AP04

Absolute Position Indicator with RS485/SIKONETZ5 interface

User manual

221/14

Table of contents

1 General Information

1.1 Documentation

The following documents are associated with this document:

- The data sheet describes the technical data, the dimensions, the pin assignment, the accessories and the order key.
- The installation instructions describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.
- The User manual for position indicator commissioning and integration into a fieldbus system.

You can also download these documents at ***http://www.siko-global.com/en-de/service-downloads***.

This manual is valid for software version V1.01 or newer!

2 Display and Control Keys

2.1 General

The position indicator has a two-line display with special characters and three control keys. The keys serve for position indicator parameterization and control. One LED (1) serves for position monitoring.

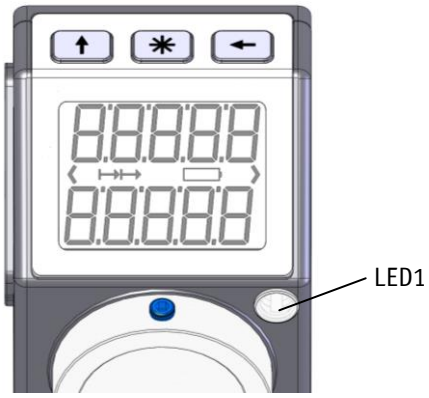

Fig. 1: Control elements

2.2 LCD display

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

With supply voltage applied to the position indicator, the 1st line shows the actual position and the 2nd line shows the set point with factory settings. The values displayed are determined by the operating mode.

Direction indicators (arrows) support positioning.
The battery symbol ▭ is shown with a critical or insufficient battery status.
With incremental measurement function activated, the incremental measurement symbol ⟼⟼ is shown.

2.2.1 Extended display range

If values below -99999 are to be displayed, this can be realized by means of the control word, Bit3 in the operational mode with SIKONETZ5 protocol. If this bit is set and the value to be displayed is in the range between -19999 ... -99999, then the negative sign and the figure with the highest value are blinking alternately. If the value range drops below -99999, "FULL" will be displayed.

2.3 LED display

In the basic state (factory setting), the LED has the following meaning:

Actual position	LED	State
In target window1	green	on
	red	off
Outside target window1	red	on
	green	off

Table 1: LED displays

2.4 Keys

Pressing the ↑ key enables or disables the incremental measurement function.

Pressing the ✱ key starts calibration (see chapter 6.1 Calibration) and acknowledges a pending error (see chapter 5.2 Errors).

Pressing the ← key starts the parameterization mode (see chapter 3.4 Parameterization of the position indicator).

3 Functional Description

3.1 Operating modes

It is differentiated between the absolute position, differential value and Modulo operating modes.

Operating mode	Absolute position	Differential value	Modulo
Line 1	Actual position	Actual position	Actual position
Line 2	Set point	Differential value	Set point

Table 2: Display with different operating modes

Absolute position:

Linear absolute position values are displayed.

Differential value display:

With factory setting: Differential value = actual position - set point

(for calculating the differential value see chapter 4 Parameter description ⇒ Parameter no. 32)

Modulo display:

Position values ranging from 0° to 360° are displayed.

Using the "Decimal places" parameter (see ⇒ Parameter no. 15) the resolution and the modulo point of the displayed values are set.

Decimal places	Display resolution	Value range
0	1°	0° ... 360°
1	1/10°	0,0° ... 360,0°
2	1/100°	0,00° ... 360,00°

3.2 Position monitoring

(see chapter 3.3 Loop positioning)

Arrows: (see chapter 4 Parameter description ⇒ Parameter no. 18)

Arrows are displayed to support the user with positioning as long as the current actual position value is outside (see chapter 4 Parameter description ⇒ Parameter no. 27) target window1. The arrows represent the shaft's direction of rotation in order to arrive at the set point. A left-hand arrow means that the shaft is to be rotated counter-clockwise. A right-hand arrow requires clockwise rotation.

In the **modulo display** operating mode, the shortest traveling distance to the set point is displayed.

Example:
Operating mode = Modulo display
Actual value = 5°
Set point = 355°
⇒ travel range shown: by (-)10°

LED display: (see e. g. chapter 4 Parameter description ⇒ Parameter no. 12)

With factory setting, the LED glows green as long as the actual position is within the programmed window. When leaving target window1, the LED glows red.

An additional target window (target window2) and an associated visualization can also be configured (see chapter 4 Parameter description ⇒ Parameter no. 27, 28 and 29).

System status word and SIKONETZ5 status word (see chapter 4 Parameter description ⇒ Parameter no. 33)**:**

In the system status word, the dynamic and static target-window-reached bit is set upon reaching target window1 the dynamic bit is deleted when leaving target window1. The user must acknowledge the static bit.

Example Position monitoring:

Parameterization:	Factory setting	
Additionally:	Target window2	= 15
	Visualization target window2	= 1
	Set point	= 100

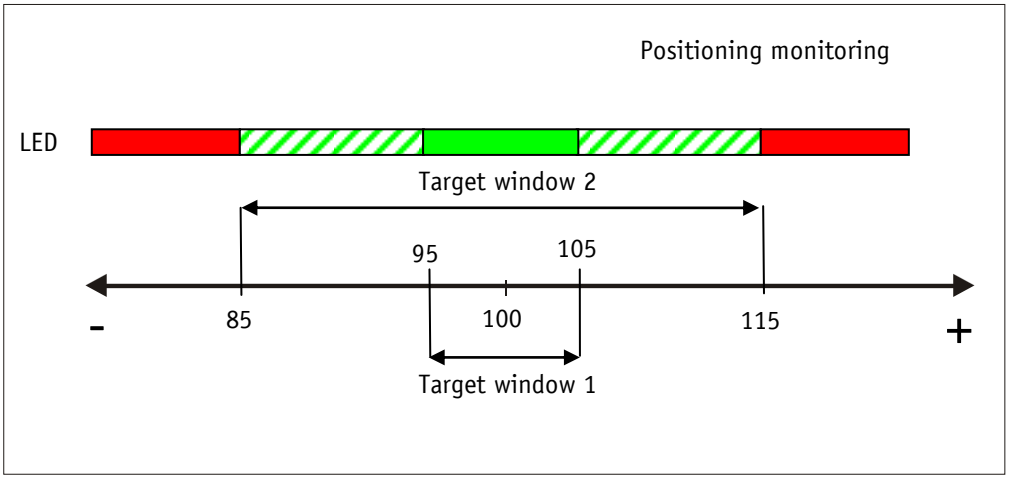

Fig. 2: Positioning monitoring

3.3 Loop positioning

NOTICE	The LED display refers always to the actual set point, not to the loop value. Target window1 is also applied to the loop length.

