter description ⇒ Parameter no.19)*
LOOP	Loop length Value range: 0 - 30000 *(see chapter 8: Parameter description ⇒ Parameter no.27)*

Table 4: Positioning menu

4.3.1.3 Actuator

Menu	PArA CHPAr	Sub-menu	PArA dru

Parameter	Description
A POS	Acceleration in the positioning mode Value range: 1 - 100 *(see chapter 8: Parameter description ⇒ Parameter no.4)*
U POS	Maximum speed in the positioning mode Gear 98:1 ⇒ value range: 1 - 30 Gear 173:1 ⇒ value range: 1 - 16 *(see chapter 8: Parameter description ⇒ Parameter no.5)*
A rot	Acceleration in rotational speed mode Value range: 1 - 100 *(see chapter 8: Parameter description ⇒ Parameter no.6)*
A InC	Acceleration in inching mode 1 /2 Value range: 1 - 100 *(see chapter 8: Parameter description ⇒ Parameter no.8)*
U InC	Maximum speed in inching mode 1/2 Gear 98:1 ⇒ value range: 1 - 30 Gear 173:1 ⇒ value range: 1 - 16 *(see chapter 8: Parameter description ⇒ Parameter no.9)*
GtrnU	Numerator gear ratio Value range: 1 - 10000 *(see chapter 8: Parameter description ⇒ Parameter no.11)*
GtrdE	Denominator gear ratio Value range: 1 - 10000 *(see chapter 8: Parameter description ⇒ Parameter no.12)*

Table 5: Actuator menu

4.3.1.4 Limiting values

Menu	PArA CHPAr	Sub-menu	PArA bound

Parameter	Description
EndP1	Limit 1 Value range: -19999 … 99999 *(see chapter 8: Parameter description ⇒ Parameter no.15)*
EndP2	Limit 2 Value range: -19999 … 99999 *(see chapter 8: Parameter description ⇒ Parameter no.16)*
torGE	Current limiting Value range: 25 - 110 *(see chapter 8: Parameter description ⇒ Parameter no.29)*
Cont	Contouring error limit Value range: 1 - 30000 *(see chapter 8: Parameter description ⇒ Parameter no.28)*

Table 6: Limiting values menu

4.3.1.5 Visualization

Menu	PArA CHPAr	Sub-menu	PArA U IS 10

Parameter	Description
d ISPL	Display orientation Selection: 0: 0° 180: 180° *(see chapter 8: Parameter description ⇒ Parameter no.45)*
OrA 2	LED 2 orange function Selection: on: Bus operation display OFF: Off *(see chapter 8: Parameter description ⇒ Parameter no.39)*
rEd 1	Red LED 1 function Selection: on: Indication of the operating status OFF: Off *(see chapter 8: Parameter description ⇒ Parameter no.40)*
Grn 1	Green LED 1 function Selection: on: Indication of the operating status OFF: Off *(see chapter 8: Parameter description ⇒ Parameter no.41)*
dEC 1	Decimal places Selection: 0: 0 0.1: 0.0 002: 0.00 0003: 0.000 00004: 0.0000 *(see chapter 8: Parameter description ⇒ Parameter no.42)*
Ind IC	Direction indication function Selection: on: On InUrS: inverted OFF: Off *(see chapter 8: Parameter description ⇒ Parameter no.44)*

Parameter	Description
L InE2	Displayed value of 2nd display line Selection: tArgt: Set point dEG: Output stage temperature CUoLt: Control voltage PUoLt: Output stage voltage UbAtt: Battery voltage I dru: Motor current POS: Actual position UELO: Actual rotational speed *(see chapter 8: Parameter description ⇒ Parameter no.49)*
tESt	Display test Selection: no: no display test YES: Start display test, pressing the ✳ key stops display test

Table 7: Visualization menu

4.3.1.6 Options

Menu	PArA CHPAr	Sub-menu	PArA OPt 10

Parameter	Description
CdELA	Key enable time Value range: 1 - 60 *(see chapter 8: Parameter description ⇒ Parameter no.37)*
bUtEn	Key function enable Selection: on: Enable all key functions OFF: All key functions disabled *(see chapter 8: Parameter description ⇒ Parameter no.38)*
OPtyP	Operating mode Selection: POS: Positioning mode UELO: Rotational speed mode *(see chapter 8: Parameter description ⇒ Parameter no.20)*
d InCH	Delta Inch Value range: -19999 … 99999 *(see chapter 8: Parameter description ⇒ Parameter no.17)*
InPOS	Inpos mode Selection: CntrL: Position control to set point SHort: Position control Off and short circuit of all motor windings FrEE: Position control Off and drive enable *(see chapter 8: Parameter description ⇒ Parameter no.26)*

Parameter	Description
A tYP	Inching mode 2 acceleration type Selection: StAt: static acceleration dYn: incremental acceleration *(see chapter 8: Parameter description ⇒ Parameter no.31)*
StoP2	Stop mode inching 2 Selection: HArd: stop with maximum deceleration SOFt: stop with programmed deceleration *(see chapter 8: Parameter description ⇒ Parameter no.25)*
O InC2	Inching 2 Offset Value range: 10 - 100 *(see chapter 8: Parameter description ⇒ Parameter no.30)*
P In	PIN change Value range: 0 - 99999 *(see chapter 8: Parameter description ⇒ Parameter no.48)*
LOAdP	S commands Selection: no: execute no S command ALL: set all parameters to default StAnd: Set standard parameters to default dr IuE: Set controller parameters to default d ISPL: Set display parameters to default bUS: Set bus parameters to default CAL Ib: Calibration dLErr: Delete error memory

Table 8: Options menu

4.3.1.7 Controller parameters

Menu	PArA CHPAr	Sub-menu	PArA Contr

Parameter	Description
CPArP	Controller parameter P Value range: 1 - 500 *(see chapter 8: Parameter description ⇒ Parameter no.1)*
CPAr I	Controller parameter I Value range: 0 - 500 *(see chapter 8: Parameter description ⇒ Parameter no.2)*
CPArd	Controller parameter D Value range: 0 - 500 *(see chapter 8: Parameter description ⇒ Parameter no.3)*

Table 9: Controller parameters menu

4.3.2 Readable parameters

Menu	PArA roPAr

Parameter	Description
dE9	Output stage temperature
CuoLt	Control voltage
PuoLt	Output stage voltage
UbAtt	Battery voltage
I dru	Motor current
POS	Actual position
UELO	Actual speed
rEdUC	Gear reduction
EnCrE	Encoder resolution
U LCd	Display controller software version
U dru	Motor controller software version
SErno	Serial number
dProd	Production date

Table 10: Readable parameters menu

4.3.3 Error memory

Menu	PArA ErrbF

Parameter	Description
Errno 0	Number of errors in the error memory *(see chapter 8: Parameter description ⇒ Parameter no.61)*
Err 1 xxxxx	Error 1 *(see chapter 8: Parameter description ⇒ Parameter no.62)*
Err 2 xxxxx	Error 2 *(see chapter 8: Parameter description ⇒ Parameter no.63)*
Err 3 xxxxx	Error 3 *(see chapter 8: Parameter description ⇒ Parameter no.64)*
Err 4 xxxxx	Error 4 *(see chapter 8: Parameter description ⇒ Parameter no.65)*
Err 5 xxxxx	Error 5 *(see chapter 8: Parameter description ⇒ Parameter no.66)*
Err 6 xxxxx	Error 6 *(see chapter 8: Parameter description ⇒ Parameter no.67)*
Err 7 xxxxx	Error 7 *(see chapter 8: Parameter description ⇒ Parameter no.68)*
Err 8 xxxxx	Error 8 *(see chapter 8: Parameter description ⇒ Parameter no.69)*
Err 9 xxxxx	Error 9 *(see chapter 8: Parameter description ⇒ Parameter no.70)*
Err 10 xxxxx	Error 10 *(see chapter 8: Parameter description ⇒ Parameter no.71)*

Table 11: Error memory menu

xxxxx = Plain text display of error codes (*see chapter 7.2.1: Error codes)*

5 Calibration

Since the measuring system is an absolute system, calibration is necessary only once with commissioning. With calibration, the calibration value is adopted for calculation of the position value. The following equation is applied in case of calibration:

Position value = 0 + calibration value + offset value

Writing a value onto the calibration value parameter *(see chapter 8: Parameter description ⇒ Parameter no. 14)* will result in the adoption of such value as the absolute position for the actuator.

Offset value *(see chapter 8: Parameter description ⇒ Parameter no. 32)*

NOTICE	Calibration is only possible when no travel job is active!

6 External gear

If an external gear is used, a factor can be programmed via the parameters no. 11 'ü – numerator' and parameter no. 12 'ü – denominator' in order to include the gear ratio in position sensing.

Example (see Fig. 7*):*

The actuator is operated on a gear with transmission reduction of 5:1. For this purpose, the parameters 'ü-numerator' and 'ü-denominator' must be programmed as follows:

- Parameter 'ü – numerator': 5
- Parameter 'ü – denominator': 1

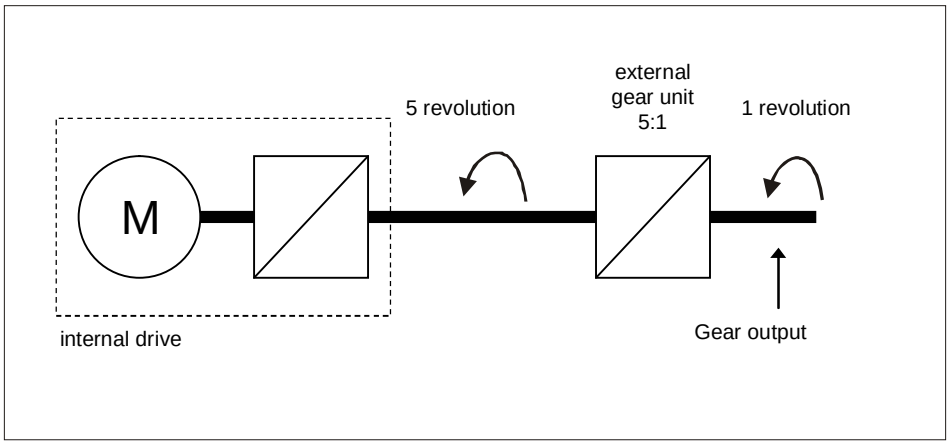

Fig. 7: External gear

Input of an odd gear transmission reduction value is possible according to the following example:

Transmission reduction = 3.78

- Parameter ‘ü – numerator’: 378
- Parameter ‘ü – denominator’: 100

7 Warnings / Errors

7.1 Warnings

Warnings do not influence the operation of the positioning drive.
Warnings disappear after removing the cause.

Possible warnings:

- Battery voltage for absolute encoder is below limit ⇒ exchange battery within the next 6 months.
- Current limiting active.

7.2 Errors

Errors cause an immediate stop of the positioning drive.
Error states are signalled via display.

Via interface errors can also be detected:

The error messages are entered in the error memory in the order of their detection. The last 10 error messages are displayed when the error memory is full.

The cause of error can be tracked down with the help of the error codes.

7.2.1 Störungscodes

Display	EMCY-Error Codes	Error
noErr	00 00_h	No error
toCLI	FF 04_h	Timeout client
toHOS	FF 05_h	Timeout host
cSCLI	FF 06_h	Check sum client
cSHOS	FF 07_h	Check sum host
dEFIn	FF 08_h	Define mismatch
bAtt	FF 09_h	Low battery voltage:
CUuLt	32 21_h	Low control electronics voltage
CouLt	32 11_h	Excess control electronics voltage
POuLt	32 12_h	Excess power electronics voltage
ouErt	43 10_h	Output stage excess temperature
LAG	86 11_h	Contouring error
bLoc	71 21_h	Shaft blocked

Display	EMCY-Error Codes	Error
noSUP	32 22$_h$	Power electronics: not supplied
bEYPE	FF 0A$_h$	Unknown bus type
SI nCO	73 00$_h$	SIN COS monitoring error
9 IouR	FF 0B$_h$	Queue 1 overrun
92ouR	FF 0C$_h$	Queue 2 overrun
9UESt	FF 0D$_h$	Response doesn't match question
CSEEP	FF 0E$_h$	Check sum EEPROM
ErPAS	FF 02$_h$	Error Passive state occurred during an active travel job
bUSOF	FF 03$_h$	Bus Off status
93ouR	FF 0F$_h$	Queue 3 overrun
94ouR	FF 10$_h$	Queue 4 overrun
CAnou	81 10$_h$	CAN overrun

Table 12: Error codes

7.3 Input errors

Input errors inform the user abaut errors that occurred during menu entries. Entries that produce errors are not adopted. Input errors are not saved in the error memory.

Display	Description
UALUE	Value range exceeded / inappropriate
LI UP	Input value exceeds upper limit
LI LO	Input value exceeds lower limit
ACCES	Access nor supported
Pr2ro	Write on read only
rd2PO	Read on write only
StAtE	Error caused by device status
bUSY	Input disabled due to ongoing EEPROM write access
dJAct	Input disabled due to active travelling job
noPr9	Programming lock activated

8 Parameter description

Column	Explanation
S	"S" = Parameter transferred is saved in the device non-volatilely "-" = Parameter transferred is saved in the device volatilely
C	Parameter class 1 = Standard parameter 2 = Controller parameter 3 = Display parameter 4 = Bus parameter 5 = general parameter

No.	Name	Selection / value	Default	Description	S	C
1	Controller parameter P	1 - 500	300	**P gain of controller** valid for all operating modes (positioning mode, speed mode, inching mode)	S	2
2	Controller parameter I	0 - 500	2	**I gain of controller** valid for all operating modes (positioning mode, speed mode, inching mode)	S	2
3	Controller parameter D	0 - 500	0	**D gain of controller** valid for all operating modes (positioning mode, speed mode, inching mode)	S	2
4	a - pos	1 - 100	50	**Acceleration in the positioning mode:** values in % 100% correspond to: Gear 98:1 $\Rightarrow$ 2.05 rps^2 Gear 173:1 $\Rightarrow$ 1.16 rps^2	S	2
5	v - pos	1 - 30 1 - 16	10	**Maximum speed** **in the positioning mode:** values in rpm gear 98:1 $\Rightarrow$ max. 30 rpm gear 173:1 $\Rightarrow$ max. 16 rpm	S	2
6	a - rot	1 - 100	50	**Acceleration in rotational speed mode** values in % 100% correspond to: Gar 98:1 $\Rightarrow$ 2.05 rps^2 Gar 173:1 $\Rightarrow$ 1.16 rps^2	S	2
7				reserved		
8	a - inch	1 - 100	50	**Acceleration in inching mode 1/2:** values in % 100% correspond to: Gear 98:1 $\Rightarrow$ 2.05 rps^2 Gear 173:1 $\Rightarrow$ 1.16 rps^2	S	2
9	v - inch	1 - 30 1 - 16	10	**Maximum speed** **in inching mode 1/2:** values in revolutions/min Gear 98:1 $\Rightarrow$ max. 30 rpm Gear 173:1 $\Rightarrow$ max. 16 rpm	S	2

