PBX21-AXIS

Technical Information

Submodules for PBX21-AXIS (4-axis controller)

Outputs:	
MAO 4	4 analog outputs
MDO 8 / MDIO 16	8 / 16 digital outputs
Inputs:	
MAI 4	4 analog inputs
MDI 8 / MDIO 16	8 / 16 digital inputs
MSSI 2	2 SSI absolute encoder interfaces
MINC 2	2 incremental encoder interfaces
MHAS 2	2 high-velocity asynchronous interfaces

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Italics and **bold** type are used for the title of a document or to emphasize text passages.

Passages written in `Courier` indicate text which is visible on the display as well as software menu selections.

"<   >" refers to keys on your computer keyboard (e.g. <RETURN>).

Note

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Revision History

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Note:
The cover of this document shows the current revision status and the corresponding date. Since each individual page has its own revision status and date in the footer, there may be different revision statuses within the document.

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Revision	Date
New chapter "Example Axis Initialization"	21.04.1998
Text supplemented on page 41; text modified and supplemented on page 48	19.02.1999

Table of contents

1 PBXAXIS hardware

The 4-axis controller has been developed from the FOX-20 basic module (B20) with the PBX-21 bus connection. The hardware components can be taken from the resources of the FOX system.

Note:
The following rules have to be observed:

- Slot 1 is reserved for a MAO4 (4-channel analog output).
  The following module/channel assignment applies:
  - Channel 1 = Axis 1
  - Channel 2 = Axis 2
  - Channel 3 = Axis 3
  - Channel 4 = Axis 4
- Slots 2, 3 and 4 are reserved for checkbacks of the actual values and are freely selectable.
- Digital input/output modules are also supplied, but may only be inserted in slots 2 and 3.
- On application of the "limit switch monitoring function", the MDI module must be inserted in slot 2.
- On application of the "axis release function", the MDO module must be inserted in slot 3.

1.1 Profibus interface

1.1.1 Data transfer between positioning module and computer

The positioning module is accessed via a 6-byte wide interface.
Identification code of the positioning module:
6 byte I/O, consistency over entire length: 0xB5 (181)

This identification can be entered up to four times. So it is possible to address all four axis at the same cycle!

Definition of the data channel (viewed from the master):

	Input	Output
Byte 0	Status byte	Control byte
Byte 1		Parameter number (address)
Byte 2	MSB byte	MSB byte
Byte 3		
Byte 4		
Byte 5	LSB byte	LSB byte

Control byte

7	6	5	4	3	2	1	0

Bit 5: PLC identification bit 1: PLC in operation, 0: PLC in STOP (all axes stationary)

Bit 6: Toggle bit

Bit 7: Write/read bit: 0: Data are read, 1: Data are written

Status byte:

The status byte is the copied control byte.

7	6	5	4	3	2	1	0

Bit 5: Communication status bit 1: Parameter/command understood
0: Parameter/command not defined

Bit 6: Toggle bit

Data:

The data are stored in bytes 2 to 5.

Value type:	-word (2 bytes):	MSB byte = byte 4
		LSB byte = byte 5
	- long type (4 bytes):	MSB byte = byte 2
		LSB byte = byte 5

Send parameters to positioning module

If data are to be sent to the module, the data and the parameter number must first be entered, then the write bit is set. On receipt, the data are copied to the sending buffer, and the higher-level computer can read out the sent data.
In order to detect whether the positioning module has received the data, the status of the toggle bit must be modified after each transfer. As the data are recopied to the sending buffer on receipt of a message, the toggle bit can be read out again, and the receipt of the message can be detected via the status change.

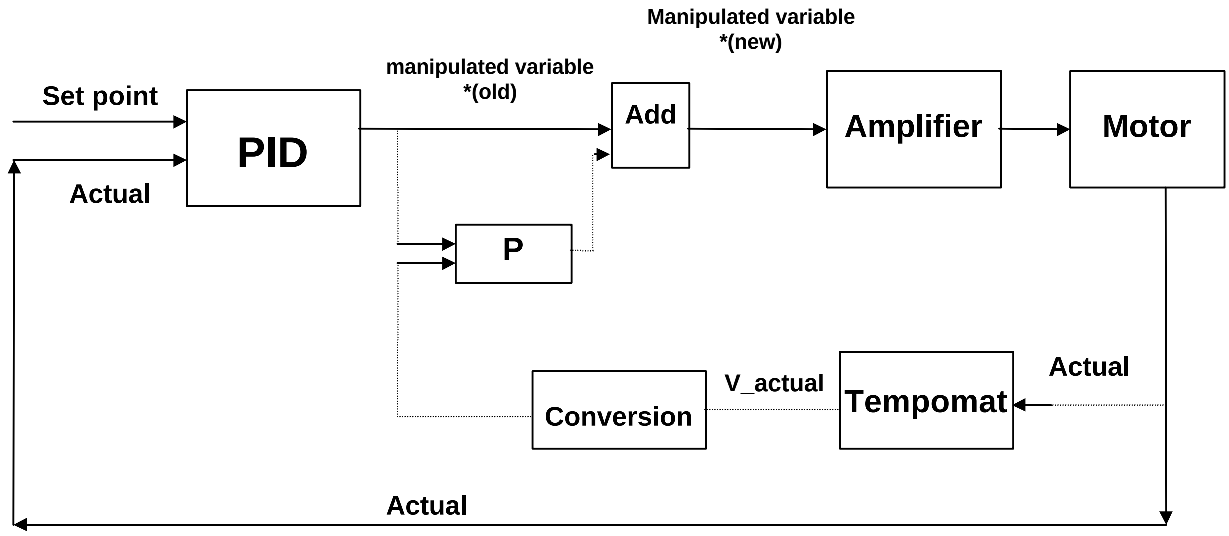
Note:
The above-mentioned method of sending data to the module only works properly if consistency over 6 bytes is ensured. If not, the write/read bit should be set to 0 first.

Read parameters from positioning module

If data are to be read from the module, the write/read bit must be set to 0. As soon as a message has been received, the desired data are copied to bytes 2 to 5 and the control byte and the parameter number are copied to the sending buffer and can be read out by the master.

2 Controller algorithm

2.1 Block diagram PBXAXIS controller



The PID controller in the FOX-20 is a PID controller with variable structure. The mathematical description is given below.

* If dotted control loop is switched on

2.2 PID algorithm

In continuous-action devices, a PID controller regulates the manipulated variable in order to reset the deviation (e). The deviation here means the difference between set point value (w) and actual value (x). The principle of the PID controller is based on the equation representing the manipulated variable M (t) as the product of a proportional component, an integral component and a differential component.
To implement the control unit in a digital computer, the continuously operating function must be converted to regular scanning of the deviation with subsequent calculation of the manipulated variable.

Definition: The deviation is: **e = w - x**

M(t)	=	K_{Prop} * e	+	$K_{integral}$ * $\int$ e dt	+	K_{diff} * de/dt
Manip. variable	=	proporti. compo.	+	integral component	+	differential component

2.2.1 The proportional controller (P-controller)

The proportional controller is defined by a simple mathematical relation

$$Y = K_{proportional} * e + C .$$

This continuously operating function must be converted to regular scanning of the deviation. The following relation applies to the proportional component:

$$Y_P = K_{proportional} * e_n$$

2.2.2 The integral controller (I-controller)

The integral controller (I-controller) has the equation

$$Y_{integral} = K_{integral} * \int e\, dt.$$

The following applies to the conversion to regular scanning in digital technology:

$$Y_{\mathrm{Integral}} = K_I * \sum_{1}^{n} e_n$$

Integral controller with variable structure

For starting up control loops, it has proved advantageous to start with a P-algorithm only, whereby the I-controller is not introduced until the system deviation (w-x) has diminished. For this reason, a parameter is defined which allows the user to determine the range in which the I-controller is to operate, in which the integral component is kept constant.

2.2.3 The differential controller (D-controller)

The differential controller (D-controller) has the equation

$$Y_{differential} = K_{differential} * de/dt.$$

Here the differentiation **de/dt** is replaced by

$$\frac{\Delta e}{\Delta T} = \frac{e_{new} - e_{old}}{\Delta T}$$

This yields $Y_{diff} = K_{diff} * (e_{new} - e_{old})$

The following equation therefore results for the manipulated variable in the PBXAXIS:

$$Y_{PBXAXIS} = Y_{proportional} + Y_{integral} + Y_{differential};$$

2.2.4 PBXAXIS special function

2.2.4.1 Set point value correction by integration via constants

The set point value correction by integration via a programmable constant (SI-controller) has the equation

$$Y_{SWK} = K_{proportional} * \int C\,dt.$$

Converted:

$$Y_{\text{SWK}} = K_{\text{Pr}op} * \sum_{1}^{\infty} c$$

2.2.4.2 Smoothing of manipulated variable with P-controller

By connecting a P-controller, an additional P-component can be activated via the manipulated variable and the velocity according to the block diagram (see page 9 dotted part).

The smoothing of the manipulated variable has the equation

$$P_{smoothing} = KVF_{prop\ man\ var} * (act\ var - V_{actual} * AK_{man\ var})$$

For the new manipulated variable, this yields:

$$Man\ var_{new} = Man\ var_{old} + P_{smoothing}$$

3 PBXAXIS DPRAM definition

3.1 Type specification

1. TR_fixed-point_8

The TR_fixed-point_8 in the controller is a 32 bit fixed-point figure consisting of:

Integer / 24 bit / two's complement	Decimal places / 8 bit

The decimal places are described mathematically as follows:

$$2^{-1} + 2^{-2} + 2^{-3} + 2^{-4} + 2^{-5} + 2^{-6} + 2^{-7} + 2^{-8}$$

velocity, acceleration and dynamic set point value are of this type

Example (practical calculation):

Given: Factor for TR_fixed-point_8 format = 256
Assumption: velocity = 1. 77

Calculation of hex value:
1.77 * 256 = 453.12

If decimal places result, they will be cut off.
Therefore: 453 dec. = 1C5 hex

Accelerations and velocity are of this type

2. TR_fixed-point_16

The TR_fixed-point_16 in the controller is a 32-bit fixed-point figure consisting of:

Integer / 16 bit / two's complement	Decimal places / 16 bit

The decimal places are described mathematically as follows:

$$2^{-1} + 2^{-2} + 2^{-3} + 2^{-4} + 2^{-5} + 2^{-6} + 2^{-7} + 2^{-8} + 2^{-9} + 2^{-10} + 2^{-11} + 2^{-12} + 2^{-13} + 2^{-14} + 2^{-15} + 2^{-16}$$

Example (practical calculation):

Given: Factor for TR_fixed-point_16 format = 65536
Assumption: KV = 21.68

Calculation of hex value:
21.68 * 65536 = 1420820.48

If decimal places result, they will be cut off.
Therefore: 1420820 dec. = 15AE14 hex

All KV factors are of this type

3.2 PBXAXIS parameters

As described in 1.1.1 page 7, the PBXAXIS contains read and write parameters.
The PBX21-AXIS has a virtual DPRAM that is divided into a read and write sector. This means that the parameters in the read sector may have the same numbers as in the write sector although they have different meanings.

3.3 PBXAXIS write parameters (control byte: bit 2^7 = 1)

"WRITE“ parameters are those which are sent to the PBXAXIS by the master via a message with control byte = 8H.