If the position indicator 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 position indicator's arrows show that the set point is to be overrun by the loop length. Afterwards, the set point is approached in positive direction.

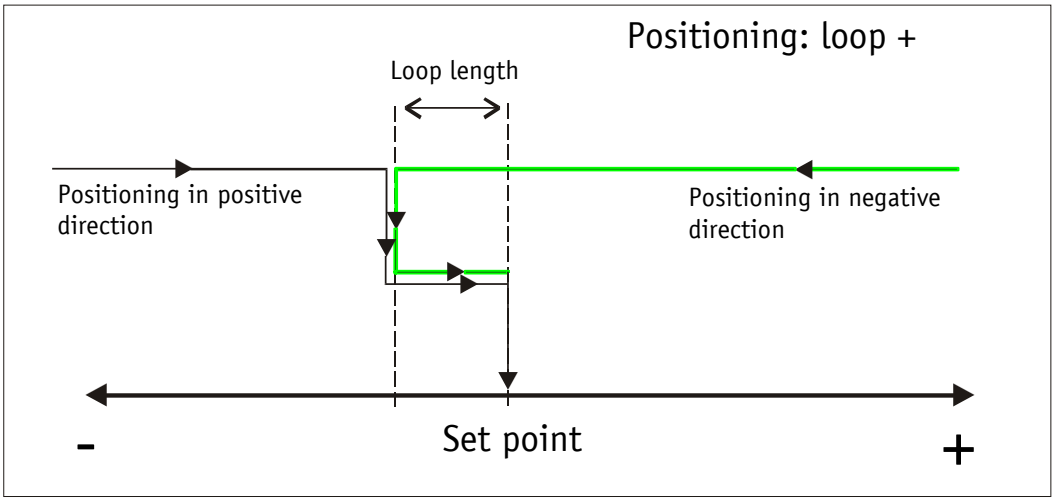

Fig. 3: Positioning Loop +

3.4 Parameterization of the position indicator

The position indicator can be completely parameterized via the keys as well as via the bus interface.

3.4.1 Manual parameterization

3.4.1.1 Starting parameterization

After applying supply voltage, the position indicator will be on the uppermost level of the menu structure (default/delivery state).

By actuating the ← key, the set node address and baud rate is displayed. Parameterization starts after expiry of the release time (see chapter 4 Parameter description ⇒ Parameter no. 9).

3.4.1.2 Value input

NOTICE	With value input via the keys, the display range is limited to -19999 ... 99999. When entering values beyond this range via SIKONETZ5 or the service protocol, "FULL" will be displayed when you call up the parameter.

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

← - decimal place selection key

↑ - Value input key

3.4.1.3 Value selection

For some parameters you can select values from a list.

Direct value input is not possible there.