No.	Name	Selection / value	Default	Description	S	C
10	Pos window	0 - 1000	10	**Operating mode: Positioning mode** Positioning window If the actual position of the actuator is within the programmed set point ± this window, this is signalled by setting bit 3 in the status word of the actuator. Spindle pitch = 0: Values refer to increments Spindle pitch > 0: Values refer to travel distance in 1/100 mm **Operating mode: Speed mode:** If the actual rotational speed is within the target rotational speed ± this window, this is signalled by setting bit 3 in the system status word of the actuator.	S	1
11	ü - numerator	1 - 10000	1	**Numerator gear ratio:** a gear factor can be programmed here when a gear is used.	S	1
12	ü - denominator	1 - 10000	1	**Denominator gear ratio** a gear factor can be programmed here when a gear is used.	S	1
13	Spindle pitch	0 - 1000000	0	**Spindle pitch** Spindle pitch parameter = 0: Position value is output in increments (720 increments per revolution of the driving shaft). Spindle pitch parameter > 0: (when operating the actuator on a spindle) The position value is output as travelling distance in 1/100 mm, not in increments. Input of target position is now in 1/100 mm as well, e. g. spindle with a pitch of 2 mm ⇒ Spindle pitch parameter = 200.	S	1
14	Calibration value	-999999 to 999999	0	**Calibration value:** Changes in the calibration value will be directly adopted for the calculation of the position value. Position value = 0 + calibration value + offset value	S	1
15	Limit 1	-9999999 to 9999999	99999	**Operating mode: Positioning mode: Limit 1** Spindle pitch = 0: Values refer to increments Spindle pitch > 0: Values refer to travelling distance in 1/100 mm If actuator's position is beyond the range defined by limit 1 and limit 2 (travel range), travelling will only be possible in inching mode in the direction of the travel range. ***Caution! !*** Limit monitoring is deactivated if 'limit 1' is equal 'limit 2'. Please note that there is a jump of the actual position if the resolution of the absolute encoder is exceeded! **Operating mode: Speed mode:** irrelevant	S	1

No.	Name	Selection / value	Default	Description	S	C
16	Limit 2	-9999999 to 9999999	-19999	**Operating mode: Positioning mode: Limit 2** Spindle pitch = 0: Values refer to increments Spindle pitch > 0: Information refers to travel distance in 1/100 mm If actuator's position is beyond the range defined by limit 1 and limit 2 (travel range), travelling will only be possible in inching mode in the direction of the travel range. ***Caution! !*** Limit monitoring is deactivated if 'limit 1' is equal 'limit 2'. Please note that there is a jump of the actual position if the resolution of the absolute encoder is exceeded! **Operating mode: Speed mode:** irrelevant	S	1
17	Delta inch	-1000000 to 1000000	720	**delta travelling distance with inching operation 1:** indicates the relative travelling distance. positive value ⇒ positive travelling direction negative value ⇒ negative travelling direction Spindle pitch = 0: Values refer to increments Spindle pitch > 0: Information refers to travel distance in 1/100 mm	S	1
18	Sense of rotation	i,e	i	**Counting direction of the measuring system:** With shaft rotating counter-clockwise (view on the clamping ring of the actuator) i sense of rotation (cw): ⇒ positive counting direction e sense of rotation (ccw): ⇒ negative counting direction	S	1
19	Pos Type	direct loop + sloop -	direct	**Operating mode: Positioning mode: Type of positioning** *direct:* direct travelling from actual position to set point *loop +:* travelling to the set point occurs always in positive direction to compensate for spindle play *loop -:* travelling to the set point occurs always in negative direction to compensate for spindle play ***Caution!*** Loop positioning in positioning mode only. **Operating mode: Speed mode:** irrelevant	S	1
20	Operating mode	positioning mode / speed mode	positioning mode	**Operating mode: Positioning mode:** *(see chapter 4.1.3.1: Positioning mode)* **Operating mode: Speed mode:** *(see chapter 4.1.3.3: Speed mode)*	S	1
21				reserved		
22	Node address	1 - 127	1	Setting the CAN Node-ID	S	5
23				reserved		

No.	Name	Selection / value	Default	Description	S	C
24	Set point	see Description column	0	**Operating mode: Positioning mode** indicates absolute target position. Spindle pitch = 0: Values refer to increments Spindle pitch > 0: Information refers to travel distance in 1/100 mm Value range: depends on the preprogrammed target values *(parameters 15/16)* **Operating mode: Speed mode:** indicates the target rotational speed in rpm Value range: Gear 98:1 ⇒ max. ±30 rpm Gear 173:1 ⇒ max. ± 16 rpm	-	1
25	Stop mode Inch 2	0 - 1	0	**Stop mode inching mode 2 / inching key operation** Stopping behaviour of inching mode 2 or inching key mode, resp., can be parameterized differently. Stop mode = 0 stop with maximum deceleration Stop mode = 1 stop with programmed deceleration (parameter no. 8)	S	1
26	Inpos mode	0 - 2	0	**Operating mode: Positioning mode** With this parameter you can define the behaviour of the actuator upon reaching the position window: Inpos mode = 0 Position control to set point Inpos mode = 1 Position control OFF and short circuit of the motor windings Inpos mode = 2 Position control OFF and drive enable **Operating mode: Speed mode:** irrelevant	S	1
27	Loop length	0 - 30000	360	**Operating mode: Positioning mode** Spindle pitch = 0: Values refer to increments Spindle pitch > 0: values refer to travel distance in 1/100 mm **Operating mode: Speed mode:** irrelevant	S	1
28	Contouring error limit	1 - 30000	400	**Contouring error limit:** Exceeding the contouring error limit during on-going positioning results in a “Contouring error” fault.	S	1
29	Current limiting	25 - 110	110	**Current limiting** Limiting of surge current. Current limiting setup in % 100% = 1.1 A	S	1
30	Inching 2 Offset	10 - 100	100	**Inching operation 2** The inching speed in Inching operation 2 can be influenced via this parameter Values in percentage of parameter no. 9	-	1

No.	Name	Selection / value	Default	Description	S	C
31	Type of acceleration Inching mode 2	0 - 1	0	**Inching operation 2** The type of acceleration can be set with this parameter. 0 = static acceleration Acceleration to final speed in one step as defined under parameter no. 8. 1 = incremental acceleration Acceleration to final speed as defined under parameter no. 8 with the following increments: 4 s to 20% of final speed 2 s to 50% of final speed 1 s to 100% of final speed	S	1
32	Offset	-999999 to 999999	0	**Offset value** Changes to the offset value are immediately entered in the calculation of the position value. The following equation is applied in case of calibration: Position value = 0 + calibration value + offset value	S	1
33	Baud rate CAN	1 - 7	3	**Baud rate of the CAN interface:** 1 = 1 Mbit/s 2 = 800 kbit/s 3 = 500 kbit/s 4 = 250 kbit/s 5 = 125 kbit/s 6 = 50 kbit/s 7 = 20 kbit/s Parameter changes become active only after cold start or software reset.	S	5
34				reserved		
35				reserved		
36				reserved		
37	Key enable time	1 - 60	3	**Display / key control:** Time in seconds the asterisk key must be held down until menu can be entered or the set point specification is enabled via display.	S	3
38	Key function enable	0 - 1	0	**Display / key control:** The access to inching mode 2, positioning mode and rotational speed mode functions via keys can be set with this parameter. 0 = all functions via key enabled 1 = All functions via key disabled	S	3
39	LED 2 orange	0 - 1	1	**LED 2 orange function:** 0 = Off 1 = Bus operation indication	S	3
40	LED 1 red	0 - 1	1	**Red LED 1 function:** 0 = Off 1 = Indication of the operating status	S	3
41	LED 1 green	0 - 1	1	**Green LED 1 function:** 0 = Off 1 = Indication of the operating status	S	3

No.	Name	Selection / value	Default	Description	S	C
42	Decimal places	0 - 4	0	**Display:** Input of decimal places 0 = 0 1 = 0.0 2 = 0.00 3 = 0.000 4 = 0.0000	S	3
43	Display divisor	0 - 3	0	**Anzeige:** **Display:** Divisor by which the display accuracy is reduced compared with the measurement resolution. 0 = 1 1 = 10 2 = 100 3 = 1000	S	3
44	Direction indication function	0 - 2	0	**Display:** The direction indicators show the key to be pressed to arrive at the set position window. 0 = On 1 = Inverted 2 = Off	S	3
45	Display orientation	0 - 1	0	**Display:** Display orientation 0 = 0° 1 = rotated by 180°	S	3
46				reserved		
47				reserved		
48	PIN Change	0 - 99999	0	**Display:** Required PIN to be able to change parameters via keys and display.	S	3
49	Displayed value 2nd display line	0 - 7	0	**Display:** Parameter to be displayed in the 2nd line of the display. 0 = set point 1 = Output stage temperature 2 = Control voltage 3 = Output stage voltage 4 = Battery voltage 5 = Motor current: 6 = Actual position 7 = Actual rotational speed	S	3
50	Output stage temperature	Read only	-	**Output stage temperature:** Values in 1/10 °C	-	-
51	Voltage of control	Read only	-	**Control voltage:** Values in 1/10 V	-	-
52	Voltage of output stage	Read only	-	**Output stage voltage:** Values in 1/10 V	-	-
53	Voltage of battery	Read only	-	**Battery voltage:** Values in 1/100 V	-	-
54	Motor current	Read only	-	**Motor current:** Values in mA	-	-
55	Actual position	Read only	-	**Actual position:** Spindle pitch = 0: values in increments Spindle pitch > 0: values in 1/100 mm	-	-

No.	Name	Selection / value	Default	Description	S	C
56	Actual rotational speed	Read only	-	**Actual rotational speed:** Values in rpm	-	-
57	Serial number	Read only	-	**Serial number**	S	-
58	Production date	Read only	-	**Production date:** Format: DDMMYYYY	S	-
59	Software version motor controller	Read only	-	**Motor controller software version**	S	-
60	Software version display controller	Read only	-	**Display controller software version**	S	-
61	Number of errors	Read only	-	**Number of errors in the error memory**	S	-
62	Error 1	Read only	-	**Error 1**	S	-
63	Error 2	Read only	-	**Error 2**	S	-
64	Error 3	Read only	-	**Error 3**	S	-
65	Error 4	Read only	-	**Error 4**	S	-
66	Error 5	Read only	-	**Error 5**	S	-
67	Error 6	Read only	-	**Error 6**	S	-
68	Error 7	Read only	-	**Error 7**	S	-
69	Error 8	Read only	-	**Error 8**	S	-
70	Error 9	Read only	-	**Error 9**	S	-
71	Error 10	Read only	-	**Error 10**	S	-
72	Gear reduction	Read only	-	**Gear reduction**	S	-
73	System Status Word	Read only	-	**System status word**	-	-
74	Display divisor application	0 - 1	0	**Positioning mode only:** 0 = The display divisor is applied to the interface's target and actual positions and to the display. 1 = The display divisor is applied to the display only.	S	3

Table 13: Parameter description

9 Communication via CAN bus

9.1 General remarks

This chapter describes activation and parameterization via CAN bus interface.
For the connector pin assignment of the CAN bus interface please refer to the installation instructions.

9.1.1 Interface

The following baud rates are supported:

1 Mbit/s, 800 kbit/s, 500 kbit/s, 250 kbit/s, 125 kbit/s, 50 kbit/s, 20 kbit/s

Termination of the CAN bus line:

If the actuator is at the end of the bus, the CAN bus connection must be terminated by a defined bus terminator.

9.2 System Status Word

The system status word consists of 2 bytes and reflects the state of the actuator *(see chapter 8: Parameter description ⇒ Parameter no. 73)*.

High Byte								Low Byte							
Bit number															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	1	0	0	1	0	1	0	0	1	0	0	0
2				9				4				8			

Fig. 8: Structure of system status word

Example (grey background):

binary: ⇒ 0010 1001 0100 1000
hex: ⇒ 2 9 4 8

9.2.1 Meaning of the bits

The table below informs about the meaning of the individual bits of the status word:

Bit	State	Description
Bit 0	‘0‘	irrelevant
Bit 1	‘0‘	irrelevant
Bit 2	‘0‘	irrelevant
Bit 3	‘1‘	**Operating mode: Positioning mode In Position** Actual position is within the positioning window of the programmed set point.
	‘0‘	Actual position is beyond the positioning window of the programmed set point.
	‘1‘	**Operating mode: Speed mode: In Position** Actual rotational speed is within the specified tolerance window of the target speed.
	‘0‘	Actual speed is outside the specified tolerance window.
Bit 4	‘1‘	**Actuator travels:** Actuator travels.
	‘0‘	Drive stands still (rotational speed < 2 rpm).

Bit	State	Description
Bit 5	‘1‘	**Operating mode: Positioning mode, upper limit:** Actual position is above the programmed limiting value. Travelling is possible only in negative direction in inching mode.
	‘0‘	Actual position is below the programmed limiting value.
	‘0‘	**Operating mode: Speed mode:** irrelevant
Bit 6	‘1‘	**Operating mode: Positioning mode, lower limit:** Actual position is below the programmed limiting value. Travelling is possible only in positive direction in inching mode.
	‘0‘	Actual position is above the programmed limiting value.
	‘0‘	**Operating mode: Speed mode:** irrelevant
Bit 7	‘1‘	**Driver state:** Motor is enabled.
	‘0‘	Motor in control.
Bit 8	‘1‘	**Error:** Actuator has switched to error. The cause of the error must be removed and acknowledged.
	‘0‘	No error present.
Bit 9	‘1‘	**Operating mode: Positioning mode: Loop travel** If travel direction unequal start direction (with loop travel).
	‘0‘	If travel direction equal start direction.
	‘0‘	**Operating mode: Speed mode:** irrelevant
Bit 10	‘1‘	**Output stage supply voltage:** No voltage, no travelling possible.
	‘0‘	Voltage applied.
Bit 11	‘1‘	**Ready for travel:** Not ready for travel
	‘0‘	Ready for travel: • Actuator not in error state • No active positioning • Supply voltage of the output stage is applied • Actual position within limits (only positioning mode)
Bit 12	‘1‘	**Battery voltage:** Battery voltage < 2,6 V
	‘0‘	Battery voltage OK
Bit 13	‘1‘	**Current limiting:** Current limiting active.
	‘0‘	Current limiting not active.
Bit 14	‘1‘	**Operating mode: Positioning mode Status:** Positioning active in positioning mode.
	‘0‘	Positioning inactive.
	‘1‘	**Operating mode: Speed mode: Status** Enable target speed.
	‘0‘	Target speed disabled.
Bit 15	‘1‘	**Contouring error:** Contouring error ⇒ the actuator cannot reach the pre-set speed due to too high load. The actuator switches the contouring error fault. Remedy: reduce programmed speed!
	‘0‘	No contouring error ⇒ actual speed corresponds to target speed.

Table 14: System Status Word

9.3 CANopen protocol

The CANopen protocol is based on the CANopen communication profile *CiA DS-301 V4.0* as well as the device profile *Drives and Motion Control CiA DSP-402 V2.0.*

The details required for a better understanding and possible deviations are included in this documentation.

9.3.1 Telegram setup

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

SOF:
Start of Frame ⇒ start bit of the telegram

Identifier:
The Identifier field contains the identifier as well as bits for the recognition of the length of the identifiers (11 or 29 bits). The identifier determines the priority of the message.
Via identifier, CANopen determines additionally the device address, channel selection as well as data direction.

Control field:
contains bits concerning the number of user data and determines whether a data frame or RTR frame (Remote Transfer 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 acknowledgement bits as well as bits for determining the end of telegram.

Fig. 9: Telegram setup

For a detailed description of the telegram please refer to the comprehensive CAN literature.
For simplification, only identifier and data field will be dealt with in the subsequent telegram descriptions.

9.3.2 Network management (NMT)

The master configures, manages and monitors network nodes via the NMT service.