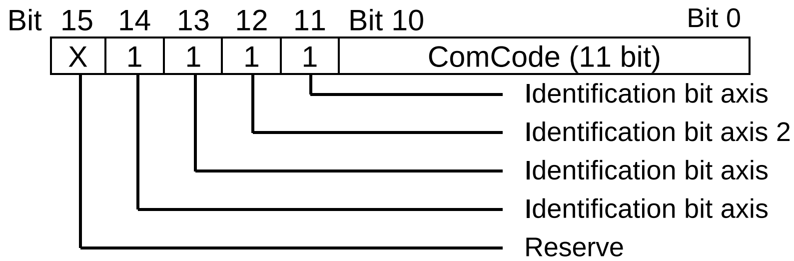
The controller distinguishes between two parameter types:

1. Indirect parameters (command for execution):
(Parameter number = 0)

To trigger an action in the positioning module PBX21-AXIS, the user describes the corresponding parameters and sends a command to the positioning module afterwards.

The command word is constituted as follows:

Type : word, value range for comcodes: see table, page 63
Address : **00** hex



2. Direct parameters (parameter number ≠ 0):

The parameter value is stored directly in the message together with the corresponding parameter number and sent to the slave.

3.3.1 Controller system parameters

3.3.1.1 Sampling interval

Type: word, value range: 5 .. 250 (0.5 ms .. 25 ms)
Address : **03** hex
COMCODE : 501 dec. (see chapter 4.3.2 page 36)

The internal timer is initialized on the basis of this value. The sampling interval unit is 0.1 ms . Default value = 7 (0.7 ms / axis)

Example:

Desired sampling interval = 1 ms
Set parameter sampling interval = 10
Send comcode = 501 to the PBXAXIS

Note:
By many additional functions (in- output operations) or in 4-axis operation the sampling interval should be not < 700 µs!

3.3.1.2 Number of axes

Type : word, value range: 1 .. 4 (1 .. 4 axes)
Address : **04** hex
COMCODE : 502 dec. (see chapter 4.3.3 page 36)

This tells the controller operating system how many axes are required.
In conjunction with the sampling interval, this parameter determines the system sampling interval. Default value for number of axes = 4

Example:

Number of axes = 2
Set parameter number of axes = 2
Send comcode = 502 to the PBXAXIS

3.3.2 Initialization parameters

3.3.2.1 Controller control block

1. $KVF_{ProportPositive}$

Loop gain factor of the P-component for positive deviation
Type : TR_fixed-point_16, value range: -2^31 .. 2^31
Address : **08** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

2. $KVF_{ProportNegative}$

Loop gain factor of the P-component for negative deviation
Type : TR_fixed-point_16, value range : -2^31 .. 2^31
Address : **0A** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

3. $KVF_{Differential}$

Loop gain factor of the D-component
Type : TR_fixed-point_16, value range : -2^31 .. 2^31
Address : **0C** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

4. $KVF_{Integral}$

Loop gain factor of the I-component (2 word)
Type : TR_fixed-point_16, value range : -2^31 .. 2^31
Address : **0E** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

5. Integral limit:

I-component is only effective if Abs (deviation) < integral limit
Type : longint, value range : -2^23 .. 2^23
Address : **10** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

6. Target window:

Type : longint, value range : -2^23 .. 2^23
Address : **12** hex
If the actual value within this window corresponds to the set point value, then the axis status = 1, otherwise = 2
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

7. Control direction:

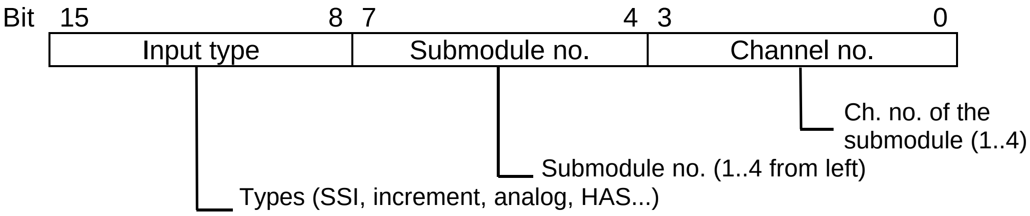
This defines the control direction of an axis

Type : integer, value range: 0, 1
Address : **14** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)
Control direction = 0 ===> set point - actual
Control direction = 1 ===> actual - set point

8. Measuring system identifier :

Type : integer, value range: see below
Address : **15** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

The control loop can be closed with the measuring system (input type) entered in the measuring system identifier. This parameter is defined as follows:



The input types are defined as follows (ident. no. for PBXAXIS)

Ident. no.	Designation	
1 (1H)	16-bit analog input	
8 (8H)	12-bit analog input	
	Standard	**FPGA SSI-25C, FOXAXIS V1.13**
24 (18H)	SSI, 24-bit binary	SSI, 24-bit binary
152 (98H)	-	SSI, 24-bit Gray
88 (58H)	-	SSI, 25-bit binary
216 (D8H)	-	SSI, 25-bit Gray
26 (1AH)	HAS-24-bit	
28 (1CH)	Incremental 24-bit	

Please note when using a 25-bit encoder

As the FOXAXIS can only process a 24-bit value, the value 8388607 is subtracted if the positive number range of $+2^{23} - 1$ is exceeded. If the negative number range of -2^{23} is exceeded, the value 8388608 is added.

Example:
Assumption: Encoder actual value = +16 000 000; this corresponds to an exceeding of the positive number range.

Corrective calculation of the FOXAXIS:

16 000 000
- 8388607
7611393 = displayed position

9. Drift compensation limit:

Typ : longint, value range : -2^23 .. 2^23
Address : **16** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

If the automatic drift compensation is active, the controller computes the drift compensation. If the current drift is higher than the limit, the controller displays the error code=1 (see Error code (error message mask), page 25).

10. Contouring error limit:

Typ : longint, value range : -2^23 .. 2^23
Address : **18** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

If the actual value differs from the calculated set point value by more than the following error, the controller stops the traversing movement, assumes the current actual value as the new target and controls on this basis. An error message with error code=2 is displayed (see Error code (error message mask), page 25).

11. $KVF_{PropActVar}$

As the block diagram (see page 9) of the controller shows, the profile of the manipulated variable can be adapted to the actual velocity. This parameter is the loop gain factor of the manipulated variable smoothing process.

Type : TR_fixed-point_16, value range : -2^31 .. 2^31
Address : **1A** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

12. $AK_{Manipulated\ variable}$

This parameter is the matching constant between manipulated variable and actual velocity.

Type : TR_fixed-point_8, value range : -2^31 .. 2^31
Address : **1E** hex
COMCODE : 100 dec. (see chapter 4.1.1 page 29)

3.3.3 Movement parameters

1. Target:

Set point value for the axis

Type : longint, value range : -2^23 .. 2^23
COMCODE : 130/135 dec. (see chapter 4.2.1/4.2.7 page 31/34)
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

2. Velocity:

If a new target and a start command are sent, this parameter defines the number of digits for each sampling interval, during which the axis moves towards the new target.

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 130/135 dec. (see chapter 4.2.1/4.2.7 page 31/34)
Address :

Axis no.	1	2	3	4
Address:	**2A hex**	**52 hex**	**7A hex**	**A2 hex**

3. Acceleration:

This variable defines the change in velocity per sampling interval. In the case of command 130, this acceleration is also the "braking acceleration".

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 130/135 dec. (see chapter 4.2.1/4.2.7 page 31/34)
Address :

Axis no.	1	2	3	4
Address:	**2C hex**	**54 hex**	**7C hex**	**A4 hex**

4. Absolute position :

If this variable = TRUE (1) ==> target = absolute value
If this variable = FALSE (0) ==> new target = actual value + target

Type : word, value range : FALSE (0) / TRUE (1)
COMCODE : 130/135 dec. (see chapter 4.2.1/4.2.7 page 31/34)
Address :

Axis no.	1	2	3	4
Address:	**2E hex**	**56 hex**	**7E hex**	**A6 hex**

5. Braking acceleration:

This variable defines the change in velocity per sampling interval on braking. It is only valid together with command 135.

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 130/135 dec. (see chapter 4.2.1/4.2.7 page 31/34)
Address :

Axis no.	1	2	3	4
Address:	**2F hex**	**57 hex**	**7F hex**	**A7 hex**

6. Set point value correction - bandwidth:

If the deviation is smaller than the bandwidth, the set point value correction is stopped, otherwise integration takes place as described in the chapter "Set point value correction by integration via constants", Seite 11

Type : longint, value range : -2^23 .. 2^23
COMCODE : 115 dec. (see chapter 4.1.11 page 31)
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

7. Set point value correction constant:

The set point value is corrected by the amount resulting from the following calculation:

$$\mathbf{SK\_value_{n+1} = SK\_value_{n} + SK\_constant}$$

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 115 dec. (see chapter 4.1.11 page 31)
Address :

Axis no.	1	2	3	4
Address:	**2A hex**	**52 hex**	**7A hex**	**A2 hex**

3.3.3.1 Variable for home return command

1. Home position_V1 :

Value of set velocity in direction of reference cam.

Type : integer, value range: -32767 .. +32767
COMCODE : 122/124 dec. (see chapter 4.2.4/4.2.5 page 32/33)
Address :

Axis no.	1	2	3	4
Address:	**44 hex**	**6C hex**	**94 hex**	**BC hex**

2. Home position_V2 :

When the reference cam is reached, the controller switches to home position_V2. The axis moves at this velocity until the reference cam is cleared again.

Type : integer, value range: -32767 .. +32767
COMCODE : 122/124 dec. (see chapter 4.2.4/4.2.5 page 32/33)
Address :

Axis no.	1	2	3	4
Address:	**45 hex**	**6D hex**	**95 hex**	**BD hex**

3. Home position_V3 :

Now the axis moves by the inverted value from home position_V3 back to the cam. When the reset pulse and the reference cam are reached, the position is zeroized.

Type : integer, value range: -32767 .. +32767
COMCODE : 122/124 dec. (see chapter 4.2.4/4.2.5 page 32/33)
Address :

Axis no.	1	2	3	4
Address:	**46 hex**	**6E hex**	**96 hex**	**BE hex**

4. Home return direction:

If this parameter = FALSE, all home return velocities are negated.

Type : integer, value range: -32767 .. +32767
COMCODE : 122/124 dec. (see chapter 4.2.4/4.2.5 page 32/33)
Address :

Axis no.	1	2	3	4
Address:	**47 hex**	**6F hex**	**97 hex**	**BF hex**

3.3.3.2 Variable for controlled home return

1. Home return direction:

"0" = negative home returns, "1" = positive home returns.

Type : longint, value range : 0, 1
COMCODE : 123 dec. (see chapter 4.2.5 page 33)
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

2. Home position_V1 :

Value of set velocity in direction of reference cam.
To ensure reliable detection of the cam, the velocity [digits/sampling interval] may not exceed approx. 70-80% of the cam length [digits].

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 123 dec. (see chapter 4.2.5 page 33)
Address :

Axis no.	1	2	3	4
Address:	**2A hex**	**52 hex**	**7A hex**	**A2 hex**

3. Acceleration:

This variable defines the change in velocity per sampling interval.

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 123 dec. (see chapter 4.2.5 page 33)
Address :

Axis no.	1	2	3	4
Address:	**2C hex**	**54 hex**	**7C hex**	**A4 hex**

4. Home position_V2 :

On reaching the reference cam, the axis switches to home position_V2 and returns. When the reset value outside the cam is reached, the actual value is zeroized and the position is held by the controller.
To ensure reliable detection of the reset pulse (approx. 1 digit), the velocity [digits/sampling interval] may not exceed approx. 70-80% of a digit.

Typ : Fixed-point8, value range : -2^23 .. 2^23
COMCODE : 123 dec. (see chapter 4.2.5 page 33)
Address :

Axis no.	1	2	3	4
Address:	**2F hex**	**57 hex**	**7F hex**	**A7 hex**

3.3.4 Digital outputs

Type : word, value range : FALSE (0) .. TRUE (1)
Address : 0F0 for MDO-8, 0F1 for MDIO-16

With the PBXAXIS controller module, 8-bit outputs (MDO-8) or 16-bit outputs (MDIO-16) can be used. The digital outputs may only be inserted in slots 2 and 3.