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

3.4.1.4 Menu selection

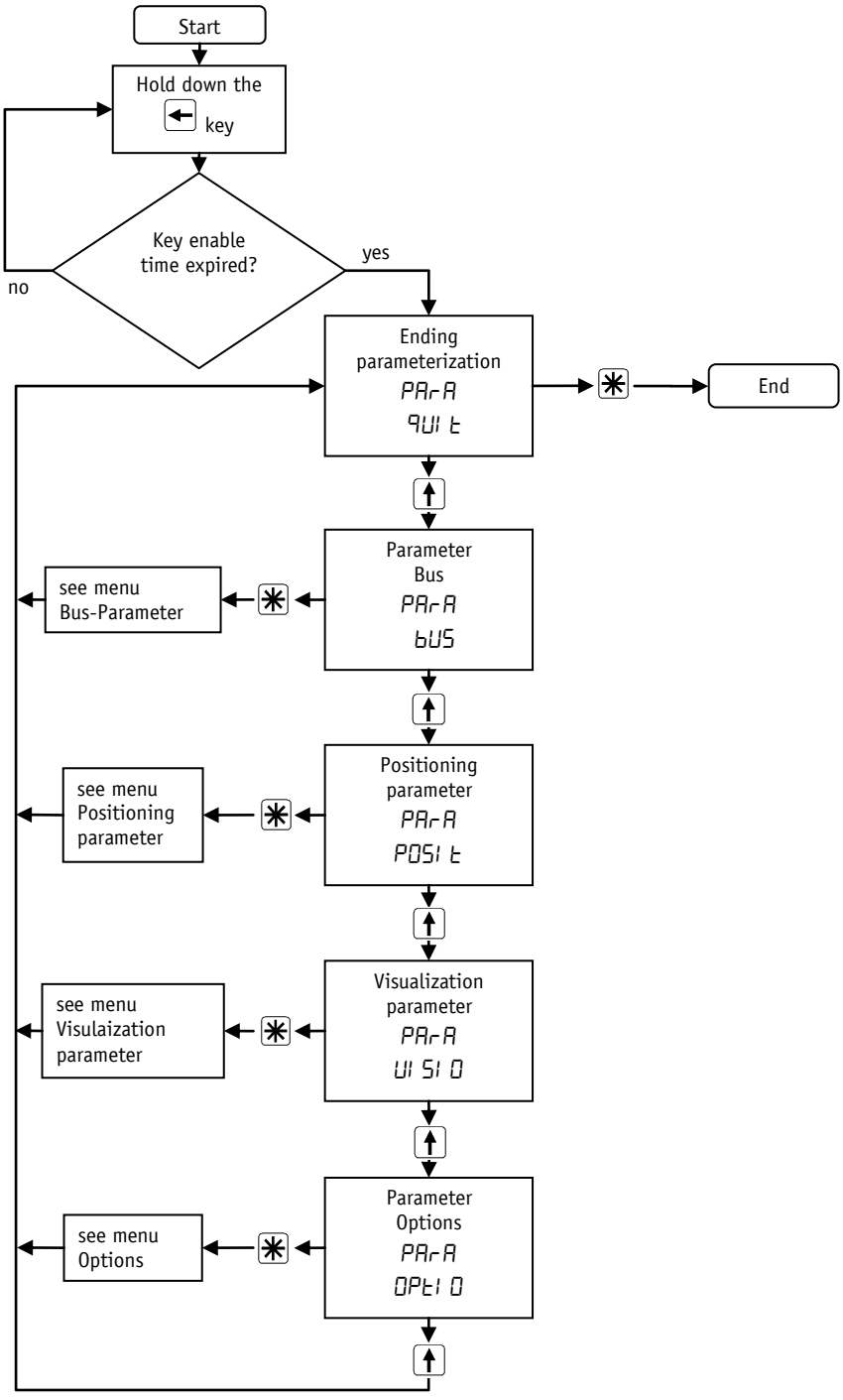

Fig. 4: Menu selection

3.4.1.5 Bus parameters

Menu	PArA bUS

Parameter display	Parameter no. acc. To chapter 4	Description
Id	3	Node address Value range: 0 - 31
bAUd	4	Baud rate Selection: 576: 57600 baud 1152: 115200 baud 192: 19200 baud
PrtCL	5	Protocol Selection: SnS: SIKONETZ5 SErvC: Service protocol
bUSto	6	Bus Timeout Value range: 0 - 20
InHbt	36	Response delay Value range: 0 - 10

Table 3: Bus parameter menu

3.4.1.6 Positioning

Menu	PArA POS It

Parameter display	Parameter no. acc. To chapter 4	Description
APU	24	Readout per revolution / spindle pitch Value range: 0 - 59999
dEC I	15	Decimal places Selection: 0: 0 01: 0.1 002: 0.02 0003: 0.003 00004: 0.0004

Parameter display	Parameter no. acc. To chapter 4	Description
d IU	16	Display divisor Selection: I: 1 10: 10 100: 100 1000: 1000
rotAt	23	Sense of rotation Selection: Cr: i sense of rotation (cw) CCr: e sense of rotation (ccw)
CAL Ib	26	Calibration value Value range: -9999 ... 9999
CAL Ib		Selection: no: no calibration YES: Execute calibration now
OFFSt	25	Offset Value range: -9999 ... 9999
tAr9 1	27	Target window 1 Value range: 0 - 9999
POtYP	30	Pos Type Selection: d Ir: direct POS: loop + nE9: loop -
LOOP	31	Loop length Value range: 0 - 9999
tAr92	28	Target window 2 Value range: 0 - 9999

Table 4: Positioning menu

3.4.1.7 Visualization

Menu	PArA U IS IO

Parameter display	Parameter no. acc. To chapter 4	Description
d ISPL	19	Display orientation Selection: 0: 0° 180: 180°
9rEEn	13	Green LED function Selection: on: Indication of the operating status OFF: Off
rEd	12	Red LED function Selection: on: Indication of the operating status OFF: Off
FLASH	14	LED blinking function Selection: on: LED blinking On OFF: Off
t2U IS	29	Visualization of target window 2 Selection: 9rEEn: target window 2 reached: Green LED rEd: target window 2 reached: Red LED OFF: Function off
Ind IC	18	Direction indication function Selection: on: On InUrS: inverted OFF: Off
L InE2	20	Displayed value of 2nd display line Selection: on: Set point OFF: Off

Table 5: Visualization menu

3.4.1.8 Options

Menu	PArA OPt 10

Parameter display	Parameter no. acc. To chapter 4	Description
CdELA	9	Key enable time Value range: 1 ... 60
rESEt	11	Key function release for Reset (calibration) Selection: on: Reset enabled via key OFF: Reset disabled via key
InC	10	Key function enable for incremental measurement Selection: on: Incremental measurement enabled via key OFF: Incremental measurement disabled via key
dIFF	32	Formula for calculating the differential value Selection: PO-tA: Differential value = actual position - set point tA-PO: Differential value = actual position - actual position
OPtyP	8	Operating mode of the display Selection: AbS: Display of absolute actual position and set point d iFF: Display of absolute actual position and differential value AnGLE: Display of angle values (0 ... 360°)
CodE		System commands Selection: I I 100: set all parameters to default (restore factory settings) I I 102: only standard parameters to default I I 105: only bus parameters to default 00 100: start equalization

Table 6: Options menu

3.4.2 Parameterization via interface

The position indicator can be completely parameterized in the SIKONETZ5 protocol via the RS485 interface (see chapter 8.8 Parameterization via SIKONETZ5).

4 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 = Bus parameter
P	Write access to the parameter can be locked via the "Configuation programming mode" parameter no 21.

No.	Name	Selection / value	Default	Description	S	C	P
1	Actual position	Read only	-	**Absolute actual position**	-	-	-
2	Set point	-999999 ... 999999	0	**Absolute target position** Can be displayed by the indicator: -19999 ... 99999	-	-	P
3	Node address	0 ... 31	1	**SIKONETZ5:** Setting the SIKONETZ5 node address Parameter changes become active only after cold start or software reset. **Service protocol:** no function	S	2	P
4	Baud rate RS485	0 ... 2	1	**Baud rate of the RS485 interface:** 0 = 19200 1 = 57600 2 = 115200 Parameter changes become active only after cold start or software reset.	S	2	P
5	Protocol	0 ... 1	0	**Protocol of the RS485 interface:** 0 = SIKONETZ5 1 = Service protocol Parameter changes become active only after cold start or software reset.	S	2	P
6	Bus Timeout	0 ... 20	0	**SIKONETZ5:** Bus Timeout values in x100 ms 0 = Function disabled (see chapter 8.7.1 Bus Timeout) **Service protocol:** no function	S	2	P

No.	Name	Selection / value	Default	Description	S	C	P
7	Write reply parameter to set point	0 ... 2	0	**SIKONETZ5:** This parameter defines the reply to the Write set point command 0 = Set point 1 = Actual value 2 = Differential value **Service protocol:** no function	S	2	P
8	Operating mode	0 ... 2	0	**Type of position value display** 0 = absolute position display 1 = differential value 2 = Modulo (see chapter 3.1 Operating modes)	S	1	P
9	Key enable time	1 ... 60	15	**Display / key control:** Time in seconds how long the ← key must be held down until configuration starts	S	1	P
10	Key function enable Incremental measurement	0 ... 1	1	**Display / key control:** 0 = incremental measurement function disabled 1 = incremental measurement function enabled	S	1	P
11	Key function enable reset	0 ... 1	1	**Display / key control:** 0 = Calibration (reset) function via key disabled 1 = Calibration (reset) function via key enabled	S	1	P
12	LED 1 red	0 ... 1	1	**Red LED 1 function:** 0 = Off 1 = position-dependent display (On) If the position-dependent display for both LEDs is switched off the LEDs can be enabled by the control word (see chapter 8.3.4 Control word).	S	1	P
13	LED 1 green	0 ... 1	1	**Green LED 1 function:** 0 = Off 1 = position-dependent display (On) If the position-dependent display for both LEDs is switched off the LEDs can be enabled by the control word (see chapter 8.3.4 Control word).	S	1	P
14	LED blinking	0 ... 1	1	**LED blinking function:** 0 = LED display glows constantly (when On) 1 = LED display glows (when On)	S	1	P