For switching between the four available communication states of a network node, INITIALISATION‘, ‘PRE-OPERATIONAL‘, ‘OPERATIONAL‘ and ‘STOPPED‘, telegrams with the identifier ‘0´as well as 2 bytes of user data are used.
The identifier of the NMT protocol is limited to 11 bits.

9.3.2.1 State Diagramm

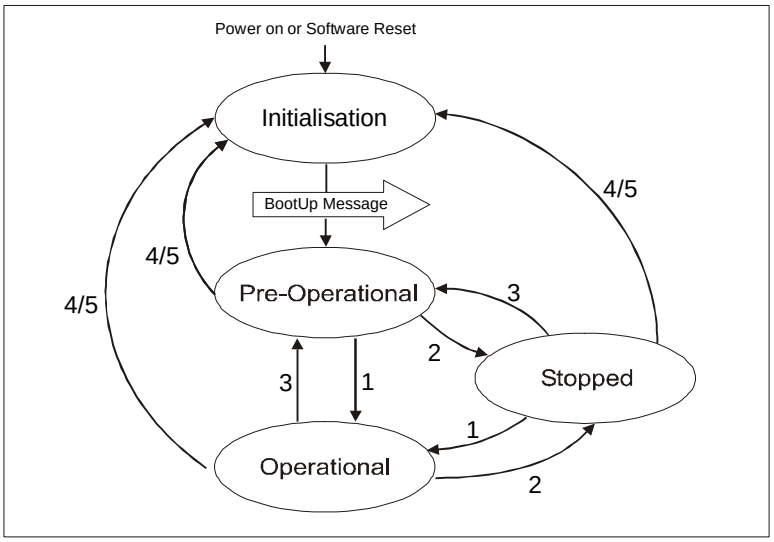

Fig. 10: State Diagramm

9.3.2.2 NMT Status 'INITIALISATION'

The actuator is not involved in the bus actions in this state. All hardware and software components are initialised. This state is attained after switching on the device or after receipt of the command code 82h of the own or global addresses. After completion of initialisation, the actuator goes automatically into the 'PRE-OPERATIONAL' status. This is signalled by a boot-up message consisting of the identifier '1791 + Node ID' and a data byte having the value '0'.

9.3.2.3 NMT Status 'PRE-OPERATIONAL'

The exchange of parameterization data (SDOs) between the actuator and the bus master is enabled. However, no process data (PDOs) is transferred.
Furthermore, the State Machine of the actuator is set to the 'SWITCH ON DISABLED' state *(see chapter 9.4: State Machine)* and the motor enabled.

NOTICE	PDO parameters can be changed in this state only!

9.3.2.4 NMT Status 'OPERATIONAL'

Exchange of process and parameterization data is enabled.

9.3.2.5 NMT Status 'STOPPED'

Exchange of all data is stopped with the exception of the heartbeat message *(see chapter 9.3.10: Heartbeat protocol)* and the node guarding protocol, if active *(see chapter 9.3.11: Node Guarding)*. Only NMT communication is enabled.
Furthermore, the State Machine of the actuator is set to the 'SWITCH ON DISABLED' state *(see chapter 9.4: State Machine)* and the motor enabled.

9.3.2.6 Switching between communication states

The network master can switch between the communication states by sending the following telegrams with the identifier '0'.

Status change		Data 1	Data 2
from	to		
PRE-OPERATIONAL / STOPPED	OPERATIONAL (1)	01h	xx
OPERATIONAL/ PRE-OPERATIONAL	STOPPED (2)	02h	xx
OPERATIONAL / STOPPED	PRE-OPERATIONAL (3)	80h	xx
OPERATIONAL / PRE-OPERATIONAL / STOPPED	INITIALISATION (4/5)	81h	xx
OPERATIONAL / PRE-OPERATIONAL / STOPPED	INITIALISATION * (4/5)	82h	xx

Table 15: Switching between communication state

* Cold start is triggered (Power on)

xx = 0 ⇒ the telegram is intended for all devices on the bus
xx = device address ⇒ the telegram is only intended for the device with the respective address.

9.3.3 SYNC object

CANopen enables the simultaneous query of all inputs and the simultaneous setting of all outputs. The synchronization telegram (SYNC), a CAN message with high priority, which contains no user data serves for this purpose.
The identifier of the Sync object can be set via object 1005_h *(see chapter 9.13.2: Description of objects)*.

9.3.4 Process Data Objects (PDOs)

Process data objects serve for fast exchange of short process data. Process data objects are transferred event-triggered, cyclically or on request.
A maximum of 8 bytes of user data can be transferred in a PDO.

NOTICE	The exchange of PDOs is enabled in the NMT status Operational only!

The actuator provides 3 Transmit PDOs (process data from the actuator ⇒ NMT master) and 3 Receive PDOs (process data from the NMT master ⇒ to the actuator).
The Receive PDOs, RPDO1, RPDO3, RPDo4 and the Transmit PDOs, TPDO1, TPDO3 and TPDO4 are supported according to the Device Profil 'Drives and Motion Control CIA DSP-402 Version 2.0'.

9.3.5 Transmit PDOs

9.3.5.1 1st Transmit PDO (TPDO1)

The first Transmit PDO contains 2 user data bytes on which the status word of the actuator is mapped.
The Transmit PDO is transferred by the actuator asynchronously as a standard. Together with the Receive PDO1 on which the control word of the state machine is mapped it forms a handshake connection (acknowledgement operation) between the higher-order control and the drive controller.
It is, therefore not recommended to change the transfer type of the TDO1.

The COB-ID of the first Transmit PDO is programmed to 180_h + Node-ID by default.
The communication parameters are set via the object 1800_h (1st Transmit PDO parameter).

1st Transmit PDO		
11/29 Bit Identifier	Byte 1	Byte 2
	LSB	MSB
	Status word (object 6041_h)	

Fig. 11: 1st Transmit PDO

9.3.5.2 3rd Transmit PDO (TPDO3)

The third Transmit PDO contains 6 user data bytes on which the status word and the current position value of the actuator are mapped.

The Transmit PDO3 is transferred only by a RTR frame (remote transfer request) as a standard, i. e., a higher-order control must request the TDO3 (polling). Synchronous transfer (value 0 to 240) can be set via the SYNC object or the time-triggered transfer (value 255) by means of a local cycle (event timer) as an alternative to polling.

The COB-ID of the third Transmit PDO is programmed to 380_h + Node-ID by default.
The communication parameters are set via the object 1802_h (3rd Transmit PDO parameter).

3rd Transmit PDO						
11/29 Bit Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	LSB	MSB	LSB	NSB	NSB	MSB
	Status word (object 6041_h)		Position value (object 6064_h)			

Fig. 12: 3rd Transmit PDO

9.3.5.3 4th Transmit PDO (TPDO4)

The fourth Transmit PDO contains 6 user data bytes on which the status word and the actual velocity of the actuator is mapped.
The Transmit PDO4 is transferred only by a RTR frame (remote transfer request) as a standard, i. e., a higher-order control must request the TDO4 (polling). Synchronous transfer (value 0 to 240) can be set via the SYNC object or the time-triggered transfer (value 255) by means of a local cycle (event timer) as an alternative to polling.
The COB-ID of the fourth Transmit PDO is programmed to 480_h + Node-ID by default.
The communication parameters are set via the object 1803_h (4th Transmit PDO parameter).

4th Transmit PDO						
11/29 Bit Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	LSB	MSB	LSB	NSB	NSB	MSB
	Status word (object 6041_h)		Actual velocity (object $606C_h$)			

Fig. 13: 4th Transmit PDO

9.3.5.4 Transfer types of the Transmit PDOs

Different transfer types can be set for the individual PDOs via objects 1800_h until 1803_h 'Transmit PDO Parameter' sub-index 2 *(see chapter 9.13.2: Description of objects)*.

Synchronous:

Sub-index 2 (transfer type) = 0:
The Transmit PDO is sent by the actuator upon receipt of each SYNC telegram.

Sub-index 2 (transfer type) = 1…240:
The Transmit PDO is sent by the actuator only after receipt of the number of SYNC telegrams indicated under 'transfer type'.

Asynchronous:

Event-Triggered: Sub-index 2 (transfer type) = 254:
A PDO is sent with every change of the position value (Profile Position Mode) or the actual velocity (Profile Velocity Mode), respectively (only possible with TPDO3 and TPDO4).

Time-Triggered: Sub-index 2 (transfer type) = 255:
The PDOs are transferred time-triggered.
The sub-index 5 'Event Timer' of the Transmit PDO parameters indicates the cycle time in milliseconds.

Sub-index 2 (transfer type) = 253:
The Transmit PDO is sent after receipt of a RTR frame with the identifier of the respective Transmit PDO.

9.3.6 Receive PDOs

9.3.6.1 1st Receive PDO (RPDO1)

The first Receive PDO contains 2 user data bytes on which the status word of the actuator is mapped.

The control word in the Receive PDO1 serves for controlling the operation transitions of the state machine. The Receive PDO1 serves for getting the state machine into the OPERATION ENABLED state or for commanding travel interruption or cancellation of travel during running drive movement, respectively.

The drive controller processes the Receive PDO1 asynchronously as a standard. Together with the Transmit PDO1 on which the control word of the state machine is mapped it forms a handshake connection (acknowledgement operation) between the higher-order control and the drive controller.
It is, therefore not recommended to change the transfer type of the RPDO1.

The COB-ID of the first Receive PDO is programmed to 200_h + Node-ID by default.

The communication parameters are set via the object 1400_h (1st Receive PDO parameter).

1st Receive PDO		
11/29 Bit Identifier	Byte 1	Byte 2
	LSB	MSB
	Control word (object 6040_h)	

Fig. 14: 1st Receive PDO

9.3.6.2 3rd Receive PDO (RPDO3)

The third Receive PDO is assigned to the operation mode 'Profile Position Mode' (positioning mode) and contains 6 user data bytes on which the control word as well as the current target value for the actuator is mapped.
The position transferred is taken over as the absolute target position. Drive movement in the positioning mode can be executed from the 'OPERATION ENABLED' state of the state machine only.

The drive controller processes the Receive PDO3 asynchronously as a standard.
Together with the Transmit PDO1 on which the status word of the state machine is mapped, it forms a handshake connection (acknowledgement operation) between the higher-order control and the drive controller.
Synchronous transfer type (value 0) can be set to enable synchronous start of more than one drive. The data of the RPDO3 is processed only after receipt of the next SYNC telegram in this case *(see chapter 9.3.3: SYNC object).*

The COB-ID of the third Transmit PDO is programmed to 400_h + Node-ID by default.
The communication parameters are set via the object 1402_h (3rd Receive PDO parameter).

3rd Receive PDO						
11/29 Bit Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	LSB	MSB	LSB	NSB	NSB	MSB
	Control word (object 6040_h)		Target value (object $607A_h$)			

Fig. 15: 3rd Receive PDO

9.3.6.3 4th Receive PDO (RPDO4)

The fourth Receive PDO is assigned to the operation mode 'Velocity Mode' and contains 6 user data bytes on which the control word as well as the current target velocity for the actuator are mapped.
A driving movement in positive or negative sense of rotation is started via the control word in the Receive PDO4. Drive movement in the velocity mode can be executed from the 'OPERATION ENABLED' state of the state machine only.

The drive controller processes the Receive PDO4 asynchronously as a standard.
Together with the Transmit PDO1 onto which the status word of the state machine is mapped, it forms a handshake connection (acknowledgement operation) between the higher-order control and the drive controller.
Synchronous transfer type (value 0) can be set to enable synchronous start of more than one drive. The data of the RPDO4 is processed only after receipt of the next SYNC telegram in this case *(see chapter 9.3.3: SYNC object).*

The COB-ID of the fourth Transmit PDO is programmed to 500_h + Nodwe-ID by default.
The communication parameters are set via the object 1403_h (4th Receive PDO parameter).

4th Receive PDO						
11/29 Bit Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	LSB	MSB	LSB	NSB	NSB	MSB
	Control word (object 6040_h)		Target velocity (object $60FF_h$)			

Fig. 16: 4th Receive PDO

9.3.6.4 Transfer types of the Receive PDOs

Different transfer types can be set for the individual PDOs via objects 1400_h until 1403_h 'Receive PDO Parameter' sub-index 2 *(see chapter 9.13.2: Description of objects)*.

Synchronous:

Sub-index 2 (transfer type) = 0…240
In the synchronous transfer type, the Receive PDOs are processed only after receipt of a SYNC telegram.

Asynchronous:

Sub-index 2 (transfer type) = 254…255
In the asynchronous transfer type, the Receive PDOs are processed by the actuator immediately after receipt of the Receive PDO.

9.3.7 Service Data Objects (SDOs)

Service Data Objects (SDOs) serve in the first place for transferring device configuration parameters.
8 bytes of user data are always transferred in a SDO. The identifier is set to 11 bits and cannot be changed.

NOTICE	The exchange of SDOs is enabled in the NMT statuses "Pre-Operational" as well as "Operational"!

There is each one COB ID for data transfer from the master to the actuator (COB-ID 600_h + Node ID) and one COB ID for data transfer from the actuator to the master (COB-ID 580_h + Node-ID).
Data transfer is always initiated and controlled by the master.
The COB IDs for the Service Data Objects cannot be changed.

SDO Telegram								
11 Bit Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	Command	Parameter index		Sub-index	Data 1	Data 2	Data 3	Data 4

Fig. 17: Setup of the SDO telegram

Byte 1: Command code

The first byte contains the command code of the SDO telegram. The following table lists the available commands and describes their meaning.

Command	Command code hexadecimal	Command code decimal	Meaning
Write Request	23_h	35	send parameters (4 data byte)
Write Request	$2B_h$	43	send parameters (2 data byte)
Write Request	$2F_h$	47	send parameters (1 data byte)
Write Response	60_h	96	response of Write Request
Read Request	40_h	64	request of a parameter
Read Response	43_h	67	response to the request (4 data byte)
Read Response	$4B_h$	75	response to the request (2 data byte)
Read Response	$4F_h$	79	response to the request (1 data byte)
Error Response	80_h	128	error message

Table 16: Command codes

Bytes 2/3: Parameter index

The parameter index is entered in the user data byte 2 (low byte) and in the user data byte 3 (high byte) using ther Intel data format.
Here, the index of the object to be parameterized is entered *(see chapter 9.13.2: Description of objects)*.

Byte 4: Sub-index

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

Bytes 5…8: Data area

In the data area, the value of the parameter is entered in left-aligned Intel notation.
Byte 5 = low-Byte ... Byte 8 = high Byte

9.3.7.1 Error code

The actuator sends an error response (byte 1 = 80_h) if a communication error has occurred. An error code is entered in the user data bytes (bytes 5 … 8).
The table below shows the supported error codes.

Command code	Data 1	Data 2	Data 3	Data 4	Meaning
80_h	11_h	00_h	09_h	06_h	Sub-Index not exist.
80_h	02_h	00_h	01_h	06_h	Attempt to write read only object.
80_h	01_h	00_h	01_h	06_h	Attempt to read write only object.
80_h	30_h	00_h	09_h	06_h	Value range of parameter exceeded.
80_h	36_h	00_h	09_h	06_h	Maximum value is less than minimum value.
80_h	00_h	00_h	02_h	06_h	Object does not exist.
80_h	00_h	00_h	01_h	06_h	Unsupportet access to an object.
80_h	22_h	00_h	00_h	08_h	Data cannot be transferred to the application because of the present device state.

Table 17: Error codes

9.3.8 Example: Parameterization

The following 2 examples are intended to illustrate parameterization via Service Data Objects.

9.3.8.1 Example: Read parameter

The actuator has device address 5 and the calibration value is to be read out!

