
POSITIONING- AND CONTOURING CONTROL SYSTEM PA8000 COMMISIONING MANUAL / CM



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1 For fast, reliable commissioning

This documentation describes how to commission all the requisite system components for using the PA8000 positioning and contouring control system.

1.1 Please note!

For commissioning work, the following procedure should be adhered to:

- Installation of the PA8000 TOOLSET software [Chapter 2.2]
- Configuration and installation of the TSR driver *mcutsr.exe* [Chapters 0 / 0]
- Setting the base address on the PA8000 [chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**]
- Installation of the PA8000 [Kapitel 3.8]
- Configuration and wiring of the PA8000 [chapter 4]
- Adjustment and planning routines as described in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** and chapter [BHB / Kapitel 4.4]

1.2 Important!

Before installing or removing any modules, always make sure that the personal computer and the external power supplies have been switched off.

Before installing the PA8000 module in the computer, first check whether the base address set and the address range thus utilized are not already being used by another module or the PC itself.

In this case, the address range of the PA8000 must be set to a free address space [Chapter 3.1].

If this instruction is ignored, the module, or even the computer itself, may be destroyed.

The manufacturer will accept no responsibility for damage/destruction which might arise from the use of his products.

The manufacture will accept no responsibility for any mistakes of any kind which may be contained in these manuals. The manufacturer further reserves the right to alter this manual, and the specification of the product described, at any time, without having to divulge or announce this alteration in any form to any person or persons.

2 Installing and configuring the PA8000 TOOLSET Software

2.1 Scope of delivery for the PA8000 TOOLSET Software

Die PA8000 TOOLSET software [TSW] is supplied on a 1.44-MB 3.5" floppy disk. Approx. 1 MB of memory are needed to install it on the hard disk.

2.2 Installing the PA8000 TSW

To install the software on the hard disk, first insert the MCU-6 TOOLSET floppy disk. You then have to call the *install.bat* batch program with the parameters for source and destination drives.

If, for example, you have inserted the program floppy in drive A, and your hard disk drive is C, then you type the following command to start the installation routine:

```
a:install a: c:
```

During the installation routine, the subdirectory *PA8000* is created, and inside this in turn further subdirectories are created in the destination drive, with the files required being copied into the appropriate directories. If the directories already exist, the installation routine will still be correctly performed, notwithstanding a DOS error message.

Once the installation routine has been correctly performed, the *PA8000* subdirectory of the destination drive will also include various graphics driver files (*.BGI) from BORLAND, which are required for the TOOLSET program *mcfg.exe*. If these files are already present in another subdirectory, they can be deleted from the *PA8000* directory. In this case, the *BGIPATH* environment variable must be used to indicate the subdirectory in which *mcfg.exe* can find these graphics driver files. The *BGIPATH* environment variable is set as follows:

```
SET BGIPATH={path}
```

2.3 Configuring the TSR driver *mcutsr.exe*

If the installation routine has been performed correctly, the *mcfg.exe* utility program will be located in the *PA8000* subdirectory of the destination drive selected. This program is now required in order to configure the TSR driver *mcutsr.exe* (TSR = Terminate Stay Resident).

For this purpose, the [PA8000 Board Parameters] menu should be called. The following particulars in this menu are required for the configuration routine: *base address*, *software interrupt* and *TSR symbolic name*.

Table 1: System parameters for configuring the TSR driver *mcutsr.exe*

Parameter	Description
Base address	This system constant specifies the I/O address from which the PA8000 is to be addressed by the PC. The address can be set in the range from 200 hex to 3E0 hex with a step size of 20 hex. Note, however, that there is a restriction imposed by the PC's I/O address space assignments, i.e. there must be no I/O address space overlaps with other modules [Chapter Fehler! Verweisquelle konnte nicht gefunden werden.]. Default value: 300 hex.
Software interrupt	This is the software interrupt channel under which the TSR driver <i>mcutsr.exe</i> is called by the TOOLSET and the PC user programs. Interrupt channels 60 hex to 6F hex are normally freely available for PC user programs. If an interrupt number from outside this range is used, you have to be prepared for system crashes, especially with small interrupt numbers, since these are assigned to DOS. Default value: 60 hex.
TSR Symbolic Name	This is a symbolic name for the TSR driver <i>mcutsr.exe</i> . It is used merely for easier comprehension and user-friendliness, and has no other function. Default name: MCUTSR

After you have made all the settings you want, the changes can be stored in the main menu using the [Save Changes] menu option. This action also patches and configures the TSR driver *mcutsr.exe*.

2.4 Installing the TSR-Driver *mcutsr.exe*

The *mcutsr.exe* program file is an MS-DOS device driver, which links a PC user program to the PA8000. It is in this driver that device-specific special features are implemented, i.e. numerous hardware and software-specific details involving the communication between PC and MCU-6 can be disregarded by the user.