No.	Name	Selection / value	Default	Description	S	C	P
15	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	1	P
16	Display divisor	0 ... 3	0	**Display:** Divisor by which the display accuracy is reduced compared with the measurement resolution. 0 = 1 1 = 10 2 = 100 3 = 1000	S	1	P
17	Display divisor application	0 ... 1	0	**Display / transmission accuracy:** 0= The display divisor is applied to the set point and actual position of interface and display unit. 1= The display divisor is only applied to the display unit. The values are transferred via the interface with undivided resolution.	S	1	P
18	Direction indication function	0 ... 2	0	**Display:** The direction indicators show the direction of shaft adjustment required to arrive at the set target window 1. 0 = On 1 = inverted 2 = Off	S	1	P
19	Display orientation	0 ... 1	0	**Display:** Display orientation 0 = 0° 1 = rotated by 180°	S	1	P
20	Displayed value 2nd display line	0 ... 1	0	**Display:** Parameter to be displayed in the 2nd line of the display. 0 = set point 1 = OFF	S	1	P
21	Programming mode configuration	0 ... 1	0	**SIKONETZ5:** 0 = programming not locked 1 = locking of programming depends on the programming mode **Service protocol:** no function	S	1	P

No.	Name	Selection / value	Default	Description	S	C	P
22	Programming mode	0 ... 1	0	**SIKONETZ5:** 0 = Programming mode Off 1 = Programming mode On **Service protocol:** no function	-	1	-
23	Sense of rotation	i, e	i	**Counting direction of the measuring system:** With shaft rotating clockwise (view on the LCD) i sense of rotation (cw): ⇒ positive counting direction e sense of rotation (ccw): ⇒ negative counting direction	S	1	P
24	APU / Spindle pitch	0 ... 59999	720	**Readout per revolution / spindle pitch:** Position value is output in x increments per revolution.	S	1	P
25	Offset	-9999 ... 9999	0	**Offset value:** Changes to the offset value are considered in the calculation of the position value immediately after value entry / transmission. The following equation is applied in case of calibration: Position value = 0 + calibration value + offset value	S	1	P
26	Calibration value	-9999 ... 9999	0	**Calibration value:** Changes to the calibration value are adopted for calculation of the position value (via ✳ key or S command) only after calibration). Then one has: Position value = 0 + calibration value + offset value	S	1	P
27	Target window1	0 ... 9999	5	**Positioning window1:** The target position has been reached when the indicator's actual position is within the programmed set point ± this window. With factory settings, this is represented as follows: LCD: no arrows LED display LED1 = green System status word or status word: Setting the corresponding bits.	S	1	P

No.	Name	Selection / value	Default	Description	S	C	P
28	Target window 2	0 ... 9999	0	**Positioning window2:** Additional target window for detecting an approach to target window1 (see also Parameter no. 29 and chapter 3.2 Position monitoring seq.).	S	1	P
29	Visualization of target window2	0 ... 2	0	**Visualization of the "target window2 reached" state** Selection: 0 = Off 1 = LED1 glows green 2 = LED1 glows red If the actual position is inside target window2, but outside target window1, the LED display glows as set here. Additionally, blinking of the LED is inverted to Parameter no. 14: LED blinking switched on.	S	1	P
30	Positioning mode	0 ... 2	direct	**Type of positioning:** 0 = direct: direct travelling from actual position to set point possible. 1 = loop +: travelling to the set point must always be in positive direction to compensate for spindle play. 2 = loop -: travelling to the set point must always be in negative direction to compensate for spindle play.	S	1	P
31	Loop length	0 ... 9999	0	**Loop length:** see chapter 3.3 Loop positioning	S	1	P
32	Differential value calculation	0 ... 1	0	**Calculation of the differential value:** 0 Differential value = actual position - set point 1: Differential value = actual position - actual position	S	1	P
33	System Status Word	Read only	-	**System Status Word** see chapters 7.3 System Status Word and 8.3.5 Status word	-	-	-
34	Voltage of battery	Read only	-	**Battery voltage:** Values in 1/100 V	-	-	-
35	Software version	Read only	-	**Software version**	S	-	-

No.	Name	Selection / value	Default	Description	S	C	P
36	Response delay	0 … 10	0	**Response delay:** 0: no delay 1 … 10: number of internal program cycles waited until an SN5-bus telegram is replied to. Thus, the response to a telegram can be delayed until the master is ready to receive. The value 10 corresponds to a delay of approx. 5 ms.	S	2	P

Table 7: Parameter description

5 Warnings / Errors

5.1 Warnings

Warnings do not influence the acquisition of the absolute position value.
Warnings are deleted after removing the cause.

Possible warnings:

- Battery voltage for absolute position detection is below limit ⇒ immediately exchange battery.
  This warning is displayed with a blinking battery symbol ▭ and in the system status word or status word (see chapter 7.3 System Status Word and accoordingly chapter 8.3.5 Status word).

5.2 Errors

Error states are signalled via display and interface.
Pending errors can be read via the interface. For returning to normal operation, the errors must be acknowledged or deleted via the ✳ key or bus interface.
(For signaling and acknowledging in the service protocol see chapter 7.3 System Status Word and accoordingly SIKONETZ5 chapter 8.3.4 and 8.3.5 Status word.)