Calculation of the identifier:

Identifier of the parameter channel to the actuator = 600_h + device address

$600_h = 1536_{dec}$

Identifier = 1536 + 5 = 1541 = 605_h

Command code = Read request (= request of a parameter from the actuator) = 40_h

Index = $607C_h$

The index of the parameter 'Calibration value was taken from the directory of objects *(chapter 9.13.2: Description of objects)*.
Sub-index = 0

The current calibration value is 2500 = $9C4_h$.

Telegram from the master to the actuator:

Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
605_h	40_h	$7C_h$	60_h	00_h	00_h	00_h	00_h	00_h

Response of the actuator:

Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
585_h	42_h	$7C_h$	60_h	00_h	$C4_h$	09_h	00_h	00_h

Command code = Read Response = 42_h

Calculation of the identifier:

Identifier of the parameter channel from the actuator to the master = 580_h + device address

$580_h = 1408_{dec}$

Identifier = 1408 + 5 = 1413 = 585_h

9.3.8.2 Example: Write parameter

For the actuator with device address 5 the limit 1 is to be set to 2000000!

Calculation of the identifier:

Identifier of the parameter channel to the actuator = 600_h + device address
$600_h = 1536_{dec}$

Identifier = 1536 + 5 = 1541 = 605_h

Command code = Write request (send parameter to the actuator) = 23_h

Index = $607D_h$

Sub-index = 2

The index and the sub-index of the parameter 'limit 1' were taken from the directory of objects *(chapter 9.13.2: Description of objects)*.
2000000 = $1E8480_h$

Telegram from the master to the actuator:

Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
605_h	23_h	$7D_h$	60_h	02_h	80_h	84_h	$1E_h$	00_h

Response of the actuator in the case of error-free execution:

Identifier	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
585_h	60_h	$7D_h$	60_h	02_h	00_h	00_h	00_h	00_h

Command code = Write Response = 60_h

Calculation of the identifier:

Identifier of the parameter channel from the actuator to the master = 580_h + device address

$580_h = 1408_{dec}$

Identifier = 1408 + 5 = 1413 = 585_h

9.3.9 Emergency Object (EMCY)

In the case of an error, the node status is transferred via high-priority emergency messages (emergency telegrams). These telegrams have a data length of 8 bytes and contain error information.
The emergency telegram is transferred as soon as the actuator goes into the fault state *(for the causes of faults refer to chapter 7.2: Faults)* or when a communication error has occurred *(see* Table 18*: Error Code 8001 – 8120)*.
Resolution of the cause of fault and resetting of the actuator with undoing the fault state are signalled by sending of an emergency telegram with the error code 0000_h (no error) (not applicable to communication errors ⇒ Error codes 8001 – 8021).
The cause of the fault is deposited in the fault buffer *(see object 1003_h).*

Setup of the emergency telegram.

Identifier	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
11/29 Bit	Emergency Error Code *(see chapter 9.3.9)*		Error Register (Object 1001_h)	Manufacturer-specific error field (not used)				

Fig. 18: Emergency protocol

The identifier of the emergency object is set to 128 + Node-ID by default; however, it can be changed via object 1014_h *(see chapter 9.13.2: Description of objects).*
Transfer of an emergency telegram is enabled in the NMT statuses 'OPERATIONAL' or 'PRE-OPERATIONAL' only!

9.3.9.1 Error Code

The following table contains the possible error codes of the emergency telegram.

Error Code		Meaning
Byte 0 (Highbyte)	**Byte 1 (Lowbyte)**	
00	00_h	No error (no fault present) Is sent after clearing the fault state. *(see chapter 7.2: Faults)*
32	11_h	Control Overvoltage The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
32	12_h	Power Overvoltage The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
32	21_h	Control Undervoltage The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
32	22_h	Power Undervoltage The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
43	10_h	Overtemperature The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
71	21_h	Motor blocked The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
73	00_h	Sensor SIN/COS monitoring The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
81	10_h	CAN overrun The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
81	20_h	Error Passive
81	40_h	Recovered from Bus Off
86	11_h	Contouring Error The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	02_h	Manufacturer specific Error Passive on Move The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	03_h	Manufacturer specific Bus Off
FF	04_h	Manufacturer specific Timeout Client The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	05_h	Manufacturer specific Timeout Host The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	06_h	Manufacturer specific Checksum Client The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.

Error Code		Meaning
Byte 0 (Highbyte)	Byte 1 (Lowbyte)	
FF	07_h	Manufacturer specific Checksum Host The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	08_h	Manufacturer specific Define Mismatch The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	09_h	Manufacturer specific Battery Undervoltage The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0A_h$	Manufacturer specific Unknown Bustype The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0B_h$	Manufacturer specific Queue 1 overrun The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0C_h$	Manufacturer specific Queue 2 overrun The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0D_h$	Manufacturer specific Question Answer The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0E_h$	Manufacturer specific Checksum EEPROM The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	$0F_h$	Manufacturer specific Queue 3 Overrun The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.
FF	10_h	Manufacturer specific Queue 4 Overrun The state machine was set to the 'Fault' state. Fault is deposited in the fault buffer.

Table 18: Error Code

9.3.10 Heartbeat protocol

The master monitors the state of the actuator via heartbeat protocol. While doing this, the actuator sends cyclically its NMT status.
The actuator sends the heartbeat telegram independently, without request via RTR frame. The actuator is a heartbeat producer, it does not receive nor process heartbeat protocols.
The cycle time of the heartbeat telegram is set via object 1017_h *(see chapter 9.13.2: Description of objects).*
The heartbeat protocol is deactivated if the cycle time is 0.

The heartbeat protocol consists of one byte.

Identifier	Byte1
11 Bit	Status

Fig. 19: Heartbeat protocol

Status = 0: ‘INITIALISATION‘

Status = 4: ‘STOPPED‘

Status = 5: ‘OPERATIONAL‘

Status = 127: ‘PRE-OPERATIONAL‘

The identifier of the heartbeat protocol is permanently set to 1792 + Node-ID and cannot be changed.
Heartbeat telegram are sent in the NMT statuses ‘OPERATIONAL’, ‘PRE-OPERATIONAL’ or ‘STOPPED’.

NOTICE	The heartbeat protocol is only enabled when node guarding is deactivated!

9.3.11 Node Guarding

Node-guarding or life-guarding mechanisms are available for failure monitoring of the CANopen network. Via node guarding the nodes are monitored that can detect a failure of the master. During guarding, the master transmits remote frames (remot transmit request, message request telegrams) on the guarding identifiers of the nodes to be monitored. The latter respond with the guarding message containing the current status of the slave as well as a toggle bit which must change after each message.
The master assumes that a node error as occurred if status or toggle bits do not correspond with those expected by the master.

Via the objects $100C_h$ (Guard Time), $100D_h$ (Life Time Factor) the time interval (life time) is set within which the actuator expects a node query (RTR frame with the COB-ID 1792 + Node-ID) by the NMT master.
The time interval ‘Life time’is calculated from the cycle time ‘Guard time’ multiplied with the factor ‘Life Time Factor’.
The actuator State Machine switches to the ‘SWITCH ON DISABLED’ state if the actuator receives no RTR frame from the master during the ‘Life Time’.
By sending the first RTR frame of the master to the actuator, Node Guarding of the actuator is activated after switching on.
Node Guarding is deactivated if the value of either object ($100C_h$/$100D_h$) is zero.

The response of the actuator to the RTR frame of the master consists of one byte of user data.

Identifier	Byte 1	
11 Bit	Bit 7: Toggle Bit	Bit 6 ... 0: Status

Fig. 20: Node-Guarding Telegram

Toggle Bit:

The toggle bit must alternate between two subsequent responses of the actuator.
The value of the toggle bit with the first response of the actuator is 0 after activation of the guarding protocol.

Status:

Status = 0: ‘INITIALISATION‘
Status = 4: ‘STOPPED‘
Status = 5: ‘OPERATIONAL‘
Status = 127: ‘PRE-OPERATIONAL‘

The identifier of the heartbeat protocol is permanently set to 1792 + Node-ID and cannot be changed.
A node guard telegram can be sent in the NMT statuses ‘OPERATIONAL’, ‘PRE-OPERATIONAL’ or ‘STOPPED’.

NOTICE	The node-guard protocol is only enabled when the heartbeat protocol is deactivated!

9.4 State Machine

In the status word, the CANopen state machine indicates operational and error states of the drive resulting from operational transitions.

The states of the state machine can change via control word *(see chapter 9.6: Control word)* or due to internal events (e. g., occurrence of a fault).
The current state of the state machine can be read via the status word *(see chapter 9.5: Status word)*.

NOTICE	The states of the state machine can be set via PDOs only!

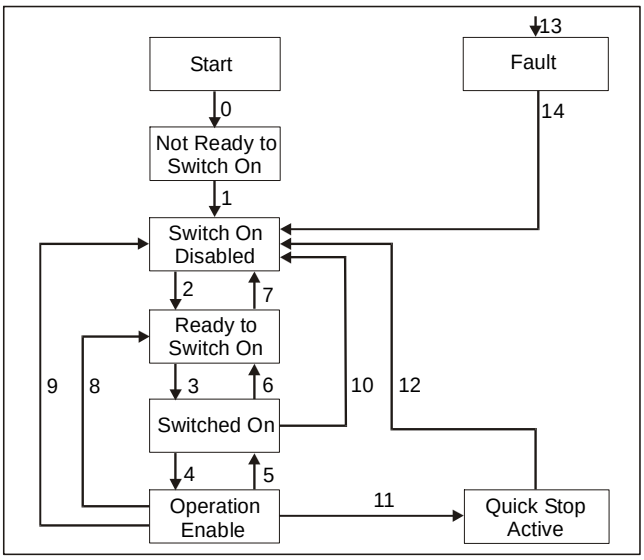

Fig. 21: State machine

The following states of the state machine of the actuator are available:

- ‘NOT READY TO SWITCH ON‘
  The actuator is being initialized after switching on.
  No travel commands can be accepted.
  Motor is enabled

- ‘SWITCH ON DISABLED‘
  Initialization completed.
  No travel commands can be accepted.
  Motor is enabled

- ‘READY TO SWITCH ON‘
  No travel commands can be accepted.
  Motor is enabled

- ‘SWITCHED ON‘
  No travel commands can be accepted.
  Motor is enabled

- ‘OPERATION ENABLED‘
  Travel commands can be accepted.
  Motor is in control state.

- ‘QUICK STOP ACTIVE‘
  The Quick Stop command was executed.
  Motor decelerates with maximum deceleration and stops with stop torque.
  Current positioning is cancelled.
  No travel commands can be accepted.

- ‘FAULT‘
  An error has occurred.
  Motor is enabled
  Current positioning is cancelled.
  No travel commands can be accepted.

The states of the State Machine can be changed via internal events or through commands of the master via control word *(see chapter 9.6: Control word)* .

- State change 0: START ⇒ NOT READY TO SWITCH ON
  Power on or software reset of the actuator

- State change 1: NOT READY TO SWITCH ON ⇒ SWITCH ON DISABLED
  Initialization and self-test of the actuator successfully completed.

- State change 2: SWITCH ON DISABLED ⇒ READY TO SWITCH ON
  ‘Shut-down’ command by master

- State change 3: READY TO SWITCH ON ⇒ SWITCHED ON
  ‘Switch-On’ command by master

- State change 4: SWITCHED ON ⇒ OPERATION ENABLE
  ‘Enable Operation’ command by master

- State change 5: OPERATION ENABLE ⇒ SWITCHED ON
  ‘Disable Operation’ command by master

- State change 6: SWITCHED ON ⇒ READY TO SWITCH ON
  'Shut-down' command by master
- State change 7: READY TO SWITCH ON ⇒ SWITCH ON DISABLED
  'Disable Voltage' command by master
- State change 8: OPERATION ENABLE ⇒ READY TO SWITCH ON
  'Shut-down' command by master
- State change 9: OPERATION ENABLE ⇒ SWITCH ON DISABLED
  'Disable Voltage' command by master
- State change 10: SWITCHED ON ⇒ SWITCH ON DISABLED
  'Disable Voltage' command by master
- State change 11: OPERATION ENABLE ⇒ QUICK STOP ACTIVE
  'Quick-Stop' command by master
- State change 12: QUICK STOP ACTIVE ⇒ SWITCH ON DISABLED
  'Disable Voltage' command by master
- State change 13: All states ⇒ FAULT
  A fault has occurred
- State change 14: FAULT ⇒ SWITCH ON DISABLED
  'Fault Reset' command by master

9.5 Status word

The status word reflects the current status of the actuator. It consists of 16 bits and is mapped on object 6041_h and on the 3 Transmit PDO's.

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

Fig. 22: Status word

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

Bit	Designation	Description
0	Ready to switch on	indicates the state of the State Machine *(see* Table 20*)*
1	Switched on	indicates the state of the State Machine *(see* Table 20*)*
2	Operation enabled	indicates the state of the State Machine *(see* Table 20*)*
3	Fault	indicates the state of the State Machine *(see* Table 20*)*
4	Voltage enabled	Bit 4 is set when the supply voltage is within the tolerance limit.
5	Quick stop	indicates the state of the State Machine *(see* Table 20*)* Bit 5 is set when the actuator is not in the 'QUICK STOP ACTIVE' state.
6	Switch on disabled	indicates the state of the State Machine *(see* Table 20*)*
7	Warning	Bit 7 is set when a warning is active *(see 7.1: Warnings).*

Bit	Designation	Description
8	Profile Position Mode: show readiness for travel	Bit 8 is set if the State Machine is in the 'OPERATION ENABLED' state und the follwing conditions are met: • no fault present • Supply voltage of the output stage is applied • no limit have been exceeded • no active travel job
	Profile Velocity Mode: show readiness for travel	Bit 8 is set if the State Machine is in the 'OPERATION ENABLED' state und the follwing conditions are met: • no fault present • no active travel job • Supply voltage of the output stage is applied
9	Remote	Bit 9 is set when the actuator is in the NMT status 'OPERATIONAL' or 'STOPPED'. The actuator receives commands via CAN interface in this case.
10	Profile Position Mode: Target reached	Bit 10 is set when the drive has come to a stop at the pre-defined target position within the defined window after a successfully executed positioning command.
	Profile Velocity Mode: Target reached	Bit 10 is set when the actual speed is within the defined window of the target speed.
11	internal Limit	Bit 11 is set when the upper or lower limits have been exceeded.
12	Profile Position Mode: Set Point Acknowledged	Bit 12 is set when the drive controller has started a travel command in the positioning mode. A travel job is started via bit 'New Setpoint' in the control word *(object 6040h, control word bit 4)* (value 0 ⇒ 1). Subsequently, the controller firmware plausibilizes the target position, the operation and control parameters and the local state of the drive and sets bit 12 after the check has been passed successfully. Bit 12 is deleted when bit 4 in the control word has been reset to zero following a positioning job (Clear new setpoint).
	Profile Velocity Mode: Speed	Bit 12 is set when the drive stands still.
13	reserved	statically on 0
14	Profile Position Mode: Pos active	Bit 14 is set when there is an active positioning job in the operation mode 'Profile Position Mode' (positioning mode). **Attention!** No new setpoint is accepted and travelling in inching operation is disabled as long as bit 14 is set!
	Profile Velocity Mode	no meaning, statically on 0
15	Profile Position Mode: drive travels	The drive shaft of the actuator is moving if bit 15 is set.
	Profile Velocity Mode	statically on 0

Table 19: Bit description of the status word

The following table represents the possible states of the state machine and the resulting bit values.

The field containing an x are irrelevant for the states of the state machine.