Example:
Describe message format MDO-8 with 55H:

Positioning module data channel:

	Input								**Output**							
Byte 0	1	X	1	X	X	X	X	X	1	X	1	X	X	X	X	X
Byte 1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
Byte 2	0	0	0	0	0	0	0	0	X	X	x	X	X	X	X	X
Byte 3	0	0	0	0	0	0	0	0	X	X	x	X	X	X	X	X
Byte 4	0	0	0	0	0	0	0	0	X	X	x	X	X	X	X	X
Byte 5	MDO output values (55H)								0	1	0	1	0	1	0	1

Assignment for 2 MDO-8 modules:

Byte 5 = MDO-8 slot 2
Byte 4 = MDO-8 slot 3.

3.3.5 Special parameters

3.3.5.1 Master / slave operation

This type of operation is also called "electronic coupling". When this mode is activated, the slave axis is coupled to the master axis. The transmission ratio is calculated from the two parameters "multiplication factor" and "division factor".

1. Master no.:

In master/slave operation, this parameter is the axis number of the master axis.
The command for this mode is 128.

Type : word, value range : 0..3, 0 = axis, 1 = axis 2, 2 = axis 3, 3 = axis 4
COMCODE : 128 dec. (see chapter 4.4 page 37)
Address :

Axis no.	1	2	3	4
Address:	**31 hex**	**59 hex**	**81 hex**	**A9 hex**

2. Multiplication factor

In master/slave operation, this parameter was used to calculate the set point value of the slave.
Rule: Set point value slave = set point value master * multiplication factor / division factor

Type : word, value range: 1 .. 1000
COMCODE : 128 dec. (see chapter 4.4 page 37)
Address :

Axis no.	1	2	3	4
Address:	**32 hex**	**5A hex**	**82 hex**	**AA hex**

Note:
To avoid overflow, the result of
"set value master * multiplication factor" must be ≤ 32 bits!

3. Division factor

In master/slave operation, this parameter was used to calculate the set point value of the slave.
Rule: Set point value slave = set point value master * multiplication factor / division factor

Type : word, value range: 1 .. 1000
COMCODE : 128 dec. (see chapter 4.4 page 37)
Address :

Axis no.	1	2	3	4
Address:	**33 hex**	**5B hex**	**83 hex**	**AB hex**

3.3.5.2 Set axis to preset position value

1. Preset value:

Actual position = target

Type : longint, value range : -2^23 .. 2^23
COMCODE : 126 dec. (see chapter 4.4.4 page 38)
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

On transmission of the command, the specified axis is set to the value stored in the variable "preset value".

Note:

This function is used for zero offset (adjustment) only!

On starting up, the PBXAXIS always reads the original encoder value, i.e. the current position value corresponds to the encoder value. If a zero offset takes place after start-up, the position value no longer corresponds to the actual encoder value, and any internal overflows will not be intercepted by the PBXAXIS.

Remedy

Definition:
Original encoder value directly before initial adjustment = OEV, position value directly before another adjustment = PV,
application-oriented final position value = AFPV

$|OEV| + (|PV1 + PV2 + PV3 + ...|) + |AFPV| \leq 2^{23}$

3.4 Input data (read parameters, (control byte: bit 2^7 = 0)

3.4.1 System data

3.4.1.1 Error flag (error message signal)

Type : word, value range : FALSE (0).. TRUE(1)
Address : **02** hex

If the operating system of the controller detects an error, the operating system enters a "1" in the mask of the error flag and the operating system sets the corresponding bit in the error code. The master detects by cyclic reading of this error mask that an error message has been stored in the error code.

3.4.2 Axis data

This data block is defined four times in the DPRAM, i.e. one block for each axis.

3.4.2.1 Error code (error message mask)

Type : word, value range : 0 .. FFFFhexa
Address :

Axis no.	1	2	3	4
Address:	**13 hex**	**43 hex**	**73 hex**	**A3 hex**

Each axis has a variable for the error message from the "controller operating system". If an error is detected, the operating system enters a "1" in the mask of the error flag and the operating system sets the corresponding bit in the error code under the axis number in which the error occurred. This variable is "bit-orientated", i.e. one bit is assigned to each error type. The error types are defined as follows:

Bit 0 : Drift compensation has reached limits

Bit 1 : Contouring error has reached limits

Bit 2 : Plus limit switch activated

Bit 3 : Minus limit switch activated

3.4.2.2 Axis status

Type : word, value range : 0 .. FFFFhexa
Address :

Axis no.	1	2	3	4
Address:	**08 hex**	**38 hex**	**68 hex**	**98 hex**

4 words (4x16 bits) are reserved in the actual data range for the status of the 4 axes. The status indicates the state of the respective axis.

Axis status	Meaning	Reason
0	Axis stationary, uncontrolled	. On start-up . After timeout and no messages from the master
1	Axis stationary, controlled	. Directly after transmission of comcode 110 . The axis is in the target window
2	Axis moving	. After transmission of comcode 130/135

3.4.2.3 Controller state

Type : word, value range : 0 .. FFFFhexa
Address :

Axis no.	1	2	3	4
Address:	**09 hex**	**39 hex**	**69 hex**	**99 hex**

This variable indicates the internal state (usually the mode). It is usually identical to the comcode which has caused this state.

3.4.2.4 Moving state (internal state of controller)

Type : word, value range : 0 .. FFFFhexa
Address :

Axis no.	1	2	3	4
Address:	**0A hex**	**3A hex**	**6A hex**	**9A hex**

This variable indicates the internal moving state (accelerating, constant velocity, braking, moving in positive or negative direction ...).

3.4.2.5 Actual value

Type : longint, value range : -2^23 .. 2^23
Address :

Axis no.	1	2	3	4
Address:	**0B hex**	**3B hex**	**6B hex**	**9B hex**

This variable indicates the actual value which is used for controlling.

3.4.2.6 Dynamic set point value

Type : longint, value range : -2^23 .. 2^23
Address :

Axis no.	1	2	3	4
Address:	**0D hex**	**3D hex**	**6D hex**	**9D hex**

This variable displays the internal and current calculated set point value.

3.4.2.7 Delta actual value

Type : longint, value range : -2^23 .. 2^23
Address :

Axis no.	1	2	3	4
Address:	**0F hex**	**3F hex**	**6F hex**	**9F hex**

"Delta actual value" means the modification of the actual value / sampling interval. This is generally the velocity.

3.4.2.8 Current drift compensation / deviation

Type : longint, value range : -2^23 .. 2^23
Address :

Axis no.	1	2	3	4
Address:	**11 hex**	**41 hex**	**71 hex**	**A1 hex**

This variable indicates the internal current drift compensation/the deviation.

Default setting or transmission of comcode 118:
Output "Current drift compensation"

Transmission of comcode 117:
Output "Deviation"

3.4.2.9 Home return started

Type : word, value range : FALSE (0) .. TRUE (1)
Address :

Axis no.	1	2	3	4
Address:	**14 hex**	**44 hex**	**74 hex**	**A4 hex**

If a home return (comcode = 122 or 124) is performed for an axis, the controller sets this variable to 1.

3.4.3 Digital inputs

Type : word, value range : FALSE (0) .. TRUE (1)
Address : 0F0 for MDI-8, 0F1 for MDIO-16

With the PBXAXIS controller module, 8-bit inputs (MDI-8) or 16-bit inputs (MDIO-16) can be used. The digital inputs may only be inserted in slots 2 and 3.

Example:
Read message format MDI-8:

Positioning module data channel:

	Input								**Output**							
Byte 0	0	X	1	X	X	X	X	X	0	X	1	X	X	X	X	X
Byte 1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
Byte 2	0	0	0	0	0	0	0	0	MSB byte							
Byte 3	0	0	0	0	0	0	0	0								
Byte 4	0	0	0	0	0	0	0	0								
Byte 5	MDI input values 2^7 - 2^0								LSB byte							

Assignment for 2 MDI-8 modules:

MDI-8 slot 2 = byte 5
MDI-8 slot 3 = byte 4

4 PBXAXIS commands (COMCODE)

4.1 Controller features and “controller control block “

4.1.1 Accept controller control block (COMCODE = 100)

Function : Load controller control block
Relevant variable : Controller control block

This command tells the controller to transfer a controller control block (CCB) from the DPRAM to the corresponding internal main memory of the axis defined in the "axis identification bit".

4.1.2 Controller ON (COMCODE = 110)

Function : Activate controller
Relevant variable : Controller control block

Following the transmission of the command, the controller algorithm is activated.
Axis status = 1, controller state = 110

4.1.3 Controller OFF (COMCODE = 111)

Function : Disable controller
Relevant variable : None

Following the transmission of the command, the controller algorithm is disabled.
Axis status = 0, controller state = 0

4.1.4 Accept controller control block & controller "ON“ (COMCODE=140)

Function : Load controller control block, then activate controller
Relevant variable : Controller control block

This command tells the controller to transfer a controller control block (CCB) from the DPRAM to the corresponding internal main memory of the axis defined in the "axis identification bit".

4.1.5 Clear I-component (COMCODE = 150)

Function : Clear **I**-component generated so far
Relevant variable : None

4.1.6 Activate drift compensation (COMCODE = 152)

Function : Starts automatic drift compensation
Relevant variable : Drift limit (in the controller control block)

Automatic drift compensation is performed as follows:

- The measured drift is assigned to the proportional component only.
- Definition of the drift within certain intervals. An additional condition is that the axis must be stationary (set velocity = 0).
- Procedure:

The drift is defined via 512 samplingsteps

$$\text{Drift\_mean} = \frac{1}{512}\sum_{512}^{n=1} \text{deviation}_n$$

Drift_new = ½ drift_mean + drift_old.

If drift_new > drift limit ==> error message & drift_new = drift_old

4.1.7 Disable drift compensation (COMCODE = 151)

Function : Stops automatic drift compensation
Relevant variable : Drift limit (in the controller control block)

Following the transmission of the command, the latest measured drift is frozen.

4.1.8 Delete drift compensation (COMCODE = 153)

Function : Deletes the measured drift compensation
Relevant variable : Internal drift compensation value

Following the transmission of the command, the current drift compensation is set to 0.

4.1.9 Activate smoothing of manipulated variable (COMCODE = 112)

Function : Activate additional function in order to smooth the manipulated variable
Relevant variable : KVP manipulated variable, AK manipulated variable in the controller control block

On acceptance of the command, an additional P-component is activated via the manipulated variable and the velocity according to the block diagram (see page 9, dotted part).

4.1.10 Disable smoothing of manipulated variable (COMCODE = 113)

Function : Disables the function COMCODE = 112
Relevant variable :

On acceptance of the command, the additional P-component is disabled via the manipulated variable and the velocity according to the block diagram (see page 9, dotted part).

4.1.11 Activate integral set point value correction (COMCODE = 115)

Function : In many cases the steady-state deviation which occurs due to an offset in the system is unacceptably high. If the KV factor is increased, the system is inclined to vibrate. One remedy is to correct the integral set point value via a programmable parameter.
Relevant variable : SK bandwidth, SK constant

On acceptance of the command, the set point value for each scanning spot is corrected by a value obtained from the discrete-time integration.

4.1.12 Disable integral set point value correction (COMCODE = 116)

Function : Disables the function COMCODE = 115
Relevant variable : None

On acceptance of the command, the resultant correction value remains frozen.

4.2 Movement commands

4.2.1 Axis to target or controlled movement (COMCODE = 130)

Function: Adjust axis to new target
Relevant variable: Target, set velocity, acceleration, absolute positioning, controller state, moving state

After transmitting the command, the controller calculates the "targets" for each axis. If the variable "Absolute positioning" = TRUE, then calculated target = internal target, otherwise target = actual value + target.
Afterwards, the controller makes the axes move towards the "target". During this movement, the axis status assumes the value 2, and the controller state is 130. On entering the target range (target ± target window), the axis status assumes the value 1, and the controller state returns to 110.