Display	Error code SIKONETZ5	Bit assignment in the system status word or status word	Error
noErr	0x0000	-	No error
▭	0x0006	11+7	Low battery voltage
SPEEd	0x0019	2+7	Speed exceeded
CSbUS	0x0080	7	Check sum SIKONETZ5
tobUS	0x0081	7	Timeout SIKONETZ5
VALUE	0x0082	7	Value range exceeded / inappropriate
LI LO	0x0182	7	Value exceeds lower limit

Display	Error code SIKONETZ5	Bit assignment in the system status word or status word	Error
LI UP	0x0282	7	Value exceeds upper limit
noPAr	0x0083	7	Unknown parameter
ACCES	0x0084	7	Access not supported
Pr2ro	0x0184	7	Write on read only
rd2P0	0x0284	7	Read on write only
StAtE	0x0085	7	Error caused by device status
noPr9	0x0385	7	Programming lock activated

Table 8: Error messages

Display	Error	Possible effect	Corrective actions
	Battery empty	Position value not reliable	Battery change + calibration travel
SPEEd	Speed exceeded	Position value not reliable	Reduce speed + calibration travel

Table 9: Corrective actions

6 System commands

6.1 Calibration

Two steps are required for executing calibration:

1. Enter/write calibration value (see chapter 3.4.1.6 Positioning and chapter 8 Communication via SIKONETZ5 ⇒ Parameter address 0x1F)
2. Execute calibration (reset) (see chapter 2.4 Keys, chapter 3.4.1.6 Positioning or chapter 8 Communication via SIKONETZ5 ⇒ Parameter address 0xA0)

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

Calibration value (see chapter 4 Parameter description ⇒ Parameter no. 26)

Offset value (see chapter 4 Parameter description ⇒ Parameter no. 25)

6.2 Restore factory settings

In some instance, for instance for evaliuating the position indicator, it may be useful to restore the device's factory settings. This may de done as follows:

Access	Coding		Factory settings are restored
Manually	PArA OPt 10	CodE 11100	all parameters
		CodE 11102	only standard parameters
		CodE 11105	only bus parameters
Service protocol	S	11100	all parameters
		11101	only standard parameters
		11102	only bus parameters
SIKONETZ5	0xA0	1	all parameters
		2	only standard parameters
		5	only bus parameters

Table 10: Access to factory settings

6.3 Alignment travel

The position indicator is aligned in the factory and is, therefore, fully functioning.
The following steps must be carried out for additional alignment:

1. Start alignment (see Table 11: Start access to alignment)
   The following is displayed:
   AbSL
   100
   The value can vary by +/- 1.
2. Rotate the position indicator's shaft counter-clockwise at the speed of << 1 rpm .
   The value will slowly change until 103.
3. If this value is finally exceeded, the alignment process will be completed.
   The position indicator enters normal operation, which is shown on the display unit.
4. Calibrate the position indicator (see chapter 6.1 Calibration)
   It is not unusual that the position value cannot be displayed at first following alignment travel and "FULL" displayed instead. The correct value will be displayed after calibration.

Alignment can be started as follows.

Access	Coding	
Manually	PArA OPt 10	CodE 00 100
Service protocol	S	00100
SIKONETZ5	0xC3	1

Table 11: Start access to alignment

7 Communication via Service Protocol

7.1 General

The service protocol enables parameterization and control of the position indicator via ASCII commands. No additional devices must be connected to the RS485 interface since this protocol is not bus-compatible.

An ASCII terminal sends a letter and additional parameters if required (ASCII). Subsequently, the position indicator sends a reply with a concluding <CR>.

Available baud rates: 19.2 kBit / 57.6 kBit (factory setting) / 115.2 kBit
Additional settings: No parity, 8 data bits, 1 stop bit, no handshake

7.2 Error number encoding

The following error messages are returned with faulty entries.

Error number	Description
?1	input of illegal parameter number
?2	illegal value range

Table 12: Error number encoding

7.3 System Status Word

The system status word consists of 2 bytes and reflects the state of the actuator.

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. 5: Structure of system status word

Example (grey background):

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

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

Bit	Meaning	Value = 0	Value = 1
0	direction indication ">"	off	on
1	direction indication "<"	off	on
2	Speed error	not present	speed is or was too high
3	Target window2 dynamic	not reached	reached
4	Target window1 static	never reached	is or was reached
5	Target window1 dynamic	not reached	reached

Bit	Meaning	Value = 0	Value = 1
6	Deviation	Actual position < = set point	Actual position >set point
7	Error	not present	present The cause of the error must be removed and acknowledged.
8	Position value output	dynamic	freezed
9	Position value = incremental measurement	off	on
10	reserved	-	-
11	Battery status (warning)	all right	critical
12	reserviert	-	-
13	↑ key	not actuated	actuated
14	✳ key	not actuated	actuated
15	← key	not actuated	actuated

Table 13: System Status Word

7.4 Service protocol commands list

Command	Length	Reply	Description	Parameter no.acc. to chapter 4
Ay	2/17	"AP04_SN5_ zWVxxx>"	**Device type / software version** y=0: hardware version; z = H y=1: software version; z = S	35
By	2/10 dez	"±xxxxxxx>"	**Diagnosis** y=3: Battery voltage [1/100 V]	34
Ey	2/11	"±xxxxxxxx>"	**Output values** ±xxxxxxxx = decimal value in increments	
			y=0: Current set point	2
			y=1: Position with incremental measurement formation	-
			y=2: Position with calibration	-
			y=3: Calibration value	26
			y=5: Offset	25
Fy±xxxxxxxx	11/2	">"	**Enter values** ±xxxxxxxx decimal value in increments	
			y=0: Target position (volatile)	2
			y=3: Calibration value	26
			y=5: Offset	25

Command	Length	Reply	Description	Parameter no.acc. to chapter 4
Gyy	3/7	"xxxxx>"	**Output 2-byte value** yy = Address xxxxx = decimal value	
			yy=00: APU / spindle pitch	24
			yy=01: Display divisor 0 = 1 1 = 10 2 = 100 3 = 1000	16
			yy=02: Display divisor application	17
			yy=03: Decimal places 0 = 0 1 = 0.0 2 = 0.00 3 = 0.000 4 = 0.0000	15
			yy=04: Target window 1	27
			yy=05: Target window 2	28
			yy=06: Visualization of target window2	29
			yy=07: Positioning mode	30
			yy=08: Loop length	31
			yy=09: Direction indication function 0 = On 1 = inverted 2 = Off	18
			yy=10: Key enable time Range 1 – 60 seconds	9
			yy=11: Key function enable reset (Calibration) 0 = Function disabled via key 1 = Function enabled via key	11
			yy=12: Key function enable incremental measurement 0 = Function disabled via key 1 = Function enabled via key	10
			yy=13: Display orientation 0 = 0° 1 = rotated by 180°	19
			yy=14: LED blinking 0 = Off 1 = On	14
			yy=15: reserviert	-
			yy=16: LED red 0 = Off 1 = On	12