State	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not Ready to Switch On	x	0	x	x	0	0	0	0
Switch On Disabled	x	1	x	x	0	0	0	0
Ready to Switch On	x	0	1	x	0	0	0	1
Switched On	x	0	1	x	0	0	1	1
Operation Enabled	x	0	1	x	0	1	1	1
Quick Stop Activ	x	0	0	x	0	1	1	1
Fault	x	0	x	x	1	0	0	0

Table 20: Low byte status word States of the state machine

9.6 Control word (Steuerwort)

The control word consists of 16 bits and is mapped on the object 6040_h, and in the 3 Receive PDOs.
It contains bits for controlling the state machine as well as controlling the operational modes, Profile Position Mode (positioning mode) and Profile Velocity Mode (velocity mode).

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

Fig. 23: Control word

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

Bit	Designation	Description
0	Switch on	controls the state of the State Machine *(see* Table 22*)*
1	Disable voltage	controls the state of the State Machine *(see* Table 22*)*
2	Quick stop	controls the state of the State Machine *(see* Table 22*)*
3	Enable operation	controls the state of the State Machine *(see* Table 22*)*
4	Profile Position Mode: New Setpoint	By bit 4, positioning is triggered in the drive controller in the OPERATION ENABLED state (value 0 ⇒ 1). The drive controller acknowledges the travel command via bit 12 'Setpoint acknowledged' in the status word *(see chapter 9.5: Status word).*
	Profile Velocity Mode:	no meaning
5	reserved	
6	reserved	
7	Fault reset	If the state machine of the actuator is in the FAULT state, the fault is reset by an edge on bit 7 (0 ⇒1) and the state machine is set to the SWITCH ON DISABLED state on the condition that the cause of the fault has been resolved in advance *(see chapter 7.2: Faults).*
8	Profile Position Mode: Stop	By setting bit 8 on value 1, interruption of travel can be triggered during a running positioning event. Motor runs out with programmed deceleration and stops in the control state. Positioning is resumed and completed after resetting the bit (value 1 ⇒ 0).
	Profile Velocity Mode: Stop	By bit 8, drive movement is triggered in the velocity mode in the OPERATION ENABLED state (value 1 ⇒ 0).
9	reserved	
10	reserved	
11	Key enable	Key enable can be controlled via Bit 11 in the OPERATION ENABLED state: 0 = Key enable as defined by object 2400h sub-index 08h 1 = Key enable inverted as defined by object 2400h sub-index 08h
12	reserved	
13	Profile Position Mode: Inching operation 1	Inching operation 1 is started by an edge change (value 0 ⇒ 1) on bit 13 *(see chapter 4.1.3.2: Inching operation).*
	Profile Velocity Mode	no meaning
14	Profile Position Mode: Inching operation 2 positive	Inching operation 2 is started in positive travel direction by an edge change (value 0 ⇒ 1) on bit 14 *(see chapter 4.1.3.2: Inching operation).* The drive travels in positive direction until bit 14 has been deleted.
	Profile Velocity Mode	no meaning

Bit	Designation	Description
15	Profile Position Mode: Inching operation 2 negative	Inching operation 2 is started in negative travel direction by an edge change (value 0 ⇒ 1) on bit 15 *(see chapter 4.1.3.2: Inching operation).* The drive travels in negative direction until bit 15 has been deleted.
	Profile Velocity Mode	no meaning

Table 21: Bit description of the control word

The following table shows the control of the state machine with the bit combinations of the control word required.

The fields containing an x are irrelevant for the control of the state machine.

Command	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	x	x	x	x	1	1	0
Switch On	0	x	x	x	0	1	1	1
Disable Voltage	0	x	x	x	x	x	0	x
Quick Stop	0	x	x	x	x	0	1	x
Disable Operation	0	x	x	x	0	1	1	1
Enable Operation	0	x	x	x	1	1	1	1
Fault Reset	0 ⇒1	x	x	x	x	x	x	x

Table 22: Low Byte Control word

NOTICE	The states of the state machine can be changed via PDOs only. PDOs are anabled in the NMT status Operational only. Travel commands are enabled in the Operation Enabled state of the state machine.

9.7 Flowchart of the Profile Position Mode (positioning mode)

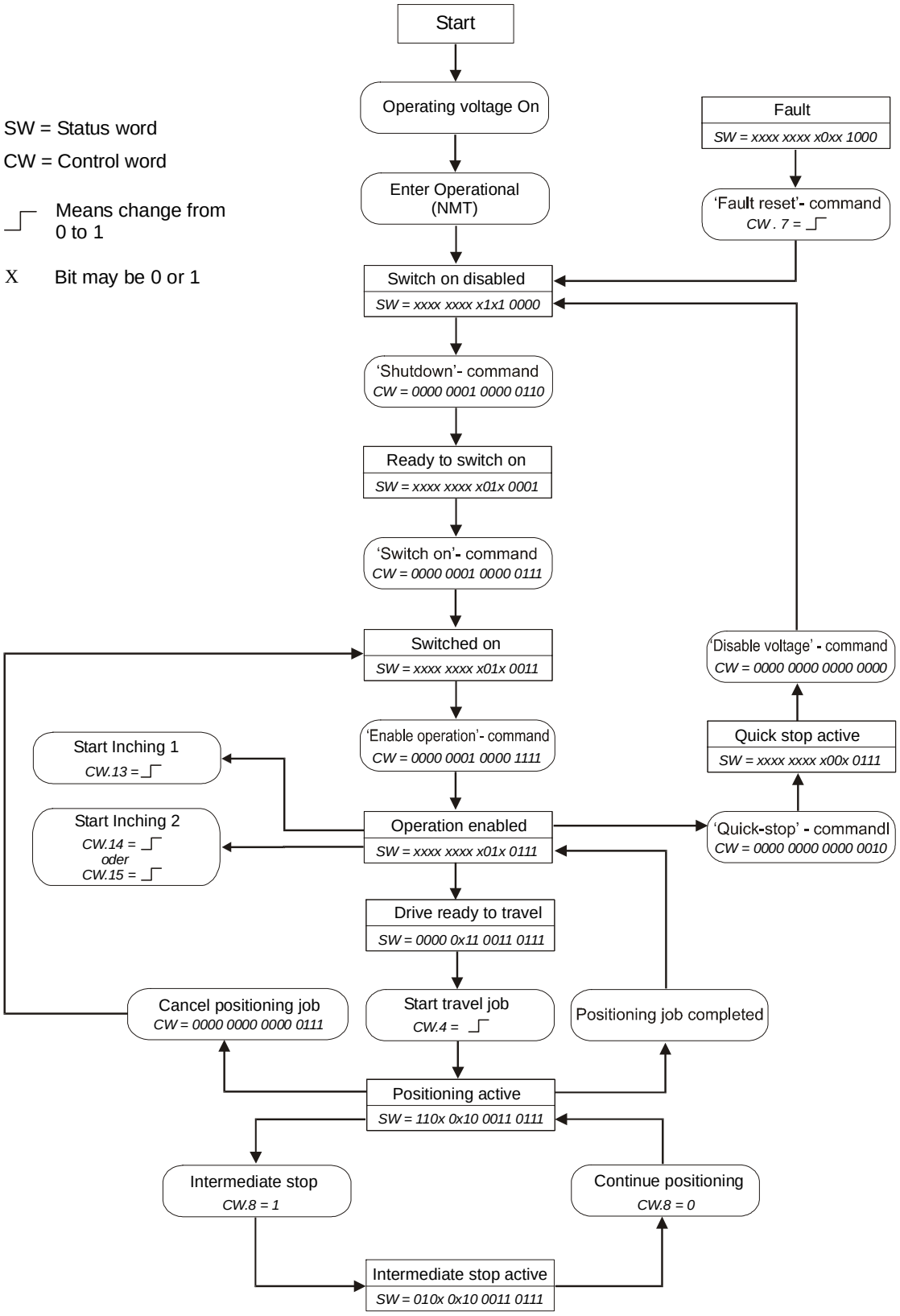

Fig. 24: Flowchart of the Profile Position Mode (positioning mode)

9.8 Flowchart of the Profile Velocity Mode operation mode (velocity mode)

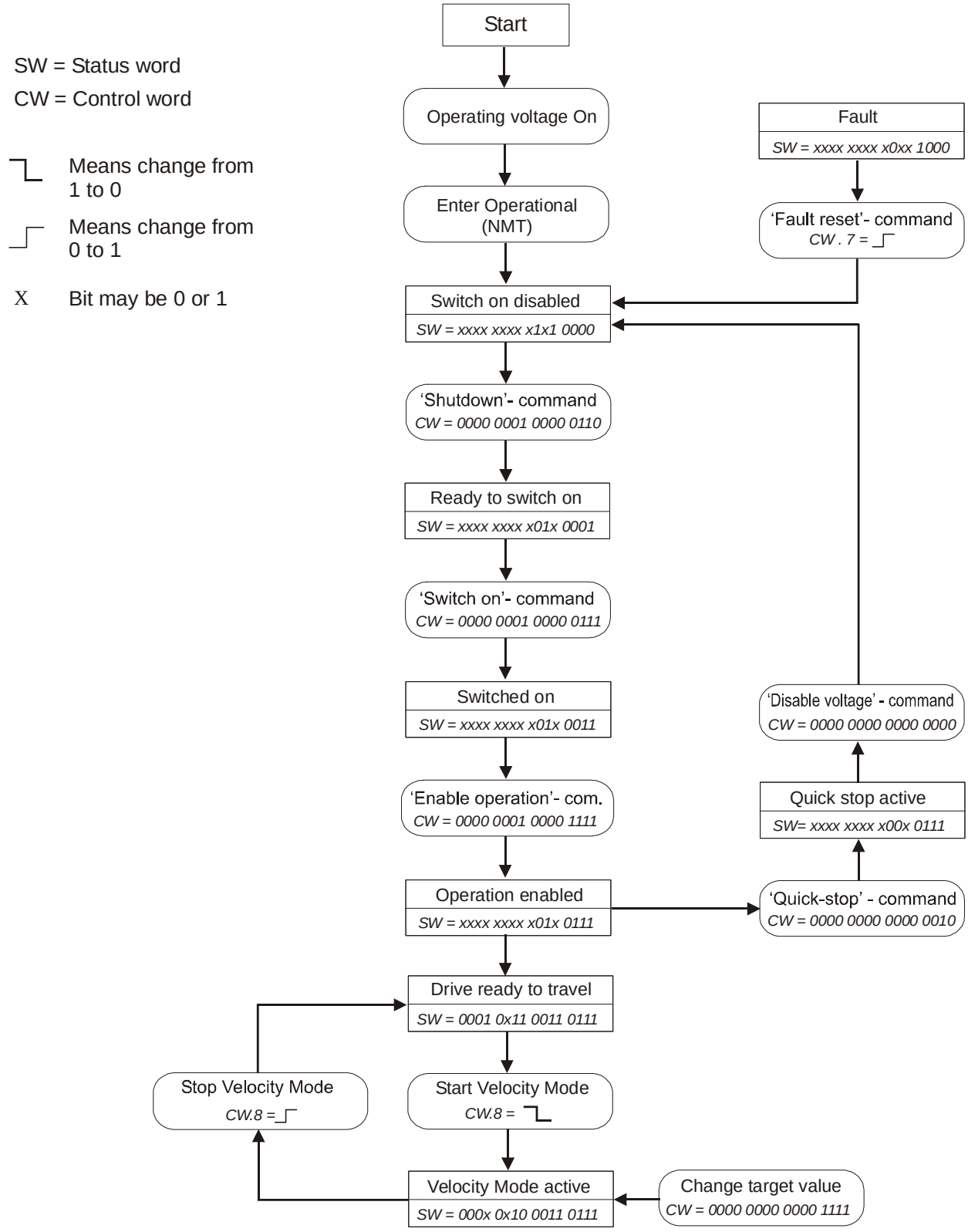

Fig. 25: Flowchart of the Profile Velocity Mode (velocity mode)

9.9 Examples

9.9.1 Example of the Profile Position Mode (positioning mode)

In the following table a positioning example in the Profile Position Mode (positioning mode) is represented.
The node address of the actuator is 5 in this example.

Identifier	Message	Meaning
0x000	0x01 0x05	NMT: Enter OPERATIONAL
0x205	0x06 0x01	RPDO1: Shutdown command
0x205	0x07 0x01	RPDO1: Switch On command
0x205	0x0F 0x01	RPDO1: Enable Operation command
0x405	0x1F 0x00 0x88 0x13 0x00 0x00	RPDO3: Travel to position +5000
-	-	wait until target position has been reached
0x205	0x0F 0x01	RPDO1: clear New Setpoint
0x405	0x1F 0x00 0x78 0xEC 0xFF 0xFF	RPDO3: Travel to position -5000
0x205	0x1F 0x01	RPDO1: Intermediate stop
0x205	0x1F 0x00	RPDO1: continue positioning
-	-	wait until target position has been reached
0x205	0x0F 0x01	RPDO1: clear New Setpoint
0x205	0x07 0x01	RPDO1: Disable Operation command
0x205	0x06 0x01	RPDO1: Shutdown command
0x205	0x00 0x01	RPDO1: Disable Voltage command
0x000	0x80 0x05	NMT: Enter PRE-OPERATIONAL

Table 23: Positioning example in Profile Position Mode

9.9.2 Example of the Profile Velocity Mode (velocity mode)

In the following table an example in the Profile Velocity Mode (velocity mode) is represented.
The node address of the actuator is 5 in this example.
Operating mode change via parameter 20, *see chapter 8: Parameter description* (Default: Profile Position Mode).

Identifier	Message	Meaning
0x000	0x01 0x05	NMT: Enter OPERATIONAL
0x205	0x06 0x01	RPDO1: Shutdown command
0x205	0x07 0x01	RPDO1: Switch On command
0x205	0x0F 0x01	RPDO1: Enable Operation command
0x505	0x0F 0x00 0x0A 0x00 0x00 0x00	RPDO4: Start of velocity mode with the target speed of +10 rev/min positive sense of rotation
-	-	wait until target speed has been reached
0x505	0x0F 0x00 0x05 0x00 0x00 0x00	RPDO4: Change of velocity to +5 rev/min
0x205	0x0F 0x01	RPDO1: Stop drive movement
0x505	0x0F 0x00 0xF8 0xFF 0xFF 0xFF	RPDO4: Start of velocity mode with the target speed of -8 rev/min (negative sense of rotation)
-	-	wait until target speed has been reached
0x205	0x0F 0x01	RPDO1: Stop drive movement
0x205	0x07 0x01	RPDO1: Disable Operation command
0x205	0x06 0x01	RPDO1: Shutdown command
0x205	0x00 0x01	RPDO1: Disable Voltage command
0x000	0x80 0x05	NMT: Enter PRE-OPERATIONAL

Table 24: Example of Profile Velocity Mode

9.10 Overview of CANopen identifiers

The following table offers an overview of the identifiers used in the actuator:

Default identifier (hexadecimal)	Default identifier (decimal)	Description	Own setting
0	0	Netzwerkmanagment (NMT)	
80	128	SYNC – Message	
80 + Node-ID	128 + Node-ID	Emergency Message	
180 + Node-ID	384 + Node-ID	TPDO1	
200 +Node-ID	512 + Node-ID	RPDO1	
380 + Node-ID	896 + Node-ID	TPDO3	
400 + Node-ID	1024 + Node-ID	RPDO3	
480 + Node-ID	1152 + Node-ID	TPDO4	
500 + Node-ID	1280 + Node-ID	RPDO4	
580 + Node-ID	1408 + Node-ID	SDO (tx)	
600 + Node-ID	1536 + Node-ID	SDO (rx)	
700 + Node-ID	1792 + Node-ID	Heartbeat Message	
700 + Node-ID	1792 + Node-ID	Node-Guard Message	

Table 25: Overview of identifiers

9.11 Setting the CAN baud rate

The CAN baud rate is entered via Object 2100h (CAN baud rate).
The baud rate is factory-set to 500 kbit/s.