Example for calculating the target
Assumption: Distance between two positionings = 10 000, actual position = 0
For variable = TRUE (absolute positioning)
- Initial positioning: Describe variable target as 10,000.
- n positionings: Every further calculation must be performed by the control unit.

For variable = FALSE (positioning via a certain incremental dimension)
- Describe variable target with 10,000.
- Each execution of the command causes the axis to traverse by 10,000. Internally, the calculation "Target = actual value + target" is performed.

4.2.2 Stop axis (COMCODE = 131)

Function : Stop axis immediately
Relevant variable : Acceleration, controller state, moving state

After transmitting the command, the controller reads the actual position and sets it as a new set point position, i.e. the selected axis stops immediately.

4.2.3 Axis ramp stop (COMCODE = 134)

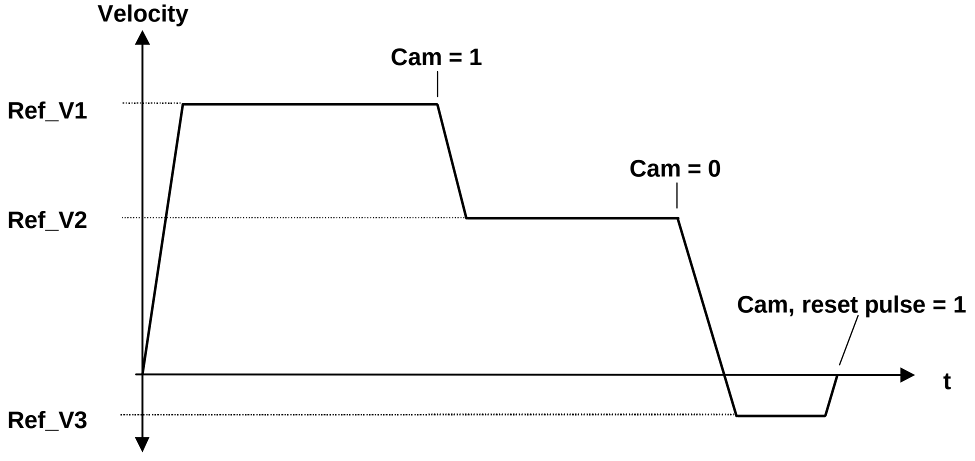
Function : Make selected axis stop via a ramp (acceleration)
Relevant variable : Acceleration, controller state, moving state

After transmission of the command, the selected axis comes to standstill via a ramp.

4.2.4 Home return (COMCODE = 122)

Function : Starts home return
Measuring unit : Velocity output in volts: 0 = 0V, 32767 = 10V
Relevant variable : Home position_V1, home position_V2, home position_V3, home return direction

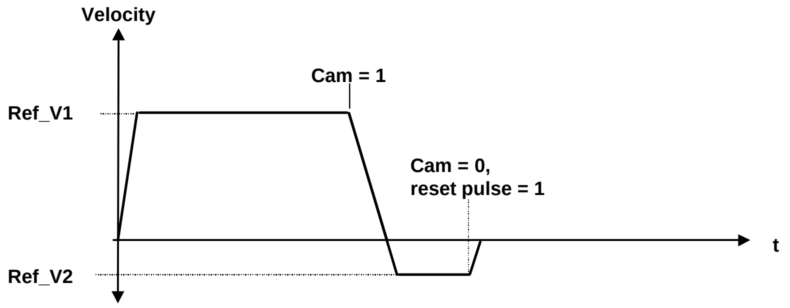
Depending on the home return direction, the programmed axis starts moving in the positive (TRUE) or negative (FALSE) direction to home position_V1. On reaching the reference cam, the axis switches to home position_V2. Now the axis passes the reference cam. On leaving the reference cam, the axis stops and moves back to the reference cam with home position_V3 in order to zeroize the actual value on reaching the reset pulse and remains held in the position by the controller.



4.2.5 Controlled home return (COMCODE = 123)

Function : Starts controlled home return
Measuring unit : Velocity output in digits / sampling interval
Relevant variable : Home position_V1, home position_V2, home return direction,
acceleration
Addresses : see chapter 3.3.3.2 page 21

Depending on the home return direction, the programmed axis starts a controlled movement with the preset acceleration in the positive (TRUE) or negative (FALSE) direction to home position_V1. On reaching the reference cam, the axis switches to home position_V2 and returns. On reaching the reset value outside the cam, the actual value is zeroized and the position is held by the controller.



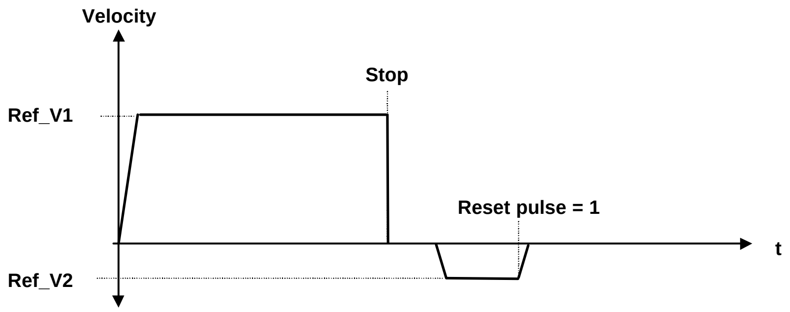
Monitor program	Parameter input
Target:	Home return direction: 0 = negative, 1 = positive
Velocity	Home position_V1
Positive acceleration	Home position_V2
Negative acceleration	Acceleration

4.2.6 Home return to the stop (COMCODE = 124)

Function : Starts home return
Measuring unit : Velocity output in volts: 0 = 0V, 32767 = 10V
Relevant variable : Home position_V1, home position_V2, home return direction

Depending on the home return direction, the programmed axis starts moving in the positive (TRUE) or negative (FALSE) direction to home position_V1. When the axis stops, it moves back to home position_V2 in order to zeroize the actual value on reaching the reset pulse and remains held in the position by the controller.

Note:
In this mode, the input "RN" of the module connector must be wired to +24V and the input "/RN" to 0V.



4.2.7 Movement with variable acceleration (COMCODE = 135)

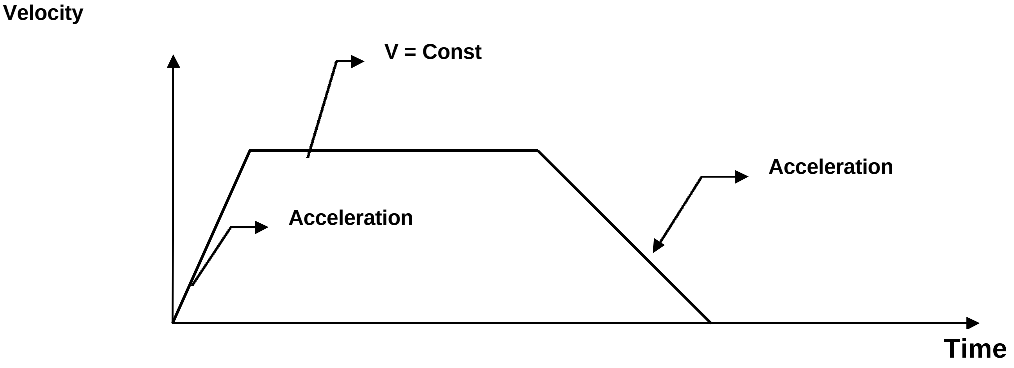
Function : Adjust axis to new target
Relevant variable : Target, set velocity, acceleration, absolute positioning, braking acceleration (deceleration)

After transmitting the command, the controller calculates the "targets" for each axis. If the variable "Absolute positioning" = TRUE, then calculated target = internal target, otherwise target = actual value + target. Afterwards, the controller makes the axes move towards the "target". During this movement, the axis status assumes the value 2, and the controller state is 135. On entering the target range (target ± target window), the axis status assumes the value 1, and the controller state returns to 110.

Example for calculating the target
Assumption: Distance between two positionings = 10 000, actual position = 0
For variable = TRUE (absolute positioning)
- Initial positioning: Describe variable target as 10,000.
- n positionings: Every further calculation must be performed by the control unit.

For variable = FALSE (positioning via a certain incremental dimension)
Describe variable target as 10,000.
- Each execution of the command causes the axis to traverse by 10,000.
  Internally, the calculation "Target = actual value + target" is performed.

Movement diagram:



4.2.8 Controlled movement with home position_V1 (COMCODE = 132)

Function : Output voltage to module MAO4
Relevant variable : Home position_V1

After transmission of the command, the variable content of home position_V1 is output accordingly as voltage to the module MAO4.
-32767 .. +32767 corresponds to -10V .. +10V

4.2.9 Controlled movement with home position_V2 (COMCODE = 133)

Function : Output voltage to module MAO4
Relevant variable : Home position_V2

After transmission of the command, the variable content of home position_V2 is output accordingly as voltage to the module MAO4.
-32767 .. +32767 corresponds to -10V .. +10V

4.2.10 Interpolating motion of several axes (COMCODE = 190)

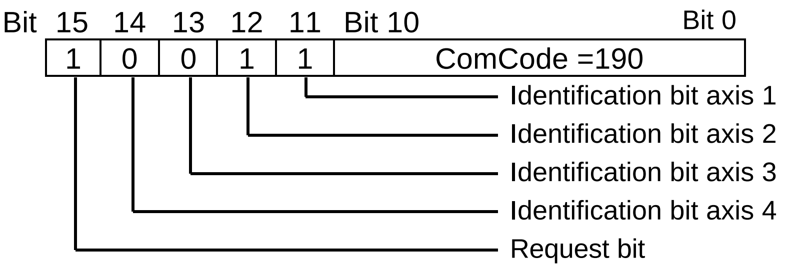
Function : Adjust several axes (at least two) uniformly at different distances from the target.
Relevant variables : Target (absolute), max. velocity, acceleration, braking acceleration (deceleration)

After transmitting the command, the controller calculates the targets with the corresponding velocity (digit/sampling interval) for each axis. Afterwards, the controller makes the axes move towards the target in such a way that all defined axes reach the target at the same time.

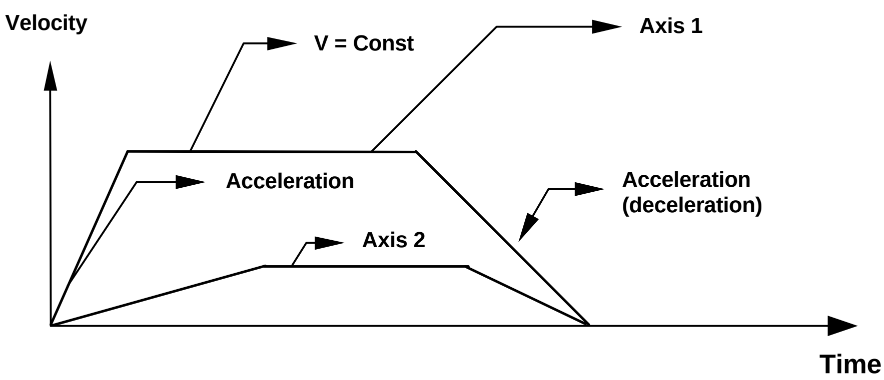
In order to execute the command, the command control word must be described as follows:

Type : word
Address : **00** hex

Example of interpolating motion of axes 1 and 2:



Example of movement diagram for axes 1 and 2



4.3 System commands

4.3.1 Clear error (COMCODE = 500)

Function : Delete error flag and error code
Relevant variable : Error flag, error code of each axis

4.3.2 Set sampling interval (COMCODE = 501)

Function : Accept parameter "sampling interval"
Relevant variable : Sampling interval

After transmission of the command, the timer is reprogrammed to the new time by the operating system of the controller.