Command	Length	Reply	Description	Parameter no.acc. to chapter 4
			yy=17: LED green 0 = Off 1 = On	13
			yy=18: Displayed value 2nd display line 0 = set point 1 = Off	20
			yy=19: Differential value calculation 0: Differential value = actual position – set point 1: Differential value = set point – actual position	32
			yy=20: reserved	-
			yy=21: Baud rate RS485 0 = 19200 1 = 57600 2 = 115200	4
			yy=22: Node address	3
			yy=23: Response delay	36
Hyyxxxxx	8/2	">"	**Enter 2-byte value** yy = Address xxxxx = decimal value	
			yy=00: APU / spindle pitch	24
			yy=01: Display divisor	16
			yy=02: Display divisor application	17
			yy=03: Decimal places	15
			yy=04: Target window 1	27
			yy=05: Target window 2	28
			yy=06: Visualization of target window2	29
			yy=07: Positioning mode	30
			yy=08: Loop length	31
			yy=09: Direction indication function	18
			yy=10: Key enable time	9
			yy=11: Key function enable reset (Calibration)	11
			yy=12: Key function enable incremental measurement	10
			yy=13: Display orientation	19
			yy=14: LED blinking	14
			yy=15: reserved	-
			yy=16: LED red	12
			yy=17: LED green	13

Command	Length	Reply	Description	Parameter no.acc. to chapter 4
			yy=18: Displayed value 2nd display line	20
			yy=19: Differential value calculation	32
			yy=20: reserved	-
			yy=21: Baud rate RS485	4
			yy=22: Node address	3
			yy=23: Response delay	36
K	1/2	">"	**Software reset**	-
L	1/2	">"	**Calibration** (see chapter 6.1 Calibration)	-
R	1/2	"xy"	**Output system status word (hex)** for the meaning of the individual bits see Table 13: System Status Word x = High Byte y = Low Byte	
Sxxxxx	6/2	">"	**Reset device to basic state / System commands**	
			x=00100: Start alignment (see chapter 6 System commands)	
			x=11100: all parameters into basic state **Caution!** All parameter classes will be reset. After restart, the factory settings will be active, this applies to bus protocol and baud rate as well.	
			x=11101: only standard parameters into basic state	
			x=11102: only bus parameters into basic state	
			x=11103: Acknowledge error	
			x=11104: Acknowledgement target window1 static (description see chapter 3.2 Position monitoring)	
			x=11105: activate bootloader	
Ty	2/2	">"	**Enter sense of rotation** y=0: i sense of rotation (cw) y=1: e sense of rotation (ccw)	23

Command	Length	Reply	Description	Parameter no.acc. to chapter 4
U	1/11	"aabbccdxyz"	**Output sensor data** aa = ADC-Sin bb = ADC-Cos cc = fine value d = quarter x = rough value [2] y = rough value [1] z = rough value [0]	
Xy	2/2	">"	**Enter operation mode** 0 = absolute position display 1 = differential value 2 = Modulo	8
Z	1/11	"±xxxxxxxx>"	**Output actual position**	1

Table 14: Service protocol commands list

8 Communication via SIKONETZ5

8.1 Interface

RS485 interface

Available baud rates: 19.2 kBit / 57.6 kBit (Factory setting) / 115.2 kBit

No parity, 8 data bits, 1 stop bit, no handshake

8.2 Data exchange

The protocol functions according to the master – slave principle.

The actuator acts as a slave. Every instance of communication must be initiated by the master. When the master has sent a command telegram, the slave sends a reply telegram. Broadcast commands are an exception, they remain always unanswered by the slave.

The protocol is optimized for cyclical data exchange. The relevant data such as set point and actual value as well as control and status words can be transferred between master and slave by a single telegram exchange.

The parameter to be returned by the slave as a reply to the master's Write set point command can be defined via the "Write set point reply parameter".

8.3 Telegram setup

Control word (CW), status word (SW) and data are transferred in the Big-Endian format.

Command telegram (from master)

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command	Node address	Parameter address	High Byte	Low Byte	MSB			LSB	Check sum
			CW		Data				

Reply telegram from slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Reply	Node address	Parameter address	High Byte	Low Byte	MSB			LSB	Check sum
			SW		Data				

8.3.1 Command

The following access types are provided by SIKONETZ5.

Access code	Meaning	Description
0x00	read	The master requests the addressed slave to output the relevant value in a response telegram.
0x01	write	The master requests the addressed slave to accept the value transferred in the same telegram.
0x02	broadcast	The master requests all connected slaves to execute the command transferred in the same telegram.

8.3.2 Node address

The device address can be freely set in the range of 0 to 31. The delivered devices are preset to node address 1 ex works and must be reset to the desired address to enable their operation with multiple slaves on the SIKONETZ5 fieldbus. Each address can be assigned in the fieldbus only once!

Description see chapter 4 Parameter description ⇒ Parameter no. 3.

8.3.3 Parameter address

A distinct address is assigned to every parameter (e.g. calibration value) or functional value (e. g. set point). Description see chapter 8.8 Parameterization via SIKONETZ5.

8.3.4 Control word

The master can give the following commands to the slave in the control word (CW).

Bit	Meaning	Value = 0	Value = 1
0	reserved	ever 0	-
1	reserved	ever 0	-
2	reserved	ever 0	-
3	Display range [1]	standard	extended
4	Acknowledgment target window1 static [2]	not acknowledged	acknowledged
5	Error	not acknowledged	acknowledged
6	reserved	ever 0	-
7	reserved	ever 0	-
8	reserved	ever 0	-
9	reserved	ever 0	-
10	reserved	ever 0	-
11	reserved	ever 0	-
12	LED green	OFF	ON [3]
13	LED red	OFF	ON [3]
14	reserved	ever 0	-
15	LED blinking	OFF	ON [3]

Table 15: Control word (Master ⇒ Slave) SIKONETZ5

8.3.5 Status word

The current status of the slave is transferred to the master in the status word (SW).