9.12 EDS file

The EDS file SIKOAG05.EDS (electronic data sheet) is available for the AG05.
This files enables easy integration and configuration of the actuator in a CANopen network using commercial CANopen configurations.

9.13 Directory of objects

Every CANopen device keeps a directory of objects where all parameters of the device are deposited in the form of object entries. The object entries can be accessed via SDO communication services *(see chapter 9.3.7: Service Data Objects).* Thus, a parameter can be read (SDO upload) and written (SDO download) if permitted by the object entry access rights or the state of the device, respectively.

The following index ranges are used:

1000_h - $1FFF_h$ objects of the communication profile CIA DS-301 V4.0.
2000_h - $5FFF_h$ manufacturer-specific object entries.
6000_h – $9FFF_h$ objects of the device profile CIA DSP-402 V2.0.

9.13.1 Overview of objects

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

Index	Name	Description	see page
1000_h	Device type	The object indicates the device profile number of the actuator.	60
1001_h	Error register	The object shows error states of the actuator.	60
1002_h	Manufacturer Status Register	Contains the system status word of the actuator *(see chapter 9.2: System Statuswort).*	61
1003_h	Pre-Defined Error Field	The object stores up to 10 error messages.	61
1005_h	COB-ID Sync Message	Setting of the COB ID of the SYNC object.	62
1008_h	Manufacturer Device Name	Indicates the device name.	62
$100A_h$	Manufacturer Software Version	Indicates the software version of the controller firmware.	63
$100C_h$	Guard Time	Setting of the 'Guard Time' for the Node Guarding protocol *(see chapter 9.3.11: Node Guarding).*	63
$100D_h$	Life Time Factor	Setting of the time interval 'Life Time' *(see chapter 9.3.11: Node Guarding).*	64
1011_h	Restore Default Parameters	Restoration of factory-set states of the changeable parameters and calibration of the actuator *(see chapter 5: Calibration).*	64
1014_h	COB-ID Emergency Message	Setting of the COB ID of the Emergency object.	66
1017_h	Producer Heartbeat Time	Setting of the cycle time for the heartbeat protocol *(see chapter 9.3.10: Heartbeat protocol).*	66
1018_h	Identity Objekt	Contains the Vendor ID of the device manufacturer.	66
1200_h	Server SDO Parameter	Contains the COB IDs of the default server SDO.	67
1400_h	1st Receive PDO Parameter	Setting of the communication parameters of the RPDO1.	68
1401_h	2nd Receive PDO Parameter	Compatibility entry	70
1402_h	3rd Receive PDO Parameter	Setting of the communication parameters of the RPDO3.	71
1403_h	4th Receive PDO Parameter	Setting of the communication parameters of the RPDO4.	72
1600_h	1st Receive PDO Mapping Parameter	Contains the objects mapped on the RPDO1 *(see chapter 9.3.6.1: 1st Receive PDO).*	74
1601_h	2nd Receive PDO Mapping Parameter	Compatibility entry	74
1602_h	3rd Receive PDO Mapping Parameter	Contains the objects mapped on the RPDO3 *(see chapter 9.3.6.2: 3rd Receive PDO).*	75
1603_h	4th Receive PDO Mapping Parameter	Contains the objects mapped on the RPDO4 *(see chapter 9.3.6.3: 4th Receive PDO).*	76
1800_h	1st Transmit PDO Parameter	Setting of the communication parameters of the TPDO1.	77
1801_h	2nd Transmit PDO Parameter	Compatibility entry	79

Index	Name	Description	see page
1802_h	3rd Transmit PDO Parameter	Setting of the communication parameters of the TPDO3.	80
1803_h	4th Transmit PDO Parameter	Setting of the communication parameters of the TPDO4.	81
$1A00_h$	1st Transmit PDO Mapping Parameter	Contains the objects mapped on the TPDO1 *(see chapter 9.3.5.1: 1st Transmit PDO).*	83
$1A01_h$	2nd Transmit PDO Mapping Parameter	Compatibility entry	84
$1A02_h$	3rd Transmit PDO Mapping Parameter	Contains the objects mapped on the TPDO3 *(see chapter 9.3.5.2: 3rd Transmit PDO).*	84
$1A03_h$	4th Transmit PDO Mapping Parameter	Contains the objects mapped on the TPDO4 *(see chapter 9.3.5.3: 4th Transmit PDO).*	85
2001_h	Manufacturer Offset	Manufacturer-specific offset value (is added internally to the position value).	86
2100_h	Can-Baud rate	Setting of the CAN baud rate.	86
2101_h	Node-ID	Setting of the node address.	87
2102_h	Transfer reduction	Contains the gear reduction.	87
2400_h	Display and Operation Parameter Set	Configuration of display and operation.	87
2410_h	Motor Parameter Set	Setting of the control parameters of the drive controller.	90
2412_h	Spindle Pitch	Setting of the spindle pitch.	92
2413_h	Pos Type	Setting of the positioning type.	93
2415_h	Delta Jog	Setting of the travel distance in inching operation 1.	93
2416_h	Stop Mode Inching Mode 2	Setting of the stop behaviour in inching operation 2.	93
2417_h	Inpos Mode	Setting of the behaviour upon reaching the positioning window.	94
2418_h	Loop Length	Setting the loop length.	94
2419_h	Contouring Error Limit	Setting the contouring error limit.	94
$241A_h$	Contouring Error	Current contouring error.	95
$241B_h$	Power Supply Voltage	Voltage supply of output stage and control.	95
$241C_h$	Output Stage Temperature	Output stage temperature.	95
$241E_h$	Motor Current	Actual motor current	96
2421_h	Motor Current Limit	Setting of motor current limitation.	96
2423_h	Battery Voltage	Actual battery voltage	96
2450_h	Inching 2 Offset	Offset value in inching operation 2.	96
2451_h	Type of acceleration Inching Mode 2	Type of acceleration in inching operation 2.	97
2500_h	Production Date	Contains the drive's production date.	97
6040_h	Controlword	Contains the control word of the state machine for drives.	97
6041_h	Statusword	Contains the status word of the state machine for drives.	98
6060_h	Modes of Operation	Setting of the operation mode: Profile Position Mode / Profile Velocity Mode.	99
6064_h	Position Actual Value	Contains the absolute actual position in the operation mode Profile Position Mode (positioning mode).	99
6067_h	Position Window	Setting of the tolerance window.	100

Index	Name	Description	see page
$606C_h$	Velocity Actual Value	Contains the actual velocity in the operation mode Profile Velocity Mode (velocity mode).	100
$607A_h$	Target Position	Contains the target position in the operation mode Profile Position Mode (positioning mode).	100
$607C_h$	Calibration Value	Calibration	101
$607D_h$	Software Position Limit	Setting of the limits.	101
$607E_h$	Polarity	Setting of the polarity.	102
6091_h	Gear Ratio	Setting of gear ratio.	102
$60FF_h$	Target Velocity	Contains the target velocity in the operation mode Profile Velocity Mode (velocity mode).	103

Table 26: Overview of objects

9.13.2 Description of objects

Below, all objects of the actuator are described sorted by their indexes.

9.13.2.1 1000_h: Device Type

Object 1000_h indicates the device profile number.

Sub-index	00_h
Description	Information on the device profile
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	00000192_h
EEPROM	no

Format description:

Bit 31 - 24	Manufacturer-specific (not used)
Bit 23 - 16	drive type (not used)
Bit 15 - 0	device profile number

9.13.2.2 1001_h: Error Register

Object 1001_h indicates the error state of the device.

Sub-index	00_h
Description	current error code
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	no
EEPROM	no

Format description:

Bit 7	Manufacturer-specific error
Bit 6	reserved (statically 0)
Bit 5	Drive shaft blocked
Bit 4	Error during data transfer
Bit 3	Temperature
Bit 2	Voltage
Bit 1	Current
Bit 0	General error (is set when error is present)

A detailed error evaluation can be attained via object 1003h (Predefined Error Field). Faults and errors are signalled at the time of their occurrence by an emergency message *(see chapter 9.3.9: Emergency Object).*

9.13.2.3 1002_h: Manufacturer Status Register

Object 1002_h indicates the system status word of the actuator *(see chapter 9.2: System Status Word).*

Sub-index	00_h
Description	Manufacturer-specific status register
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Format description:

Bit 31 - 16	not used
Bit 15 - 0	*see chapter 9.2: System Status Word*

9.13.2.4 1003_h: Pre-defined Error Field

Object 1003_h stores the last 10 causes of faults.
The entry under sub-index 00_h contains the number of faults currently stored.
The latest fault message is stored under sub-index 01_h.
Writing a '0' on sub-index 00_h resets the fault buffer.

Sub-index	00_h
Description	number of fault messages
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	no
Value range	0 ... 10

Sub-index	01_h ... $0A_h$
Description	faults that occurred
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	yes

Format description:

Bit 31 - 16	not used
Bit 15 - 8	error code high byte *(see chapter 9.3.9.1: Error Code)*
Bit 7 – 0	error code low byte *(see chapter 9.3.9.1: Error Code)*

9.13.2.5 1005_h: COB-ID Sync Message

The COB-ID of the SYNC object is set via object 1005_h.
The SYNC message is sent to all network participant (broadcast object).

Sub-index	00_h
Description	COB-ID SYNC message (recordable in the „Pre-Operational“ state)
Access	read-write
PDO mapping	no
Data type	Unsigned32
Default	80_h
EEPROM	yes

Format description:

Bit 31 - 30	not used
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 – 0	bit 10 ...0 of the identifier

9.13.2.6 1008_h: Manufacturer Device Name

Object 1008_h indicates the device name.

Sub-index	00_h
Description	Device name in ASCII characters
Access	const
PDO mapping	no
Data type	Visible String
Default	no
EEPROM	no

Format description (example):

Bit 7 – 0	41_h = ‘ A ‘ (ASCII character, ISO 8859)
Bit 15 – 8	47_h = ‘ G ‘ (ASCII character, ISO 8859)
Bit 23 – 16	30_h = ‘ 0 ‘ (ASCII character, ISO 8859)
Bit 31 - 24	33_h = ‘ 5 ‘ (ASCII character, ISO 8859)

Device name = AG05

9.13.2.7 $100A_h$: Manufacturer Software Version

Object $100A_h$ indicates the software version of the controller firmware.

Sub-index	00_h
Description	Software version as ASCII characters
Access	const
PDO mapping	no
Data type	Visible String
Default	no
EEPROM	no

Format description (example):

Bit 7 – 0	31_h = ‘ 1 ‘ (ASCII character, ISO 8859)
Bit 15 – 8	$2E_h$ = ‘ . ‘ (ASCII character, ISO 8859)
Bit 23 – 16	30_h = ‘ 0 ‘ (ASCII character, ISO 8859)
Bit 31 - 24	30_h = ‘ 0 ‘ (ASCII character, ISO 8859)

Software version = V 1.00

9.13.2.8 $100C_h$: Guard Time

The cycle time ‘Guard Time’ for node guarding is set via object $100C_h$.
The cycle time ‘Guard Time’ is given in milliseconds *(see chapter 9.3.11: Node Guarding).*

Sub-index	00_h
Description	Guard Time
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	no
EEPROM	yes

Data description:

Value ‘0’ means that node guarding is deactivated.

9.13.2.9 $100D_h$: Life Time Factor

The time interval 'Life Time' for life guarding is set via object $100D_h$ *(see chapter 9.3.11: Node Guarding).*

Sub-index	00_h
Description	Life Time Faktor (recordable in the „Pre-Operational“ and „Operational“ states)
Access	read-write
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes

Data description:

Value '0' means that Life Guarding is deactivated.

9.13.2.10 1011_h: Restore Default Parameters

The default values of the changeable parameters can be retrieved via object 1011_h.
Parameter ranges are specified by selecting the respective subindex.

Sub-index 01_h: set all parameters to default values
Sub-index 04_h: set only standard parameters to default values.
Sub-index 05_h: set only control parameters to default values.
Sub-index 06_h: calibrate the actuator
Sub-index 07_h: set only display parameter to default

Sub-index	00_h
Description	Anzahl der Subindexe
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	alle Parameter auf Defaultwert setzen
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Sub-index	04_h
Description	Standard Parameter auf Defaultwert setzen
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Sub-index	05_h
Description	Regler Parameter auf Defaultwert setzen
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Sub-index	06_h
Description	calibrate the actuator
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Sub-index	07_h
Description	Set display parameter to default
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Format description sub-index 01_h, 04_h – 07_h:

Bit 31 - 24	64_h = ‘ d ‘ (ASCII character, ISO 8859)
Bit 23 - 16	61_h = ‘ a ‘ (ASCII character, ISO 8859)
Bit 15 – 8	$6F_h$ = ‘ o ‘ (ASCII character, ISO 8859)
Bit 7 – 0	$6C_h$ = ‘ l ‘ (ASCII character, ISO 8859)

By writing the signature ‘load’ to a sub-index 01, 04 … 07, the factory settings *(see chapter 8: Parameter description ⇒ Default column)* of the respective parameters are retrieved.
By writing the signatuare ‘load’ to sub-index 06, the actuator is calibrated *(see chapter 5: Calibration).*

9.13.2.11 1014_h: COB-ID Emergency Message

The COB-ID of the Emergency object is set via object 1014_h *(see chapter 9.3.9: Emergency Object).*

Sub-index	00_h
Description	COB-ID der Emergency-Message
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	80_h + Node-ID
EEPROM	yes

Format description:

Bit 31	0 = EMCY existed / is valid 1 = EMCY does not exist / is not valid
Bit 30	reserved (always 0)
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 – 0	bit 10 ...0 of the identifier

9.13.2.12 1017_h: Producer Heartbeat Time

The cycle time ‘Heartbeat Time’ for the heartbeat protocol is set via object 1017_h. The ‘Heartbeat Time’ is given in milliseconds *(see chapter 9.3.10: Heartbeat protocol).*

Sub-index	00_h
Description	Producer Heartbeat Time
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	0
EEPROM	yes

Data description:

Value ‘0’ means that the heartbeat protocol is deactivated.

9.13.2.13 1018_h: Identity Object

The Vendor ID of the manufacturer is indicated via object 1018_h.

Sub-index	00_h
Description	Number of subindexes
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	4
EEPROM	no

Sub-index	01_h
Description	Vendor - ID
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	195_h (SIKO GmbH)
EEPROM	no

Sub-index	02_h
Description	Product Code (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	0
EEPROM	no

Sub-index	03_h
Description	Revision Number (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	0
EEPROM	no

Sub-index	04_h
Description	Serial Number
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	no

Vendor-ID:

The Vendor ID is assigned by the CAN user organization CiA e. V. (CAN in Automation). Vendor ID '195_h' has been assigned to the company SIKO GmbH.

9.13.2.14 1200_h: Server SDO Parameter

The COB IDs for the Default Server SDO are indicated via object 1200_h *(see chapter 9.3.7: Service Data Objects).*

Sub-index	00_h
Description	Number of subindexes
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	COB-ID Master ⇒ actuator (rx)
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	600_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	COB-ID actuator ⇒ Master (tx)
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	580_h + Node-ID
EEPROM	no

Format description:

Bit 31	0 = SDO valid 1 = SDO not valid
Bit 30	reserved (statically 0)
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 – 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 – 7	4 bit function code of the identifier
Bit 6 – 0	7 bit Node ID of the identifier

Data description:

The default DSO cannot be changed (according to the CiA DS-301 Predefined Connection Set).