4.3.3 Set number of axes (COMCODE = 502)

Function : Accept parameter "Number of axes"
Relevant variable : Number of axes

After transmitting the command, the controller operating system only handles as many axes as are indicated in the parameter "Number of axes".

4.3.4 Clear error code (COMCODE = 199)

Function : Acknowledgement for controller after error message
Relevant variable : ERROR CODE

Once the command has been transmitted and all errors rectified, the variable "Error code" is set to 0.

4.4 **Special commands**

4.4.1 Activate deviation output (COMCODE 117)

The current drift compensation is output by default. By transmitting comcode 117, drift compensation output is disabled and the output of the deviation in the actual axis data is activated instead.

Note:
The same addresses are used for the output of deviation and drift compensation.

4.4.2 Activate drift compensation output (COMCODE 118)

If drift compensation output is activated by comcode 117, deviation output is disabled by transmitting comcode 118 and the output of the current drift compensation in the actual axis data is activated instead.
Default setting: Output of current drift compensation

Note:
The same addresses are used for the output of deviation and drift compensation.

4.4.3 Activate synchronous run (COMCODE = 128)

Function : Starts synchronous operation
Relevant variable : Master number, multiplication factor, division factor

On accepting the command, the defined PBXAXIS master axis memorizes the master axis start value, master axis actual value and slave axis start value and switches to the slave state (controller state = 128). In the control cycle, the set point value of the slave axis is calculated by means of set point value modification as follows:

Set point value modification = (master actual value - master start value) * multiplication factor / division factor
Set point value = slave start + set point value modification

Note:
To disable the "synchronous state“, command 110 or 111 is recommended.

4.4.4 Set preset value (COMCODE = 126)

Function : Sets axis to preset value
Relevant variable : Preset value

To assimilate the axes to mechanical conditions, they can be adjusted by presetting an offset.

4.4.5 Limit switch monitoring (COMCODE = 510-512)

A limit switch monitoring function can be implemented via an MDI-8 module inserted in slot 2. The function is disabled by default and has to be activated by a corresponding command to the axis. For each axis, two limit switch inputs are reserved and assigned as follows:

Bit no.	7	6	5	4	3	2	1	0
Axis no.	Axis 4		Axis 3		Axis 2		Axis 1	

All limit switches are low-active. Two modes can be selected to govern the reaction of the PBXAXIS when a limit switch is set to low.

Setting a limit switch to "0" when the axis release function is activated (comcode = 513) makes the corresponding axis stop, i.e. the axis release bit is set to "0" in this axis.

Note:
If both the limit switch monitoring and axis release function are required and an incremental or SSI encoder is used for controlling, only two axes can be actuated due to the lack of slots.
Module MDIO-16 is currently in preparation for applications with four axes.

4.4.5.1 Mode 1: Start-up with command 510

If a limit switch edge change from high to low is detected in an axis, it is switched to the non-controlled state, i.e. the corresponding axis is stopped immediately.

4.4.5.2 Mode 2: Start-up with command 511

If a limit switch edge change from high to low is detected in an axis, all axes are switched to the non-controlled state, i.e. they are stopped immediately.

4.4.5.3 Disable limit switch monitoring with command 512

Limit switch monitoring can be disabled with this command in order to allow the limit switches to be approached or moved away from the axis during set-up.

4.4.6 Axis release (COMCODE = 513-514)

An axis release function can be implemented via an MDO-8 module inserted in slot 3. The function is disabled by default and has to be activated by a corresponding command to the axis.
An axis release output is reserved for each axis, and the assignment is defined as follows:

Bit no.	3	2	1	0
Axis no.	Axis 4	Axis 3	Axis 2	Axis 1

The axis release bits are low when the axis is non-controlled. On execution of the command 110, "Activate axis", the corresponding bits are set to "1".
Axis release is activated with command 513 and can be disabled with command 514.
Command 111, "Disable controller", or limit switch = "0" sets the corresponding axis release bit to "0" and stops the axis.

Note:
If the limit switch monitoring and axis release function are both required and an incremental or SSI encoder is used for controlling, only two axes can be actuated due to the lack of slots.
Module MDIO-16 is currently in preparation for applications with four axes.

4.4.7 Brake operation (COMCODE = 515-516)

From version 1.06
A motor brake can be triggered via an MDO-8 module inserted in slot 3. The function is disabled by default and has to be activated by a corresponding command to the axis. The motor brake output is actuated on reaching the target range.
A brake operation output is reserved for each axis, and assignment is defined as follows:

Bit no.	3	2	1	0
Axis no.	Axis 4	Axis 3	Axis 2	Axis 1

Comcode 515: Brake operation ON, output = 24 V
Comcode 516: Brake operation OFF, output = 0 V

5 Positioning with digital outputs

Positioning tasks are performed using module MDIO16 (from version 1.02) or via the MDO8 module (from version 1.03). The various modes are set by corresponding commands to the PBXAXIS.

5.1 Positioning with MDIO16

2-axis operation: 1x MDIO16 (8A/8E) inserted in slot 1.
4-axis operation: 2x MDIO16 (8A/8E), inserted in slots 1 and 2.
MDIO16 :
left connector = input, right connector = output

5.1.1 Initialize/activate mode

5.1.1.1 Describe parameters

1. Velocity bit combination:

Type : longint
Parameter no. : 08H
Relevant COMCODE : 300 dec.

To set an axis in motion or to stop it, a "4-bit combination" is output to the MDIO16. This parameter is also used to define the type of movement. Each type of movement is assigned a nibble in this parameter.

The allocation is defined as follows:

- Creep speed plus:	Bit 00..bit 03	(e.g.: 0110)
- Creep speed minus:	Bit 04..bit 07	(e.g.: 0101)
- Rapid motion plus:	Bit 08..bit11	(e.g.: 1010)
- Rapid motion minus:	Bit 12..bit15	(e.g.: 1001)
- Stop:	Bit 16.. bit19	(e.g.: 0000)

Example:
The parameter "Velocity" could be as follows in this mode:

Binary (32 bit): 0000 0000 0000 **0000** *1001* **1010** *0101* **0110**

With this initializing value, e.g. for axis 1, and if the positioning module receives the command "Move axis 1 in positive direction at creep speed" from the user in manual operation, the bit combination 0110 is output at the output port of the MDIO16 in slot 1.

2. Preliminary cut-off point (digit) :

Type : longint, positive figures only, no plausibility check
Parameter no. : 0AH
Relevant COMCODE : 300 dec.

This parameter defines the distance to the target, starting in rapid motion and switching to creep speed for positioning.

3. Cut-off point:

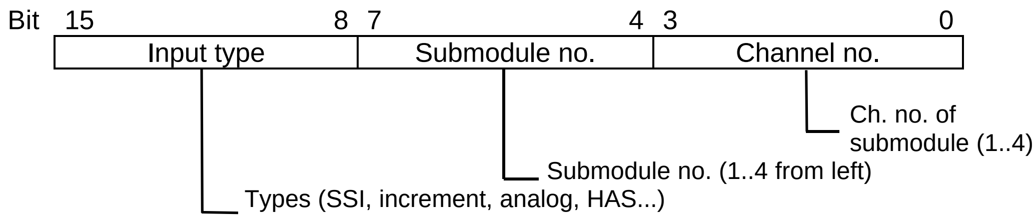
Type : longint, positive figures only, no plausibility check
Parameter No. : 0CH
Relevant COMCODE : 300 dec.

This parameter defines the distance to the target, whereby positioning is stopped at creep speed.

4. Measuring system identifier:

Type : word
Parameter no. : 15H
Relevant COMCODE : 300 dec.

The control loop can be closed with the measuring system (input type) entered in the measuring system identifier. This parameter is defined as follows:



The input types are defined as follows (ident no. for PBXAXIS)

Ident. no.	Designation		
1 (1H)	16-bit analog input		
8 (8H)	12-bit analog input		
	Standard	**From FPGA Ver. SSI24B**	**From FPGA SSI-25C, 1.06**
24 (18H)	SSI, 24-bit binary	SSI, 24-bit binary	SSI, 24-bit binary
184 (B8H)	SSI, 12 bit Gray	SSI, 12 bit Gray	SSI, 12 bit Gray
152 (98H)	-	SSI, 24-bit Gray	SSI, 24-bit Gray
88 (58H)	-	-	SSI, 25-bit binary
216 (D8H)	-	-	SSI, 25-bit Gray
26 (1AH)	HAS 24-bit		
28 (1CH)	Incremental 24-bit		

Please note when using a 25-bit encoder

As the FOXAXIS can only process a 24-bit value, the value 8388607 is subtracted if the positive number range of $+2^{23} - 1$ is exceeded. If the negative number range of -2^{23} is exceeded, the value 8388608 is added.

Example:

Assumption: Encoder actual value = +16 000 000, this corresponds to an exceeding of the positive number range.

Corrective calculation of the FOXAXIS:

```
  16 000 000
-    8388607
     7611393    = displayed position
```

5.1.1.2 Accept initialization data (COMCODE = 300)

After accepting the command, the selected axis switches to the stand-by state and can also be actuated in manual mode if the corresponding bits are set in the corresponding parameter.

5.1.2 Positioning

5.1.2.1 Program target

Preset value for the axis

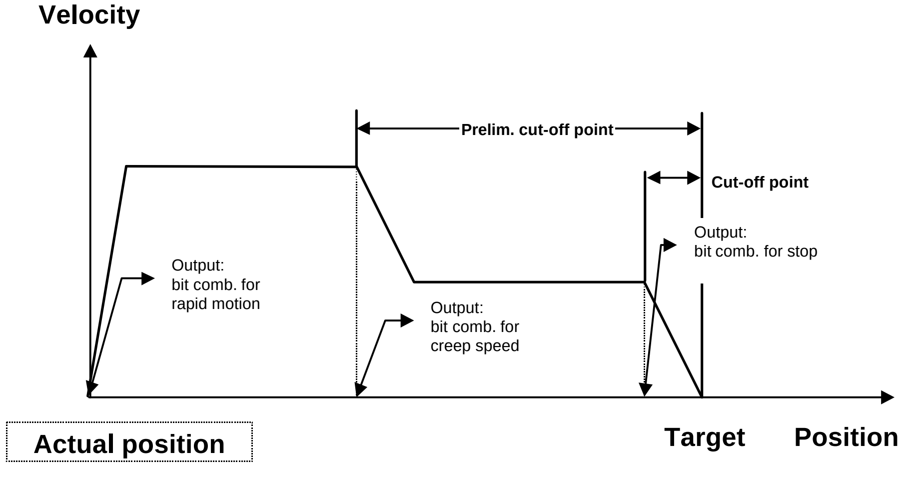
Type : longint, value range : -2^23 .. 2^23
COMCODE : 320
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

5.1.2.2 Start positioning (COMCODE = 320)

After transmission of the command, positioning is started.

Note:
The identification bit for the corresponding axis must be set.



5.1.3 Manual operation

For each axis, a WORD parameter is defined which is responsible for manual operation.