Bit	Meaning	Value = 0	Value = 1
0	Direction indication ">"	OFF	ON
1	Direction indication "<"	OFF	ON
2	Speed error	is / was not present	max. speed is / was exceeded
3	Target window2 dynamic	not reached	reached
4	Target window1 static [4]	never reached	reached
5	Target window1 dynamic [4]	not reached	reached
6	Deviation	Actual position <= set point	actual position > set point
7	General error	not present	is present
8	Output of position value [5]	dynamic	freezed

[1] *see chapter 2.2.1 Extended display range*
[2] *see status word bit SW 4: "Target window1 static"*
[3] *In order to get access to the LED via the control word, the position-dependent function must be inactivated viaParameter no. 12, 13 and 14.*
[4] *The bit SW.4: "Target window1 static" is set when target window1 was reached. It is not deleted when leaving the window. Deletion occurs via acknowledgment with bit CW.4. Bit SW.5 is deleted automatically upon leaving the window.*
[5] *see chapter 8.8: Parameter address 0xAA.*

Bit	Meaning	Value = 0	Value = 1
9	Position value = incremental measurement	OFF	ON
10	reserved for future use	-	-
11	Battery status (warning)	all right	critical
12	reserved for future use	-	-
13	← key	not actuated	actuated
14	* key	not actuated	actuated
15	↑ key	not actuated	actuated

Table 16: Status word (Slave ⇒ Master) SIKONETZ5

8.3.6 Data

Range for data exchange. Size: 4 bytes.

8.3.7 Check sum

For checking error-free data transfer, a check sum is formed at the end of the telegram. The check sum is the exclusive-OR-link of bytes 1 ... 9:

Check sum [Byte10] =

[Byte1] XOR [Byte2] XOR [Byte3] XOR [Byte4] XOR [Byte5] XOR [Byte6] XOR [Byte7] XOR [Byte8] XOR [Byte9]

The following applies for checking the telegram received:

[Byte1] XOR [Byte2] XOR [Byte3] XOR [Byte4] XOR [Byte5] XOR [Byte6] XOR [Byte7] XOR [Byte8] XOR [Byte9] XOR [Byte 10] = 0

With a result unequal 0 a transmission error is to be assumed.

8.4 Synchronization

NOTICE	Processing of the "Restore factory settings" system command may take up to 100 ms. Acknowledgment is reported only after proper updating of all parameters in the non-volatile memory.

Byte/telegram synchronization is via "Timeout". The intervals between the individual bytes of a telegram must not exceed the value of 10 ms. If an addressed device does not respond, the master must not send another telegram earlier than after 30 ms.

8.5 Error telegram

Illegal entries are replied with an error telegram.

An error telegram consists of parameter address 0xFD and an error code.

The error code is in the data section of the reply telegram. The error code is divided in two bytes. Code 1 describes the error proper, code 2 contains additional information if available.

In the following example an attempt was made at writing a value of 90 to the key enable time parameter address.

However, a maximum value of only 60 is admissible for this parameter.

Telegram from master to slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command	Node address	Parameter address	CW		Data				Check sum
0x01	0x01	0x04	0x00	0x00	0x00	0x00	0x00	0x5A	0x5E

Reply telegram from slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command	Node address	Parameter address	SW		Data				Check sum
							Code 2	Code 1	
0x01	0x01	0xFD	0x00	0x81	0x00	0x00	0x02	0x82	0xFC

8.5.1 SIKONETZ5 error codes

Code 1	Description	Code 2	Description
0x80	Check sum SIKONETZ5	0x00	no further information available
0x81	Timeout SIKONETZ5	0x00	no further information available
0x82	Value rage exceeded / inadequate	0x00	no further information available
		0x01	Value < MIN
		0x02	Value > MAX
0x83	Unknown parameter	0x00	no further information available
0x84	Access is not supported	0x00	no further information available
		0x01	write attempt to read only
		0x02	read attempt to write only
0x85	Error due to device status	0x00	no further information available
		0x03	Programming locked

Table 17: SIKONETZ5 error codes

8.6 Errors

If a slave is in the error state the slave signals the error with SW.7 = 1.

An error must be acknowledged by CW.5 = 0/1 or by pressing the ✳ key. If the cause of the error has not been resolved at the time of acknowledgment, the error will not be reset or triggered anew, resp.

Errors that have not been acknowledged can be read via a read command on Parameter address 0xFD. The error code will be output (see chapter 5.2 Errors and 8.5.1 SIKONETZ5 error codes).

8.7 Communication monitoring

8.7.1 Bus Timeout

Bus timeout monitoring is activated via parameterization of a valid time value (>0) for timeout (see chapter 4 Parameter description ⇒ Parameter no. 6).

The first telegram received by the slave starts time monitoring.

Every new telegram recognized as valid by a slave (correct check sum) triggers time monitoring.

If timeout occurs, this will result in the Timeout error.

After establishing cyclic communication between master and slave, this function can detect a broken cable of the connection line for instance and signal the defect.

8.7.2 Programming interlock

Programming interlock is controlled via Parameter no. 21 "Programming mode configuration" This parameter being enabled, the interlock must be canceled prior to write access to a lockable parameter (see Table 7: Parameter description) by applying a write access to Parameter no. 22: "Programming mode". Correspondingly, the interlock should be enabled again immediately after a write access.

This mechanism enhances protection against unintentional parameterization.

Write access to locked parameters is replied with "Error due to device state" (see chapter 8.5.1 SIKONETZ5 error codes).

8.8 Parameterization via SIKONETZ5

On principle, the position indicator sends a telegram acknowledging write and read commands of the master. With the command executable the value adopted is in the reply telegram.

If the actuator was unable to execute the command, e. g. because it attempted to write a value beyond the admissible range, the position indicator will send an error telegram in reply.