9.13.2.15 1400_h: 1st Receive PDO Parameter

Durch das Objekt 1400_h werden die Kommunikationsparameter des ersten Receive-PDOs (RPDO1) eingestellt.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	200_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.6.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Format description sub-index 01_h:

Bit 31	not used
Bit 30	not used
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node ID of the identifier

Data description sub-index 02_h:

0	synchronous: RPDO1 is processed only after a SYNC message has been received
1 ... 240	synchronous: identical with value 0
241 ... 251	reserved
252	reserved
253	reserved
254	identical with value 255
255	asynchronous: RPDO1 is immediately processed

PDO mapping:

See object 1600_h *(1st receive PDO mapping parameter*).

Processing of PDOs:

Receive PDOs are processed in the NMT status 'OPERATIONAL' only. It is not recommended to change the transfer type of the RPDO1 since otherwise the functioning of the state machine would no longer be ensured.

Changing PDO parameters:

PDO parameters can be changed in the NMT status 'PRE-OPERATIONAL' only.

9.13.2.16 1401_h: 2^{nd} Receive PDO Parameter

Object 1401_h was implemented for compatibility reasons only and has no function.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	301_h
EEPROM	no

Sub-index	02_h
Description	Übertragungsart (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

9.13.2.17 1402_h: 3rd Receive PDO Parameter

The communication parameters of the third Receive PDO (RPDO3) are set via object 1402_h.

Sub-index	00_h
Description	größter unterstützter Subindex
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	400_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.6.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Format description sub-index 01_h:

Bit 31	not used
Bit 30	not used
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node ID of the identifier

Data description sub-index 02_h:

0	synchronous: RPDO1 is processed only after a SYNC message has been received
1 ... 240	synchronous: identical with value 0
241 ... 251	reserved
252	reserved
253	reserved
254	identical with value 255
255	asynchronous: RPDO1 is immediately processed

PDO mapping:

See object 1602_h *(3rd receive PDO mapping parameter*).

Processing of PDOs:

Receive PDOs are processed in the NMT status 'OPERATIONAL' only.

Changing PDO parameters:

PDO parameters can be changed in the NMT status 'PRE-OPERATIONAL' only.

9.13.2.18 1403_h: 4th Receive PDO Parameter

The communication parameters of the fourth Receive PDO (RPDO4) are set via object 1403_h.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational" state)
PDO mapping	no
Data type	Unsigned32
Default	500_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.6.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational" state)
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Format description sub-index 01_h:

Bit 31	not used
Bit 30	not used
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node ID of the identifier

Data description sub-index 02_h:

0	synchronous: RPDO1 is processed only after a SYNC message has been received
1 ... 240	synchronous: identical with value 0
241 ... 251	reserved
252	reserved
253	reserved
254	identical with value 255
255	asynchronous: RPDO1 is immediately processed

PDO mapping:

See object 1603_h *(4th receive PDO mapping parameter)*.

Processing of PDOs:

Receive PDOs are processed in the NMT status ‘OPERATIONAL’ only.

Changing PDO parameters:

PDO parameters can be changed in the NMT status ‘PRE-OPERATIONAL’ only.

9.13.2.19 1600_h: 1st Receive PDO Mapping Parameter

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

Sub-index	00_h
Description	Number of mapped application objects in RPDO 1
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	1
EPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60400010_h
EEPROM	no

Format description sub-index 01_h:

Bit 31 - 16	Index 16 bits
Bit 15 - 8	Sub-index 8 bits
Bit 7 - 0	8 bits object length

Data description

The object cannot be changed (static mapping).

Mapped objects:

- object 6040_h (control word) in bytes 0 and 1.

9.13.2.20 1601_h: 2nd Receive PDO Mapping Parameter

Object 1601_h was implemented for compatibility reasons only and has no function.

Sub-index	00_h
Description	Number of mapped application objects in RPDO 2
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	0
EPROM	no

9.13.2.21 1602_h: 3rd Receive PDO Mapping Parameter

Object 1602_h determines the objects that are mapped on the third Receive PDO (RPDO3).

Sub-index	00_h
Description	Number of mapped application objects in RPDO 3
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60400010_h
EEPROM	no

Sub-index	02_h
Description	second object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	$607A0020_h$
EEPROM	no

Format description sub-index 01_h – 02_h:

Bit 31 - 16	index 16 Bit
Bit 15 - 8	sub-index 8 bits
Bit 7 - 0	8 bits object length

Data Description:

The object cannot be changed (static mapping).

Mapped objects:

- object 6040_h (control word) in bytes 0 and 1.
- object $607A_h$ (target position) in bytes 2 to 5.

9.13.2.22 1603_h: 4th Receive PDO Mapping Parameter

Object 1603_h determines the objects that are mapped on the fourth Receive PDO (RPDO4).

Sub-index	00_h
Description	Number of mapped application objects in RPDO 4
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60400010_h
EEPROM	no

Sub-index	02_h
Description	second object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	$60FF0020_h$
EEPROM	no

Format description sub-index 01_h – 02_h:

Bit 31 - 16	index 16 bits
Bit 15 - 8	sub-index 8 bits
Bit 7 - 0	8 bits object length

Data description:

The object cannot be changed (static mapping).

Mapped objects:

- object 6040_h (control word) in bytes 0 and 1.
- object $60FF_h$ (target velocity) in bytes 2 to 5.

9.13.2.23 1800_h: 1st Transmit PDO Parameter

The communication parameters of the first Transmit PDO (TPDO1) are set via object 1800_h.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	180_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.5.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	0
EEPROM	no
Value range	10 ... 65535

Format description sub-index 01_h:

Bit 31	0 = PDO existed / is valid 1 = PDO does not exist / is not valid
Bit 30	0 = request via RTR frame enabled 1 = request via RTR frame disabled
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node-ID of the identifier

Data description sub-index 02_h:

0	synchronous: acyclic, PDO is sent after each SYNC message.
1 ... 240	synchronous: cyclic, PDO is sent after 1…240 SYNC messages received.
241 ... 251	reserved
252	reserved
253	asynchronous: on request (RTR frame). PDO is sent immediately after receipt of the RTR frame. **Attention!** Must have been enabled via bit 30 of sub-index 1.
254	identical with value 255
255	asynchronous: time-triggered

PDO mapping:

see object $1A00_h$ *(1st transmit PDO mapping parameter*).

Event Timer:

The ‘Event Timer’ parameter serves for setting a cycle time (in milliseconds) for time-triggered transfer of the Transmit PDO1.

Processing of PDOs:

Transmit PDOs are transferred in the NMT status ‘OPERATIONAL’ only.
It is not recommended to change the transfer type of the TPDO1 since otherwise the functioning of the state machine would no longer be ensured.

Changing PDO parameters:

PDO parameters can be changed in the NMT status ‘PRE-OPERATIONAL’ only.

9.13.2.24 1801_h: 2nd Transmit PDO Parameter

Object 1801_h was implemented for compatibility reasons only and has no function.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	281_h
EEPROM	no

Sub-index	02_h
Description	Transmission type (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	255
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	0
EEPROM	no

9.13.2.25 1802_h: 3rd Transmit PDO Parameter

The communication parameters of the third Transmit PDO (TPDO3) are set via object 1802_h (TPDO3) eingestellt.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	380_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.5.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	253
EEPROM	no

Sub-index	03_h
Description	Inhibit Time (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	0
EEPROM	no
Value range	10 ... 65535

Format description sub-index 01_h:

Bit 31	0 = PDO existed / is valid 1 = PDO does not exist / is not valid
Bit 30	0 = request via RTR frame enabled 1 = request via RTR frame disabled
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node-ID of the identifier

Data description sub-index 02_h:

0	synchronous: acyclic, PDO is sent after each SYNC message.
1 ... 240	synchronous: cyclic, PDO is sent after 1 … 240 SYNC messages received.
241 ... 251	reserved
252	reserved
253	asynchronous: on request (RTR frame). PDO is sent immediately after receipt of the RTR frame. **Attention!** Must have been enabled via bit 30 of sub-index 1.
254	asynchronous: event-triggered (with every change of the position value)
255	asynchronous: time-triggered

PDO mapping:

See object $1A02_h$ *(3rd transmit PDO mapping parameter)*.

Event Timer:

The ‘Event Timer’ parameter serves for setting a cycle time (in milliseconds) for time-triggered transfer of the Transmit PDO3.

Processing of PDOs:

Transmit PDOs are transferred in the NMT status ‘OPERATIONAL’ only.

Changing PDO parameters:

PDO parameters can be changed in the NMT status ‘PRE-OPERATIONAL’ only.

9.13.2.26 1803_h: 4th Transmit PDO Parameter

The communication parameters of the fourth Transmit PDO (TPDO4) are set via object 1803_h.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	5
EEPROM	no

Sub-index	01_h
Description	COB-ID
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned32
Default	480_h + Node-ID
EEPROM	no

Sub-index	02_h
Description	Transfer type *(see chapter 9.3.5.4: Transfer types of the Receive PDOs)*
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	253
EEPROM	no

Sub-index	03h
Description	Inhibit Time (no function: Compatibility entry)
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	no

Sub-index	05_h
Description	Event Timer
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Unit	milliseconds
Data type	Unsigned16
Default	0
EEPROM	no
Value range	10 ... 65535

Format description sub-index 01_h:

Bit 31	0 = PDO existed / is valid 1 = PDO does not exist / is not valid
Bit 30	0 = request via RTR frame enabled 1 = request via RTR frame disabled
Bit 29	0 = 11-bit identifier (CAN 2.0A) 1 = 29-bit identifier (CAN 2.0B)
Bit 28 - 11	if bit 29=1, bit 28 ... 11 of the 29-bit identifier
Bit 10 - 7	4 bit function code of the identifier
Bit 6 - 0	7 bit Node-ID of the identifier

Data description sub-index 02_h:

0	synchronous: acyclic, PDO is sent after each SYNC message.
1 ... 240	synchronous: cyclic, PDO is sent after 1 … 240 SYNC messages received.
241 ... 251	reserved
252	reserved
253	asynchronous: on request (RTR frame). PDO is sent immediately after receipt of the RTR frame. **Attention!** Must have been enabled via bit 30 of sub-index 1.
254	asynchronous: Event-triggered (with every change of actual velocity).
255	asynchronous: time-triggered

PDO mapping:

See object $1A03_h$ (*4th transmit PDO mapping parameter*).

Event Timer:

The 'Event Timer' parameter serves for setting a cycle time (in milliseconds) for time-triggered transfer of the Transmit PDO4.

Processing of PDOs:

Transmit PDOs are transferred in the NMT status 'OPERATIONAL' only.

Changing PDO parameters:

PDO parameters can be changed in the NMT status 'PRE-OPERATIONAL' only.

9.13.2.27 $1A00_h$: 1st Transmit PDO Mapping Parameter

Object $1A00_h$ determines the objects that are mapped on the first Transmit PDO (TPDO1).

Sub-index	00_h
Description	Number of mapped application objects in TPDO 1
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	1
EEPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60410010_h
EEPROM	no

Format description sub-index 01_h:

Bit 31 - 16	index 16 bits
Bit 15 - 8	sub-index 8 bits
Bit 7 - 0	8 bits object length

Data description:

The object cannot be changed (static mapping).

Mapped objects:

- object 6041_h (status word) in bytes 0 and 1.

9.13.2.28 $1A01_h$: 2nd Transmit PDO Mapping Parameter

Object $1A01_h$ was implemented for compatibility reasons only and has no function.

Sub-index	00_h
Description	Number of mapped application objects in TPDO 2
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	no

9.13.2.29 $1A02_h$: 3rd Transmit PDO Mapping Parameter

Object $1A02_h$ determines the objects that are mapped on the third Transmit PDO (TPDO3).

Sub-index	00_h
Description	Number of mapped application objects in TPDO 3
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60410010_h
EEPROM	no

Sub-index	02_h
Description	second object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60640020_h
EEPROM	no

Format description sub-index 01_h – 02_h:

Bit 31 - 16	index 16 bits
Bit 15 - 8	sub-index 8 bits
Bit 7 - 0	8 bits object length

Data description:

The object cannot be changed (static mapping).

Mapped objects:

- object 6041_h (status word) in bytes 0 and 1.
- object 6064_h (position actual value) in bytes 2 to 5.

9.13.2.30 $1A03_h$: 4th Transmit PDO Mapping Parameter

Object $1A03_h$ determines the objects that are mapped on the fourth Transmit PDO (TPDO4).

Sub-index	00_h
Description	Number of mapped application objects in TPDO 4
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	first object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	60410010_h
EEPROM	no

Sub-index	02_h
Description	second object mapped
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	$606C0020_h$
EEPROM	no

Format description sub-index 01_h – 02_h:

Bit 31 - 16	index 16 bits
Bit 15 - 8	sub-index 8 bits
Bit 7 - 0	8 bits object length

Data description:

The object cannot be changed (static mapping).

Mapped objects:

- object 6041_h (status word) in bytes 0 and 1.
- object $606C_h$ (velocity actual value) in bytes 2 to 5.

9.13.2.31 2001_h: Manufacturer Offset

Sub-index	00_h
Description	Herstellerspezifischer Offsetwert *(see chapter 8: Parameter description ⇒ Parameter no. 32)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer32
Default	0
EEPROM	yes
Value range	-999999 ... 999999

9.13.2.32 2100_h: CAN baud rate

The CAN baud rate is set via object 2100_h.

Sub-index	00_h
Description	CAN baud rate *(see chapter 8: Parameter description ⇒ Parameter no. 33)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states) The baud rate set here will only be applied after re-initialisation of communication or power-up.
PDO mapping	no
Data type	Unsigned8
Default	3
EEPROM	yes
Value range	1 ... 7

Data description:

Value = 1: 1 Mbit/s
Value = 2: 800 kbit/s
Value = 3: 500 kbit/s
Value = 4: 250 kbit/s
Value = 5: 125 kbit/s
Value = 6: 50 kbit/s
Value = 7: 20 kbit/s

9.13.2.33 2101_h: Node-ID

The set node ID of the actuator can be read via object 2101_h.

Sub-index	00_h
Description	Node-ID *(see chapter 8: Parameter description ⇒ Parameter no. 22)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states) The node ID set here will only be applied after re-initialisation of communication or power-up Node-ID.
PDO mapping	no
Data type	Unsigned8
Default	1
EEPROM	yes
Value range	1 ... 127

9.13.2.34 2102_h: Gear reduction

The gear reduction of the actuator can be read out via object 2102_h.