Type : word
Address :

Axis no.	1	2	3	4
Address:	**34 hex**	**5C hex**	**84 hex**	**AC hex**

The bit combination is defined as follows:

Bit 0 : Direction (0 = negative, 1 = positive)
Bit 1 : Creep speed (1 = creep speed)
Bit 1 = 0, bit 2 = 0 ➔ Stop
Bit 1 = 1, bit 2 = 1 ➔ Rapid motion

5.1.4 Digital inputs/outputs

5.1.4.1 Inputs:

Type : word, value range : FALSE (0) / TRUE (1)
Parameter no. : 0F1H

The 8 inputs in slot 1 are reserved for the limit switches of each axis:

Bit 0, 1: Limit switch axis 1
Bit 2, 3: Limit switch axis 2
Bit 4, 5: Limit switch axis 3
Bit 6, 7: Limit switch axis 4

Even bit numbers are limit switches which are approached in the negative direction:

Axis 4		Axis 3		Axis 2		Axis 1	
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
positive	negative	positive	negative	positive	negative	positive	negative

The total of 8 digital inputs in slot 2 can be freely defined by the user.
To read the entire 16-bit information, parameter no. 241 (0F1H) must be called. Byte 5 comprises the inputs of slot 1, byte 4 those of slot 2.

5.1.4.2 Outputs

The 8 outputs in slot 1 are the digital outputs for movement of axes 1 and 2.
The 8 outputs in slot 2 are the digital outputs for movement of axes 3 and 4.

5.1.5 Actual values

1. Current actual value (position) :

Type : longint, value range : -2^31 .. +2^31
Parameter no. :

Axis no.	1	2	3	4
Parameter no.:	**0B hex**	**3B hex**	**6B hex**	**9B hex**

The current actual value is normally defined as longint (-2^31 .. +2 ^31) and is only sent to the master if the slave has received a read message. In the MDIO16 mode, the 32 bits have been redefined as follows:

2^{31}-2^{30}	2^{29}-2^{28}	2^{27} - 2^{24}	2^{23} - 2^{0}
Reserve	2 limit switches	4 outputs	24 bit actual value (-2^23 ... + 2^23)

The actual value is also sent to the master if the parameters have been described for manual operation.

Example:
Read message format of axis 1 actual value:

Positioning module data channel:

	Input								**Output**							
Byte 0	0	X	1	X	X	X	X	X	0	X	1	X	X	X	X	X
Byte 1	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1	1
Byte 2	Reserve		ES 2^{29}-2^{28}		Output 2^{27}-2^{24}				MSB byte							
Byte 3	Actual value 2^{23} - 2^{16}															
Byte 4	Actual value 2^{15} - 2^{8}															
Byte 5	Actual value 2^{7} - 2^{0}								LSB byte							

2. Controller state:

Type : word, value range : 0 .. FFFFH
Parameter no. :

Axis no.	1	2	3	4
Parameter no.:	**09 hex**	**39 hex**	**69 hex**	**99 hex**

In mode "MDIO16 positioning", value 310 is returned.

3. Moving state:

Type : word, value range : 0 .. FFFFhexa
Parameter no. :

Axis no.	1	2	3	4
Parameter no.:	**0A hex**	**3A hex**	**6A hex**	**9A hex**

Detect whether an axis is in rapid motion, creep speed or stop.

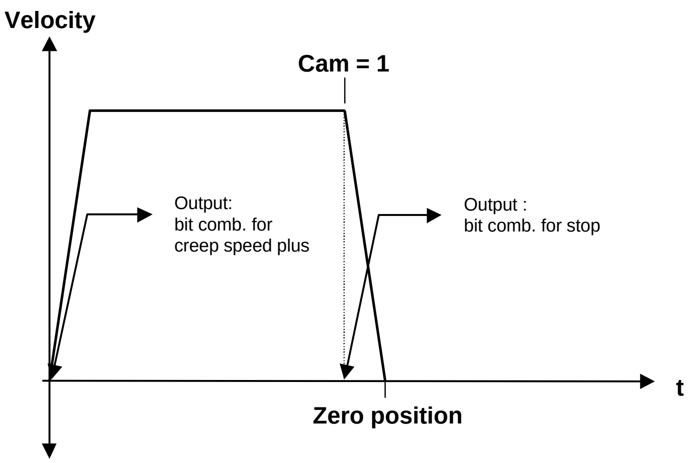
5.1.6 Home return with reset pulse (COMCODE = 322)

From version 1.04 on

Function : Starts home return with reset pulse and reference cam
Relevant variable : Home return direction

Depending on the home return direction, the programmed axis starts moving in the positive (home return direction = TRUE) or negative (home return direction = FALSE) direction at creep speed. On reaching the reference cam and the reset pulse, the counter is assigned the value from the"Target" parameter and switches to the "STOP" state (bit combination output for stop).

Home return direction = TRUE



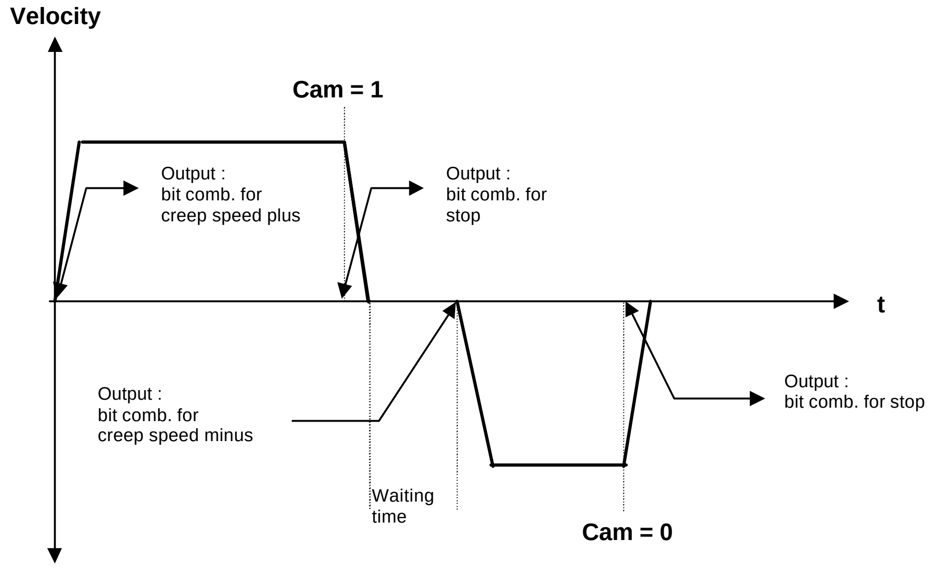
5.1.7 Home return without reset pulse (COMCODE = 324)

From version 1.04 on

Function : Starts home return without reset pulse
Relevant variable : Home return direction

Depending on the home return direction, the programmed axis starts moving in the positive (home return direction = TRUE) or negative (home return direction = FALSE) direction at creep speed. On reaching the reference cam, the axis stops for a programmable waiting time (parameter speed) before it moves in the opposite direction at creep speed. On leaving the reference cam, the value from the "Target" parameter is assigned to the counter, then the counter switches to the "STOP" state (bit combination output for stop).

Home return direction = TRUE



5.2 Positioning with MDO8

2-axis operation: 1x MDO8 inserted in slot 2.
4-axis operation: 2x MDO8 inserted in slots 2 and 3.

5.2.1 Initialize/activate mode

5.2.1.1 Describe parameters

1. Velocity bit combination:

Type : longint
Parameter no. : 08H
Relevant COMCODE : 400 dec.

To set an axis in motion or to stop it, a "4-bit combination" is output to the MDO8. This parameter is also used to define the type of movement. Each type of movement is assigned a nibble in this parameter.

The allocation is defined as follows:

- Creep speed plus:	Bit 00..bit 03	(e.g.: 0110)
- Creep speed minus:	Bit 04..bit 07	(e.g.: 0101)
- Rapid motion plus:	Bit 08..bit11	(e.g.: 1010)
- Rapid motion minus:	Bit 12..bit15	(e.g.: 1001)
- Stop:	Bit 16.. bit19	(e.g.: 0000)

Example:
The parameter "Velocity" could be as follows in this mode:

Binary (32 bit): 0000 0000 0000 **0000** *1001* **1010** *0101* **0110**

With this initializing value, e.g. for axis 1, and if the positioning module receives the command "Move axis 1 in positive direction at creep speed" from the user in manual operation, the bit combination 0110 is output at the output port of the MDO8 in slot 2.

2. Preliminary cut-off point plus (digit):

From version 1.04

Type : longint, positive figures only, no plausibility check
Parameter no. : 0AH
Relevant COMCODE : 400 dec.

This parameter defines the distance to the target, starting in rapid motion and switching to creep speed for positioning. The parameter is valid for positioning in positive directions.

3. Cut-off point plus (digit):

From version 1.04

Type : longint, positive figures only, no plausibility check
Parameter no. : 0CH
Relevant COMCODE : 400 dec.

This parameter defines the distance to the target, whereby positioning at creep speed is stopped. The parameter is valid for positioning in positive directions.

4. Preliminary cut-off point minus (digit):

From version 1.04

Type : longint, positive figures only, no plausibility check
Parameter no. : 0EH
Relevant COMCODE : 400 dec.

This parameter defines the distance to the target, starting in rapid motion and switching to creep speed for positioning. The parameter is valid for positioning in negative directions.

5. Cut-off point minus (digit):

From version 1.04

Type : longint, positive figures only, no plausibility check
Parameter no. : 10H
Relevant COMCODE : 400 dec.

This parameter defines the distance to the target, whereby positioning at creep speed is stopped. The parameter is valid for positioning in negative directions.

6. Maximum return distance:

From version 1.04

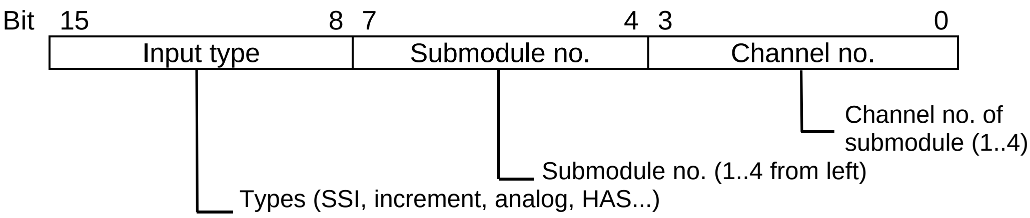
Type : longint, positive figures only, no plausibility check
Parameter no. : 12H
Relevant COMCODE : 400 dec.

This parameter defines the max. distance to the target that an axis must have in order to avoid returning. If the distance to the target is less than the max. return distance, the axis moves to an intermediate target, returns and then moves to the programmed target.

7. Measuring system identifier:

Type : word
Parameter no. : 15H
Relevant COMCODE : 400 dec.

The control loop can be closed with the measuring system (input type) entered in the measuring system identifier. This parameter is defined as follows:



The input types are defined as follows (ident. no. for PBXAXIS)

Ident. no.	Designation		
1 (1H)	16-bit analog input		
8 (8H)	12-bit analog input		
	Standard	**From FPGA Ver. SSI24B**	**From FPGA SSI-25C, 1.06**
24 (18H)	SSI, 24-bit binary	SSI, 24-bit binary	SSI, 24-bit binary
152 (98H)	-	SSI, 24-bit Gray	SSI, 24-bit Gray
88 (58H)	-	-	SSI, 25-bit binary
216 (D8H)	-	-	SSI, 25-bit Gray
26 (1AH)	HAS 24-bit		
28 (1CH)	Incremental 24-bit		

Please note when using a 25-bit encoder

As the FOXAXIS can only process a 24-bit value, the value 8388607 is subtracted if the positive number range of $+2^{23} - 1$ is exceeded. If the negative number range of -2^{23} is exceeded, the value 8388608 is added.

Example:

Assumption: Encoder actual value = +16 000 000, this corresponds to an exceeding of the positive number range.

Corrective calculation of the FOXAXIS:

```
  16 000 000
-    8388607
     7611393    = displayed position
```

5.2.1.2 Accept initialization data (COMCODE = 400)

After accepting the command, the selected axis switches to the stand-by state and can also be actuated in manual mode if the corresponding bits are set in the corresponding parameter.