Access
rw = read write
ro = read only
wo = write only

Parameter		Name	Access	Format	Description
no.acc. to chapter 4	Adr. [hex]				
3	0x00	Node address	rw	Unsigned8	Value range 0 ... 31 Parameter changes become active only after cold start or software reset.
4	0x01	Baud rate	rw	Unsigned8	0 = 19200 1 = 57600 2 = 115200 Parameter changes become active only after cold start or software reset.
6	0x02	Bus Timeout	rw	Unsigned16	Value range 0 ... 20 (see chapter 8.7.1 Bus Timeout)
7	0x03	Reply parameter to write set point command	rw	Unsigned8	0 = Set point 1 = Actual position 2 = Differential value
9	0x04	Enable keys time	rw	Unsigned8	Value range 1 ... 60
11	0x05	Key function enable reset	rw	Unsigned8	0 = key function locked 1 = Calibration (reset) key function enabled
14	0x06	LED blinking	rw	Unsigned8	0 = LED display glows constantly 1 = LED display blinks
12	0x08	LED 1 red	rw	Unsigned8	0 = LED 1 red Off 1 = LED 1 red On
13	0x09	LED 1 green	rw	Unsigned8	0 = LED 1 green Off 1 = LED 1 green On
15	0x0A	Decimal places	rw	Unsigned8	Value range 0 ... 4 0 = 0 1 = 0.0 2 = 0.00 3 = 0.000 4 = 0.0000
16	0x0B	Display divisor	rw	Unsigned8	Value range 0 ... 3 0 = 1 1 = 10 2 = 100 3 = 1000
18	0x0C	Direction indication function	rw	Unsigned8	Value range 0 ... 2 0 = on 1 = inverted 2 = off
19	0x0D	Display orientation	rw	Unsigned8	0 = normal 1 = rotated by 180°

Parameter		Name	Access	Format	Description
no.acc. to chapter 4	Adr. [hex]				
21	0x0E	Programming mode Configuration	rw	Unsigned8	0 = no programming mode 1 = apply programming mode
23	0x1B	Sense of rotation	rw	Unsigned8	0 = i sense of rotation (cw) 1 = e sense of rotation (ccw)
24	0x1C	APU / Spindle pitch	rw	Unsigned16	Value range 0 ... 59999
25	0x1E	Offset	rw	Integer32	Value range -9999 ... 9999
26	0x1F	Calibration value	rw	Integer32	Value range -9999 ... 9999
27	0x20	Target window1	rw	Unsigned16	Value range 0 ... 9999
30	0x21	Positioning mode	rw	Unsigned8	0 = direct 1 = loop + 2 = loop -
31	0x22	Loop length	rw	Unsigned16	Value range 0 ... 9999
8	0x28	Operating mode	rw	Unsigned8	0 = absolute position display 1 = differential value 2 = Modulo
20	0x30	Displayed value 2nd display line	rw	Unsigned8	0 = set point 1 = OFF
28	0x31	Target window2	rw	Unsigned16	Value range 0 ... 9999
29	0x32	Target window2 – visualization	rw	Unsigned16	0 = OFF 1 = LED 1 glows green 2 = LED 1 glows red
17	0x33	Display divisor application	rw	Unsigned8	0 = application to display and interface 1 = application to display only
32	0x34	Differential value calculation	rw	Unsigned8	0 Diff. = actual position - set point 1 Diff. =set point - actual position
10	0x35	Key function enable incremental measurement	rw	Unsigned8	0 = key function disabled 1 = incremental measurement key function enabled
34	0x63	Voltage of battery	ro	Integer16	Output of voltage [1/100 V]
	0x65	Device code	ro	Unsigned8	1 = AP04
35	0x67	Software version	ro	Unsigned16	Versions number Bx.: 101_{dec} corresponds to V1.01

Parameter		Name	Access	Format	Description
no.acc. to chapter 4	Adr. [hex]				
	0xA0	S command	wo	Unsigned16	1 = all parameters to default **Caution!** All parameter classes will be reset. After restart, the factory settings will be active, this applies to node address and baud rate as well. 2 = only standard parameters to default 5 = bus parameters to default 7 = calibration 9 = software reset
	0xA8	Programming mode On / Off temporary	wo	Unsigned8	Programming interlock depending on the parameter "Configuration programming mode" 0 = Programming mode Off: Write parameter disabled. Write attempts are acknowledged with an error message. 1 = Programming mode On: Write parameter enabled (see chapter 8.7.2 Programming interlock)
	0xAA	Freeze actual position	wo	Unsigned8	1 = Freeze actual position: The current actual value is cached until next reading of the actual position
	0xC3	Start alignment	wo	Unsigned8	(see chapter 6.3 Alignment travel)
	0xCA	Switching the bus protocol	wo	Unsigned8	Configuration of bus protocol 0 = SIKONETZ5 1 = Service protocol Parameter changes become active only after cold start or software reset.
36	0xD0	Response delay	rw	Unsigned8	Response delay: 0: no delay 1 … 10: number of program cycles
	0xFA	Status word	ro	Unsigned16	(see chapter 8.3.5 Status word)
	0xFC	Differential value	ro	Integer32	(see chapter 3.1 Operating modes)

Parameter		Name	Access	Format	Description
no.acc. to chapter 4	Adr. [hex]				
	0xFD	Error		Integer32	(see chapter 8.5 Error telegram)
	0xFE	Actual position	ro	Integer32	Actual position (see chapter 3.1 Operating modes)
	0xFF	Set point	rw	Integer32	Set point

Table 18: Parameter description SIKONETZ5

8.9 Examples of access

8.9.1 Example: Read parameter

NOTICE	With read commands the data range shall be set to value 0.

Reading the parameter target window1 of node address 1:

Read command: 0x00
Node address: 0x01
Parameter address: 0x20 Target window1
Data: 0x00 00 00 00

Telegram from master to slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command	Node address	Parameter address	CW		Data				Check sum
0x00	0x01	0x20	0x00	0x00	0x00	0x00	0x00	0x00	0x21

Reply telegram from slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command / Reply	Node address	Parameter address	SW		Data				Check sum
0x00	0x01	0x20	0x00	0x01	0x00	0x00	0x00	0x05	0x25

8.9.2 Example: Write parameter

Set parameter offset value of node address 1 to value 500:

Write command: 0x01
Node address: 0x01
Parameter address: 0x1E Offset value
Data: 0x00 00 01 F4 $\Rightarrow 500_{dec}$

Telegram from master to slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command	Node address	Parameter address	CW		Data				Check sum
0x01	0x01	0x1E	0x00	0x00	0x00	0x00	0x01	0xF4	0xEB

Reply telegram from slave

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte	9th byte	10th byte
Command / Reply	Node address	Parameter address	SW		Data				Check sum
0x01	0x01	0x1E	0x00	0x01	0x00	0x00	0x01	0xF4	0xEA