Sub-index	00_h
Description	Gear reduction *(see chapter 8: Parameter description ⇒ Parameter no. 72)*
Access	read
PDO mapping	no
Data type	Unsigned8
Default	no
EEPROM	no
Value range	0 ... 1

Data description:

Value = 0: Gear reduction 98:1
Value = 1: Gear reduction 173:1

9.13.2.35 2400_h: Display and Operation Parameter Set

The object 2400_h contains all adjustable parameters regarding display and operation.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	13
EEPROM	no

Sub-index	01_h
Description	Number of decimal places *(see chapter 8: Parameter description ⇒ Parameter no. 42)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 4

Sub-index	02_h
Description	Display divisor *(see chapter 8: Parameter description ⇒ Parameter no. 43)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 3

Sub-index	03_h
Description	Direction indication function *(see chapter 8: Parameter description ⇒ Parameter no. 44)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 2

Sub-index	04_h
Description	Display orientation *(see chapter 8: Parameter description ⇒ Parameter no. 45)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 1

Sub-index	05_h
Description	PIN change *(see chapter 8: Parameter description ⇒ Parameter no. 48)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned32
Default	0
EEPROM	yes
Value range	0 … 99999

Sub-index	06_h
Description	Displayed value 2nd display line *(see chapter 8: Parameter description ⇒ Parameter no. 49)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 7

Sub-index	07_h
Description	Key enable time *(see chapter 8: Parameter description ⇒ Parameter no. 37)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	3
EEPROM	yes
Value range	1 ... 60

Sub-index	08_h
Description	Key function enable *(see chapter 8: Parameter description ⇒ Parameter no. 38)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 … 1

Sub-index	09_h
Description	Key enable
Access	read-write (recordable in the „Pre-Operational“ state)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	no
Value range	0 … 1

Sub-index	$0A_h$
Description	LED 2 orange *(see chapter 8: Parameter description ⇒ Parameter no. 39)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	1
EEPROM	yes
Value range	0 … 1

Sub-index	$0B_h$
Description	LED 1 red *(see chapter 8: Parameter description ⇒ Parameter no. 40)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	1
EEPROM	yes
Value range	0 … 1

Sub-index	$0C_h$
Description	LED 1 green *(see chapter 8: Parameter description ⇒ Parameter no. 41)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	1
EEPROM	yes
Value range	0 … 1

Sub-index	$0D_h$
Description	Display divisor application *(see chapter 8: Parameter description ⇒ Parameter no. 74)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 … 1

9.13.2.36 2410_h: Motor Parameter Set

Object 2410_h contains all adjustable control parameters of the drive controller.

Sub-index	00_h
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	9
EEPROM	no

Sub-index	01_h
Description	Controller parameter P *(see chapter 8: Parameter description ⇒ Parameter no. 1)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned16
Default	300
EEPROM	yes
Value range	1 ... 500

Sub-index	02_h
Description	Controller parameter I *(see chapter 8: Parameter description ⇒ Parameter no. 2)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned16
Default	2
EEPROM	yes
Value range	0 ... 500

Sub-index	03_h
Description	Controller parameter D *(see chapter 8: Parameter description ⇒ Parameter no. 3)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned16
Default	0
EEPROM	yes
Value range	0 ... 500

Sub-index	04_h
Description	a - Pos (acceleration positioning mode) *(see chapter 8: Parameter description ⇒ Parameter no. 4)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	50
EEPROM	yes
Value range	1 ... 100

Sub-index	05_h
Description	v - Pos (velocity positioning mode) *(see chapter 8: Parameter description ⇒ Parameter no. 5)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	10
EEPROM	yes
Value range	Gear 98:1 ⇒ 1 ... 30 Gear 173:1 ⇒ 1 ... 16

Sub-index	06_h
Description	a – Rot (acceleration velocity mode) *(see chapter 8: Parameter description ⇒ Parameter no. 6)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	50
EEPROM	yes
Value range	1 ... 100

Sub-index	08_h
Description	a – Inch (acceleration inching operation) *(see chapter 8: Parameter description ⇒ Parameter no. 8)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	50
EEPROM	yes
Value range	1 ... 100

Sub-index	09_h
Description	v – Inch (velocity inching operation) *(see chapter 8: Parameter description ⇒ Parameter no. 9)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	10
EEPROM	yes
Value range	Gear 98:1 ⇒ 1 … 30 Gear 173:1 ⇒ 1 … 16

9.13.2.37 2412_h: Spindle Pitch

Spindle pitch is set via object 2412_h.

Sub-index	00_h
Description	Spindle pitch *(see chapter 8: Parameter description ⇒ Parameter no. 13)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	0
EEPROM	yes
Value range	0 ... 1000000

9.13.2.38 2413_h: Pos Type

The positioning type is set via object 2413_h.

Sub-index	00_h
Description	Positioning type *(see chapter 8: Parameter description ⇒ Parameter no. 19)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 2

Data description:

Value = 0: direct
Value = 1: loop +
Value = 2: loop –

9.13.2.39 2415_h: Delta Jog

The travel distance in inching operation 1 is set via object 2415_h.

Sub-index	00_h
Description	Travel distance inching operation 1 *(see chapter 8: Parameter description ⇒ Parameter no. 17)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer32
Default	720
EEPROM	yes
Value range	- 1000000 ... + 1000000

9.13.2.40 2416_h: Stop Mode Inching Mode 2

The stop behaviour in inching mode 2 is set via object 2416_h.

Sub-index	00_h
Description	stop mode inching 2 *(see chapter 8: Parameter description ⇒ Parameter no. 25)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 … 1

9.13.2.41 2417_h: Inpos Mode

The drive's behaviour when reaching the positioning window is defined by object 2417_h.

Sub-index	00_h
Description	Inpos Mode *(see chapter 8: Parameter description ⇒ Parameter no. 26)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 … 2

9.13.2.42 2418_h: Loop Length

Loop length is determined by Object 2418_h.

Sub-index	00_h
Description	Loop Length *(see chapter 8: Parameter description ⇒ Parameter no. 27)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned16
Default	360
EEPROM	yes
Value range	0 … 30000

9.13.2.43 2419_h: Contouring Error Limit

The contouring error limit can be set via object 2419_h.

Sub-index	00_h
Description	Contouring error limit *(see chapter 8: Parameter description ⇒ Parameter no. 28)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned16
Default	400
EEPROM	yes
Value range	1 … 30000

9.13.2.44 241A$_h$: Contouring Error

The current contouring error can be read via object 241A$_h$.

Sub-index	00$_h$
Description	Current contouring error
Access	read-only
PDO mapping	no
Data type	Integer16
Default	no
EEPROM	no

9.13.2.45 241B$_h$: Power Supply Voltage

Object 241B$_h$ contains the supply voltages.

Sub-index	00$_h$
Description	largest sub-index supported
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01$_h$
Description	Output stage supply voltage *(see chapter 8: Parameter description ⇒ Parameter no. 52)*
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	no
EEPROM	no

Sub-index	02$_h$
Description	Control supply voltage *(see chapter 8: Parameter description ⇒ Parameter no. 51)*
Access	read-only
PDO mapping	no
Data type	Unsigned16
Default	no
EEPROM	no

9.13.2.46 241C$_h$: Output Stage Temperature

Object 241C$_h$ contains the output stage temperature.

Sub-index	00$_h$
Description	Output stage temperature *(see chapter 8: Parameter description ⇒ Parameter no. 50)*
Access	read-only
PDO mapping	no
Data type	Integer16
Default	no
EEPROM	no

9.13.2.47 241E$_h$: Motor Current

Object 241E$_h$ contains the actual motor current.

Sub-index	00$_h$
Description	Motor current *(see chapter 8: Parameter description ⇒ Parameter no. 54)*
Access	read-only
PDO mapping	no
Data type	Integer16
Default	no
EEPROM	no

9.13.2.48 2421$_h$: Motor Current Limit

Motor current limitation is set via object 2421$_h$.

Sub-index	00$_h$
Description	Motorstrombegrenzung *(see chapter 8: Parameter description ⇒ Parameter no. 29)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	110
EEPROM	yes
Value range	25 … 110

9.13.2.49 2423$_h$: Battery Voltage

Object 2423$_h$ contains the current battery voltage.

Sub-index	00$_h$
Description	Battery voltage *(see chapter 8: Parameter description ⇒ Parameter no. 53)*
Access	read-only
PDO mapping	no
Data type	Integer16
Default	no
EEPROM	no

9.13.2.50 2450$_h$: Inching 2 Offset

An offset value can be set in inching operation 2 via object 2450$_h$.

Sub-index	00$_h$
Description	Offset value in inching operation 2 *(see chapter 8: Parameter description ⇒ Parameter no. 30)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	no
Data type	Unsigned8
Default	100
EEPROM	no
Value range	10 … 100

9.13.2.51 2451_h: Type of acceleration Inching mode 2

The type of acceleration can be set in inching operation 2 via object 2451_h.

Sub-index	00_h
Description	Type of acceleration in inching operation 2 *(see chapter 8: Parameter description ⇒ Parameter no. 31)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 … 1

9.13.2.52 2500_h: Production Date

Object 2500_h indicates the production date.

Sub-index	00_h
Description	date of productionin readable hex notation *(see chapter 8: Parameter description ⇒ Parameter no. 58)*
Access	read-only
PDO mapping	no
Data type	Unsigned32
Default	no
EEPROM	yes

Format description (example):

15 07 20 09_h = 15.07.2009 = DDMMJJJJ

9.13.2.53 2501_h: Display Software Version

Object 2501_h indicates the software version of the display controller firmware.

Sub-index	00_h
Description	Software version in ASCII characters
Access	const
PDO mapping	no
Data type	Visible String
Default	no
EEPROM	no

Format description (example):

Bit 7 – 0	31_h = ‘ 1 ‘ (ASCII character, ISO 8859)
Bit 15 – 8	$2E_h$ = ‘ . ‘ (ASCII character, ISO 8859)
Bit 23 – 16	30_h = ‘ 0 ‘ (ASCII character, ISO 8859)
Bit 31 - 24	30_h = ‘ 0 ‘ (ASCII character, ISO 8859)

Software version = V 1.00

9.13.2.54 6040_h: Control word

The object 6040_h is the control word of the state machine for drives according to the device profile CiA DSP-402.

Sub-index	00_h
Description	control word
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	yes
Data type	Unsigned16
Default	no
EEPROM	no

Format description:

See chapter 9.6: Control word.

PDO mapping:

The control word is mapped on the three Receive PDOs *(see objects 1600_h – 1603_h).*

9.13.2.55 6041_h: Status word

The object 6041_h is the status word of the state machine for drives according to the device profile CiA DSP-402.

Sub-index	00_h
Description	Status word
Access	read-only
PDO mapping	yes
Data type	Unsigned16
Default	no
EEPROM	no

Format description:

See chapter 9.5: Status word

PDO mapping:

The status word is mapped on the three Transmit PDOs *(see objects $1A00_h$ – $1A03_h$).*

9.13.2.56 6060_h: Modes of Operation

The operation mode of the actuator is set via object 6060_h.

Sub-index	00_h
Description	Operating mode *(see chapter 8: Parameter description ⇒ Parameter no. 20)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer8
Default	1
EEPROM	yes
Value range	1 ... 2

Data description

Value = 1: Profile Position Mode (positioning mode)
Value = 2: Profile Velocity Mode (velocity mode)

9.13.2.57 6061_h: Modes of Operation Display

The operating mode set can be read via object 6061_h.

Sub-index	00_h
Description	Operating mode *(see chapter 8: Parameter description ⇒ Parameter no. 20)*
Access	read-only
PDO mapping	no
Data type	Integer8
Default	no
EEPROM	no

Data description

Value = 1: Profile Position Mode (positioning mode)
Value = 2: Profile Velocity Mode (velocity mode)

9.13.2.58 6064_h: Position Actual Value

Object 6064_h contains the actual position value in the Profile Position Mode (positioning mode).

Sub-index	00_h
Description	absolute position value in the positioning mode
Access	read-only
PDO mapping	yes
Data type	Integer32
Default	no
EEPROM	no

PDO mapping:

The absolute position value and the status word of the state machine are mapped on the Transmit PDO3, see object $1A02_h$ (3^{rd} Transmit PDO mapping parameter).

9.13.2.59 6067_h: Position Window

A symmectric range of tolerable positions for standstill monitoring in the target point of positioning is set via object 6067_h.

Sub-index	00_h
Description	Pos- window *(see chapter 8: Parameter description ⇒ Parameter no. 10)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	10
EEPROM	yes
Value range	0 ...1000

9.13.2.60 $606C_h$: Velocity Actual Value

Object $606C_h$ contains the actual velocity in the Profile Velocity Mode (velocity mode).

Sub-index	00_h
Description	Actual velocity in velocity mode
Access	read-only
PDO mapping	yes
Data type	Integer32
Default	no
EEPROM	no

PDO mapping:

The actual velocity and the status word of the state machine are mapped on the Transmit PDO4, see object $1A03_h$ (4^{th} Transmit PDO mapping parameter).

9.13.2.61 $607A_h$: Target Position

The target position of a drive movement in the operation mode Profile Position Mode (position mode) is entered via object $607A_h$.

Sub-index	00_h
Description	setpoint in the positioning mode
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	yes
Data type	Integer32
Default	no
EEPROM	no
Value range	± 9999999

PDO mapping:

The target position and the control word of the state machine are mapped on the Receive PDO3, see object 1602_h (3^{rd} Receive PDO mapping parameter).

9.13.2.62 607C$_h$: Calibration Value

The calibration value is programmed and the programmed calibration value taken over as the absolute position value via object 607C$_h$.

Sub-index	00$_h$
Description	Calibration value *(see chapter 8: Parameter description ⇒ Parameter no. 14 and chapter 5: Calibration)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer32
Default	0
EEPROM	yes
Value range	± 999999

9.13.2.63 607D$_h$: Software Position Limit

Via object 607D$_h$, the software limit switches defining the working range of the drive are set.

Sub-index	00$_h$
Description	Number of subindexes
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no
Sub-index	01$_h$
Description	Limit 2 *(see chapter 8: Parameter description ⇒ Parameter no. 16)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer32
Default	-19999
EEPROM	yes
Value range	± 9999999

Sub-index	02$_h$
Description	Limit 1 *(see chapter 8: Parameter description ⇒ Parameter no. 15)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Integer32
Default	99999
EEPROM	yes
Value range	± 9999999

9.13.2.64 $607E_h$: Polarity

The polarity of the drive's sense of rotation is set via object $607E_h$.

Sub-index	00_h
Description	Sense of rotation *(see chapter 8: Parameter description ⇒ Parameter no. 18)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned8
Default	0
EEPROM	yes
Value range	0 ... 1

Data description:

Value '0' = sense of rotation 'i'
Value '1' = sense of rotation 'e'

9.13.2.65 6091_h: Gear Ratio

A gear ratio can be programmed via object 6091_h.

Sub-index	00_h
Description	Number of subindexes
Access	read-only
PDO mapping	no
Data type	Unsigned8
Default	2
EEPROM	no

Sub-index	01_h
Description	Numerator gear ratio *(see chapter 8: Parameter description ⇒ Parameter no. 11)*
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	1
EEPROM	yes
Value range	1 ... 10000

Sub-index	02_h
Description	Denominator gear ratio *(see chapter 8: Parameter description ⇒ Parameter no. 12)*
Access	read-write recordable in the „Pre-Operational“ and „Operational“ states, cannot be written with active travel job)
PDO mapping	no
Data type	Unsigned32
Default	1
EEPROM	yes
Value range	1 ... 10000

See also chapter 6: External gear unit.

9.13.2.66 $60FF_h$: Target Velocity

The target velocity of a drive movement in the operation mode Profile Velocity Mode (velocity mode) is entered via object $60FF_h$.

Sub-index	00_h
Description	Target velocity in the velocity mode of operation
Access	read-write (recordable in the „Pre-Operational“ and „Operational“ states)
PDO mapping	yes
Data type	Integer32
Default	no
EEPROM	no
Value range	Gear 98:1 $\Rightarrow \pm$ 30 U/min Gear 173:1 $\Rightarrow \pm$ 16 U/min

PDO mapping:

The target velocity and the control word of the state machine are mapped on the Receive PDO4, see object 1603_h (4^{th} Receive PDO mapping parameter).