5.2.2 Positioning

5.2.2.1 Program target

Preset value for the axis

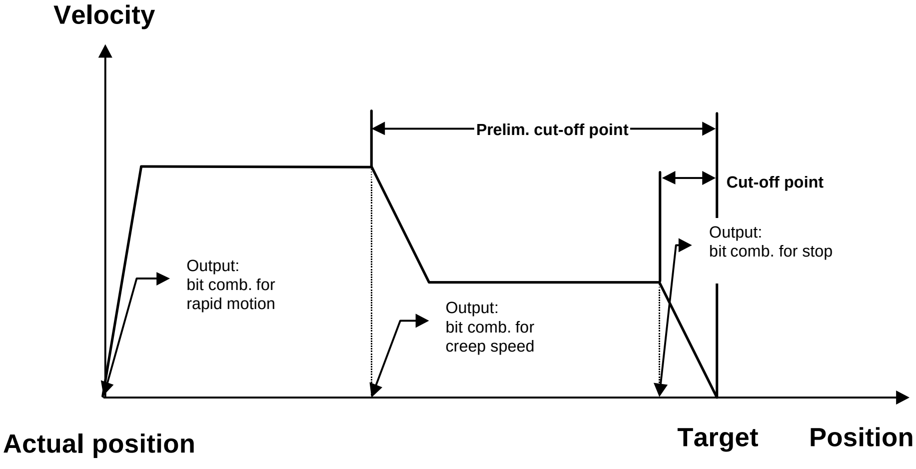
Type : longint, value range : -2^23 .. 2^23
COMCODE : 420
Address :

Axis no.	1	2	3	4
Address:	**28 hex**	**50 hex**	**78 hex**	**A0 hex**

5.2.2.2 Start positioning (COMCODE = 420)

After transmission of the command, positioning is started.

Note:
The identification bit for the corresponding axis must be set.



5.2.3 Manual operation

For each axis, a WORD parameter is defined which is responsible for manual operation.

Type : word
Address :

Axis no.	1	2	3	4
Address:	**34 hex**	**5C hex**	**84 hex**	**AC hex**

The bit combination is defined as follows:

Bit 0 :Direction (0 = negative, 1 = positive)
Bit 1 :Creep speed (1 = creep speed)
Bit 1 = 0, bit 2 = 0 ➔ Stop
Bit 1 = 1, bit 2 = 1 ➔ Rapid motion

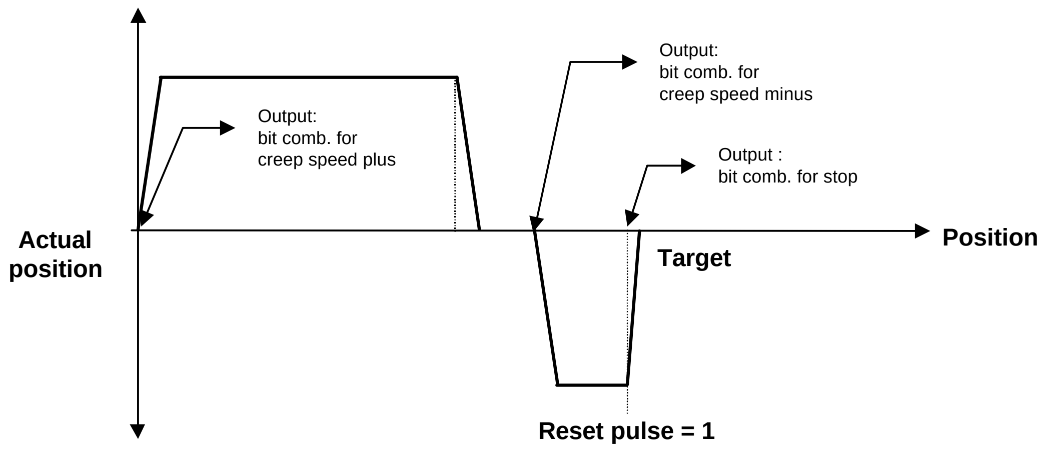
5.2.4 Home return (COMCODE = 424)

Function : Starts home return to the limit stop
Relevant variable : Home return direction

Depending on the home return direction, the programmed axis starts moving in the positive (home return direction = TRUE) or negative (home return direction = FALSE) direction at creep speed. When the axis stops, it moves in the opposite direction at creep speed in order to assign the value from the "Target" parameter to the counter on reading the reset pulse, and then switches to the "STOP" state (bit combination output for stop).

Note:

- In this mode, the MINC2 module connector must be wired as follows:
  Input "RN" to 24V
  Input "/RN" to 0V
- As the hardware does not allow overwriting of the counter, the value is stored as an offset value and the actual value + offset value are added together before output.



5.2.5 Start cut-off point correction (COMCODE = 430)

This command is used for correcting the cut-off point of the last performed movement as follows:
Cut-off point NEW = cut-off point OLD - (target - actual) / 2
The current cut-off point can be **read** from version 1.04.

Cut-off point plus (read):

Type : longint
Address :

Axis no.	1	2	3	4
Address:	**16 hex**	**46 hex**	**76 hex**	**A6 hex**

Cut-off point minus (read):

Type : longint
Address :

Axis no.	1	2	3	4
Address:	**18 hex**	**48 hex**	**78 hex**	**A8 hex**

6 PBXAXIS parameter definition (address / type)

DUAL PORTED RAM "WRITE" PARAMETERS **Control byte: Bit 2^7 = 1**			
Parameter name	**Type**	**Command**	**Addr. in DPRAM**
Command word [S13]	word	-	000H
Error acknowledge word (with handshake bit) [S25]	word	-	002H
Sampling interval [S14]	word	501	003H
Number of axes [S14]	word	502	004H
8 digital outputs (slots 2 and 3) for MDO-8 [S22]	1 word	-	0F0H
16 digital outputs (max. 1 MDIO-16) [S22]	1 word	-	0F1H
CONTROLLER CONTROL BLOCK			
KV factor proportional (pos. deviation) [S15]	TR_FK16	100	008H
KV factor proportional (neg. deviation) [S15]	TR_FK16	100	00AH
KV factor differential (D-component) [S15]	TR_FK16	100	00CH
KV factor integral (I-component) [S15]	TR_FK16	100	00EH
Integral limit [S15]	longint	100	010H
Target window [S15]	longint	100	012H
Control direction [S16]	word	100	014H
Measuring system identifier [S16]	word	100	015H
Drift limit [S17]	longint	100	016H
Contouring error limit [S17]	longint	100	018H
KV factor proportional (manipulated variable) [S17]	TR_FK16	100	01A
AK manipulated variable (matching constant) [S17]	TR_FK8	100	01E
Set point data axis 1			
Set point value correction/bandwidth [S19]	longint	115	028H
Target [18]	longint	130/135	028H
Home return direction [S21]	longint	123	028H
Set preset value (actual position = target) [S24]	longint	126	028H
Set point value correction/constant [S19]	TR_FK8	115	02AH
Home return velocity 1 [S21]	TR_FK8	123	02AH
Velocity [S18]	TR_FK8	130/135	02AH
Acceleration [S21,18]	TR_FK8	123/130/135	02CH
Absolute positioning [S18]	word	130/135	02EH
Home return velocity 2 [S21]	TR_FK8	123	02FH
Braking acceleration [S19]	TR_FK8	130/135	02FH
Master no. [S23]	1 word	130/135	031H
Multiplication factor [S23]	1 word	130/135	032H
Division factor [S23]	1 word	130/135	033H
Home return velocity 1 [S20, 34]	integer	122/124/132	044H
Home return velocity 2 [S20, 34]	integer	122/124/133	045H
Home return velocity 3 [S20]	integer	122/124/	046H
Home return direction positive [S20]	word	122/124/	047H

Set point data axis 2	Type :	Command	Addr. in DPRAM
Set point value correction/bandwidth [S19]	longint	115	050H
Target [S18]	longint	130/135	050H
Home return direction [S21]	longint	123	050H
Set preset value (actual position = target) [S24]	longint	126	050H
Set point value correction/constant [S19]	longint	115	052H
Home return velocity 1 [S21]	TR_FK8	123	052H
Velocity [S18]	longint	130/135	052H
Acceleration [S21,18]	longint	123/130/135	054H
Absolute positioning [S18]	word	130/135	056H
Home return velocity 2 [S21]	TR_FK8	123	057H
Braking acceleration [S19]	longint	130/135	057H
Master no. [S23]	1 word	130/135	059H
Multiplication factor [S23]	1 word	130/135	05AH
Division factor [S23]	1 word	130/135	05BH
Home return velocity 1 [S20, 34]	word	122/124/132	06CH
Home return velocity 2 [S20, 34]	word	122/124/133	06DH
Home return velocity 3 [S20]	word	122/124/	06EH
Home return direction positive [S20]	word	122/124/	06FH
Set point data axis 3			
Set point value correction/bandwidth [S19]	longint	115	078H
Target [S18]	longint	130/135	078H
Home return direction [S21]	longint	123	078H
Set preset value (actual position = target) [S24]	longint	126	078H
Set point value correction/constant [S19]	longint	115	07AH
Home return velocity 1 [S21]	TR_FK8	123	07AH
Velocity [S18]	longint	130/135	07AH
Acceleration [S21,18]	longint	123/130/135	07CH
Absolute positioning [S18]	word	130/135	07EH
Home return velocity 2 [S21]	TR_FK8	123	07FH
Braking acceleration [S19]	longint	130/135	07FH
Master no. [S23]	1 word	130/135	081H
Multiplication factor [S23]	1 word	130/135	082H
Division factor [S23]	1 word	130/135	083H
Home return velocity 1 [S20, 34]	word	122/124/132	094H
Home return velocity 2 [S20, 34]	word	122/124/133	095H
Home return velocity 3 [S20]	word	122/124/	096H
Home return direction positive [S20]	word	122/124/	097H

Set point data axis 4	Type :	Command	Addr. in DPRAM
Set point value correction/bandwidth [S19]	longint	115	0A0H
Target [S18]	longint	130/135	0A0H
Home return direction [S21]	longint	123	0A0H
Set preset value (actual position = target) [S24]	longint	126	0A0H
Set point value correction/constant [S19]	longint	115	0A2H
Home return velocity 1 [S21]	TR_FK8	123	0A2H
Velocity [S18]	longint	130/135	0A2H
Acceleration [S21,18]	longint	123/130/135	0A4H
Absolute positioning [S18]	word	130/135	0A6H
Home return velocity 2 [S21]	TR_FK8	123	0A7H
Braking acceleration [S19]	longint	130/135	0A7H
Master no. [S23]	1 word	130/135	0A9H
Multiplication factor [S23]	1 word	130/135	0AAH
Division factor [S23]	1 word	130/135	0ABH
Home return velocity 1 [S20, 34]	word	122/124/132	0BCH
Home return velocity 2 [S20, 34]	word	122/124/133	0BDH
Home return velocity 3 [S20]	word	122/124/	0BEH
Home return direction positive [S20]	word	122/124/	0BFH

DUAL PORTED RAM "READ" PARAMETERS Control byte: bit $2^7 = 0$		
System parameters (all axis)	**Type**	**Address in DPRAM**
Error acknowledge word (with handshake bit) [S25]	word	002H
8 digital inputs (slots 2 and 3) for MDI-8 [S28]	word	0F0H
16 digital inputs (only 1 MDIO-16 is supported) [S28]	word	0F1H
Software version	word	0FFH
Actual data axis 1		
Axis status [S26]	word	008H
Controller state [S26]	word	009H
Movement state [S26]	word	00AH
Current actual value [S26]	long	00BH
Dynamic set point value [S27]	long	00DH
Delta actual value (velocity) [S27]	long	00FH
Current drift compensation (default / Comcode 118) [S27]	long	011H
Deviation (Comcode 117) [S27]	long	011H
Error code [S25]	word	013H
Home return started [S27]	word	014H
Actual data axis 2		
Axis status [S26]	word	038H
Controller state [S26]	word	039H
Movement state [S26]	word	03AH
Current actual value [S26]	long	03BH
Dynamic set point value [S27]	long	03DH
Delta actual value (velocity) [S27]	long	03FH
Current drift compensation (default / Comcode 118) [S27]	long	041H
Deviation (Comcode 117) [S27]	long	041H
Error code [S25]	word	043H
Home return started [S27]	word	044H
Actual data axis 3		
Axis status [S26]	word	068H
Controller state [S26]	word	069H
Movement state [S26]	word	06AH
Current actual value [S26]	long	06BH
Dynamic set point value [S27]	long	06DH
Delta actual value (velocity) [S27]	long	06FH
Current drift compensation (default / Comcode 118) [S27]	long	071H
Deviation (Comcode 117) [S27]	long	071H
Error code [S25]	word	073H
Home return started [S27]	word	074H
Actual data axis 4		
Axis status [S26]	word	098H
Controller state [S26]	word	099H
Movement state [S26]	word	09AH
Current actual value [S26]	long	09BH
Dynamic set point value [S27]	long	09DH
Delta actual value (velocity) [S27]	long	09FH
Current drift compensation (default / Comcode 118) [S27]	long	0A1H
Deviation (Comcode 117) [S27]	long	0A1H
Error code [S25]	word	0A3H
Home return started [S27]	word	0A4H

6.1 Mode: Positioning with digital outputs

DUAL PORTED RAM "WRITE" PARAMETERS **Control byte: bit 2^7 = 1**			
Parameter name	**Type**	**Command**	**Addr. in DPRAM**
MDIO16 :			
Command word [S13]	word	-	000H
Error acknowledge word (with handshake bit) [S25]	word	-	002H
Sampling interval [S14]	word	501	003H
Number of axes [S14]	word	502	004H
8 digital outputs (slots 2 and 3) for MDO-8 [S22]	1 word	-	0F0H
16 digital outputs (max. 1 MDIO-16) [S22]	1 word	-	0F1H
INITIALIZATION DATA			
Velocity bit combination [S40]	longint	300	008H
Preliminary cut-off point (digit) [S41]	longint	300	00AH
Cut-off point [S41]	longint	300	00CH
Measuring system identifier [S41]	word	300	015H
Set point data axis 1			
Target [S43]	longint	320	028H
Manual operation (direction, creep speed, rapid motion, stop) [S44]	word	-	034H
Set point data axis 2			
Target [S43]	longint	320	050H
Manual operation (direction, creep speed, rapid motion, stop) [S44]	word	-	05CH
Set point data axis 3			
Target [S43]	longint	320	078H
Manual operation (direction, creep speed, rapid motion, stop) [S44]	word	-	084H
Set point data axis 4			
Target [S43]	longint	320	0A0H
Manual operation (direction, creep speed, rapid motion, stop) [S44]	word	-	0ACH

DUAL PORTED RAM "WRITE" PARAMETERS Control byte: bit 2^7 = 1			
Parameter name	**Type**	**Command**	**Addr. in DPRAM**
MDO8			
INITIALIZATION DATA			
Velocity bit combination [S49]	longint	400	008H
Preliminary cut-off point plus (digit) [S50]	longint	400	00AH
Cut-off point plus [S50]	longint	400	00CH
Preliminary cut-off point minus (digit) [S50]	longint	400	00EH
Cut-off point minus (digit) [S50]	longint	400	010H
Maximum return distance [S51]	longint	400	012H
Measuring system identifier [S51]	word	400	015H
Set point data axis 1			
Target [S53]	longint	420	028H
Manual operation (direction, creep speed, rapid motion, stop) [S54]	word	-	034H
Set point data axis 2			
Target [S53]	longint	420	050H
Manual operation (direction, creep speed, rapid motion, stop) [S54]	word	-	05CH
Set point data axis 3			
Target [S53]	longint	420	078H
Manual operation (direction, creep speed, rapid motion, stop) [S54]	word	-	084H
Set point data axis 4			
Target [S53]	longint	420	0A0H
Manual operation (direction, creep speed, rapid motion, stop) [S54]	word	-	0ACH

DUAL PORTED RAM "READ" PARAMETERS Control byte: bit 2^7 = 1		
System parameters (all axis)	**Type**	**Address in DPRAM**
Error acknowledge word (with handshake bit) [S25]	word	002H
8 digital inputs (slots 2 and 3) for MDI-8 [S28]	word	0F0H
16 digital inputs MDIO-16, 8 limit switches, 8 free [S45]	word	0F1H
Software version	word	0FFH
MDIO16 :		
Actual data axis 1		
Current actual value (24 bit actual value, 4 outputs, 2 limit switches) [S46]	longint	00BH
Controller state [S46]	word	009H
Movement state [S47]	word	00AH
Actual data axis 2		
Current actual value (24 bit actual value, 4 outputs, 2 limit switches) [S46]	longint	03BH
Controller state [S46]	word	039H
Movement state [S47]	word	03AH
Actual data axis 3		
Current actual value (24 bit actual value, 4 outputs, 2 limit switches) [S46]	longint	06BH
Controller state [S46]	word	069H
Movement state [S47]	word	06AH
Actual data axis 4		
Current actual value (24 bit actual value, 4 outputs, 2 limit switches) [S46]	longint	09BH
Controller state [S46]	word	099H
Movement state [S47]	word	09AH
MDO8		
Actual data axis 1		
Cut-off point correction plus [S55]	longint	016H
Cut-off point correction minus [S55]	longint	018H
Actual data axis 2		
Cut-off point correction plus [S55]	longint	046H
Cut-off point correction minus [S55]	longint	048H
Actual data axis 3		
Cut-off point correction plus [S55]	longint	076H
Cut-off point correction minus [S55]	longint	078H
Actual data axis 4		
Cut-off point correction plus [S55]	longint	0A6H
Cut-off point correction minus [S55]	longint	0A8H

7 Summary of comcodes

Comcode	Meaning
	Controller commands
100 (64H)	Accept controller control block [S29]
110 (6EH)	Activate controller [S29]
111 (6FH)	Disable controller [S29]
140 (8CH)	Accept controller control block and activate controller [S29]
150 (96H)	Clear I-component [S29]
152 (98H)	Start automatic drift compensation [S30]
151 (97H)	Stop automatic drift compensation [S30]
153 (99H)	Delete current drift compensation variable [S30]
112 (70H)	Activate smoothing of manipulated variable [S30]
113 (71H)	Disable smoothing of manipulated variable [S31]
115 (73H)	Activate integral set point value correction [S31]
116 (74H)	Disable integral set point value correction [S31]
	Movement commands
130 (82H)	Axis to target or controlled movement (acceleration **=** deceleration) [S31]
131 (83H)	Stop axis immediately [S32]
134 (86H)	Stop axis via ramps [S32]
122 (7AH)	Home return (with reference cam and reset pulse) [S32]
123 (7BH)	Controlled home return (with reference cam and reset pulse) [S33]
124 (7CH)	Home return to limit stop (reference cam = high and reset pulse) [S33]
135 (87H)	Axis to target or controlled movement (acceleration **<>** deceleration) [S34]
132 (84H)	Controlled movement with home position_V1 [S34]
133 (85H)	Controlled movement with home position_V2 [S34]
190 (BE)	Interpolating motion of several axes [S35]
	System commands
500 (1F4H)	Clear error code and flag of all axes [S36]
501 (1F5H)	Set new sampling interval [S36]
502 (1F5H)	Define new number of axes [S36]
199 (C7H)	Clear error code and flag of a specific axis [S36]
	Special commands
117 (75H)	Deviation output (actual axis data) [S37]
118 (76H)	Current drift compensation output (actual axis data) [S37]
128 (80H)	Activate master/slave mode [S37]
126 (7EH)	Set preset value (actual position = target) [S38]
510 (1FEH)	Activate limit switch monitoring, stop error axis in case of error [S38]
511 (1FFH)	Activate limit switch monitoring, stop all axes in case of error [S38]
512 (200H)	Disable limit switch monitoring [S38]
513 (201H)	Activate axis release [S39]
514 (202H)	Disable axis release [S39]

7.1 Mode: Positioning with digital outputs

Comcode	Meaning
	Initialization commands
300 (12CH)	Accept MDIO16 initialization data [S43]
400 (190H)	Accept MDO8 initialization data [S53]
	Movement commands
320 (140H)	Start MDIO16 positioning [S43]
322 (142H)	MDIO16 home return (with reference cam and reset pulse) [S47]
324 (144H)	MDIO16 home return without reset pulse [S48]
420 (1A4H)	Start MDO8 positioning [S53]
424 (1A8H)	MDO8 home return to limit stop (reference cam = high and reset pulse) [S54]
430 (1AEH)	Start MDO8 cut-off correction for the last performed movement [S55]
515 (203H)	Activate brake operation [S39]
516 (204H)	Disable brake operation [S39]

8 Example Axis Initialization

Hardware configuration

	PBX21	MAO4	MINC2		

For Axis 1

KVF_Proportional_Positive = 20,5
KVF_Proportional_Negative = 25,5
KVF_Differential = 15
KVF_Integral = 0,005
Integral_Limit = 0
Target window = 1000
Control direction = 1
Measuring system: Incremental encoder; channel no. 1 of MINC2, entered in slot 2 (slot 2, because the PBX21-coupler is not counting as a slot).

Remark:

The following examples just describe the send-telegrams.

KVP_Positive

Address: 8 H
Value: 20,5
Transmitted value = 20.5 x 2^{16} = 1343448 dec. = 148000 H

Telegram:

Control-Byte	Address	Transmitted value			
* A0	08	00	14	80	00

KVP_Negative

Address: 0A H
Value: 25,5
Transmitted value = 25,5 x 2^{16} = 1071168 dec. = 198000 H

Telegram:

Control-Byte	Address	Transmitted value			
* A0	0A	00	19	80	00

KVF_Difference

Address: 0C H
Value: 15
Transmitted value = 15×2^{16} = 983040 dec. = F0000 H

Telegram:

Control-Byte	Address	Transmitted value			
* A0	0C	00	0F	00	00

KVF_Integral

Address: 0E H
Value: 0,005
Transmitted value = $0{,}005 \times 2^{16}$ = 327,68 dec. = 147 H

Telegram:

Control-Byte	Address	Transmitted value			
* A0	0E	00	00	01	47

Integral limit

Address: 10 H
Value: 0
Transmitted value = 0

Telegram:

Control-Byte	Address	Transmitted value			
* A0	10	00	00	00	00

Target window

Address: 12 H
Value: 1000 dec.
Transmitted value = 1000 dec. = 3E8 H

Telegram:

Control-Byte	Address	Transmitted value			
* A0	12	00	00	03	E8

Control direction

Address: 14 H
Value: 1
Transmitted value = 1

Telegram:

Control-Byte	Address	Transmitted value			
* A0	14	00	00	00	01

Measuring system identifier

Address: 15 H
Transmitted value:

Measuring system: Incremental-Encoder --> ID = 1C H
Position is slot 2, channel 1 --> Measuring system parameter = 1C21 H (see page 16)

Telegram:

Control-Byte	Address	Transmitted value			
* A0	15	00	00	1C	21

After all telegrams are transmitted the transmitted values are in the DPR of the PBX-Axis. To tell the PBX-Axis to use the transmitted values command 100 dec. = 64 h has to be send to the PBX-Axis (see page 29).

Telegram:

Control-Byte	Address	Transmitted value			
	comcode			Bit for axis 1	Comcode
* A0	00	00	00	08	64

|
see page 13

Parameters, which are equal to the default values need not to be transmitted.

* Register structure see chapter "Profibus interface" page 7