The driver has been completely encoded in Assembler. This has several advantages:

- Very little main memory is required.
- The individual commands are executed very quickly.
- All the usual high-level languages can be used for user programming, since only simple software interrupt calls are necessary.

To activate *mcutsr.exe*, all that is needed is a call conforming to DOS convention.

After being called, *mcutsr.exe* is loaded as resident software into the PC's main memory. It need be called only once per system boot. So the most convenient option is to have the call executed in the AUTOEXEC.BAT batch file.

Please note: The *mcutsr.exe* TSR driver has to be loaded for the PA8000 to be accessed at all. It is accessed both from the PC user programs (PCAP programming) and from the TOOLSET software like *mcfq.exe*. If the driver has already been loaded as a resident program, and has to be loaded again (e.g. because the software interrupt number has been reconfigured), then the PC has to be rebooted beforehand.

2.5 Floppy disk contents of the PA8000 TSW

This section provides a tabulated listing of all program and system files which have been copied onto the hard disk with the *install.bat* installation program. The functions of the individual files are supplemented by a brief description.

2.5.1 Root directory

install.bat	Batch file for installation of the PA8000 TSW.
iserver.exe	Host file server and boot program for the PA8000.
mcbt.exe	calls <i>iserver.exe</i> with the correct parameters.
mcfg.dat	System file for <i>mcfg.exe</i> .
mcfg.exe	Installation, diagnostic, programming and development environment for the PA8000.
mcfg.hlp	Help file for <i>mcfg.exe</i> .
mcfg.lnf	Screen masks for <i>mcfg.exe</i> .
mcutsr.exe	TSR program for <i>mcfg.exe</i> and PC user programs.
ncc.exe	Command line compiler for generating stand-alone application programs (SAP).
rwtos.btl	Transputer operating system software. Is loaded onto the PA8000 with the boot program <i>mcbt.exe</i> .
sysgen.exe	Generates the <i>system.dat</i> and <i>mcfg.dat</i> files, if these files are not already present in the working directory.
system.dat	System file for <i>mcfg.exe</i> .
*.bgi	Graphics driver files for <i>mcfg.exe</i> .

2.5.2 Directory \SAP

*.src

Stand-Alone Application (SAP) example programs

2.5.3 Directory \TP

*.pas

Example programs and function libraries for the *Turbo Pascal* programming language

2.5.4 Directory \C

*.c, *.h

Example programs and function libraries for the *Turbo C* and *Microsoft C* programming languages

2.5.5 Directory \C\SRVR

*.c, *.h

Example programs and function libraries for the *Turbo C* and *Microsoft C* programming languages with direct access to the PA8000

3 Installing the PA8000

3.1 Setting the PA8000 base address

The base address of the PA8000 is set with the S1 switch assembly. The position of the components can be seen in the component mounting diagram [Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**]. In the factory, the base address has been set to 300hex and configured as a master board.

Using the *mcfg.exe* program file included in the TSW, you can read off the setting for the requisite base address in the [PA8000 Board Parameters] menu. It is displayed in the [PART S1] screen window.

Please make sure that the installation parameters do not overlap with other components of the PC system [Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**], i.e. you must use an as yet unassigned address range for the PA8000. If you find you have to change the address set in the factory, please consult Chapters 2.3 and 2.4.

The PA8000 is addressed in the PC's I/O area, and requires an address space of 32 bytes. The PA8000's base address can be set in the range from 200hex to 3E0hex with a step size of 20hex. The base address is selected with switches 1 to 5 of S1.

Table 2: Base addresses of the PA8000

Address (hex)	S1:2	S1:3	S1:4	S1:5
200	ON	ON	ON	ON
220	OFF	ON	ON	ON
240	ON	OFF	ON	ON
260	OFF	OFF	ON	ON
280	ON	ON	OFF	ON
2A0	OFF	ON	OFF	ON
2C0	ON	OFF	OFF	ON
2E0	OFF	OFF	OFF	ON
300	ON	ON	ON	OFF (Standard)
320	OFF	ON	ON	OFF
340	ON	OFF	ON	OFF
360	OFF	OFF	ON	OFF
380	ON	ON	OFF	OFF
3A0	OFF	ON	OFF	OFF
3C0	ON	OFF	OFF	OFF
3E0	OFF	OFF	OFF	OFF

3.2 Setting the PA8000 as master or slave board

If only one PA8000 is installed in the PC, this has to be configured as a master board. In multi-axis operation (more than 6 axis channels), only one PA8000 can be declared as a master board.

The PA8000 is configured as a master board using S1 Switch 1 in the ON position. If, however, the board is configured as a slave board (S1, Switch 1 in the OFF position), the PC-PA8000 interface is switched off. In this case, the preset base address for the PA8000 is without significance.

As for the setting of the base address, a simple planning instruction for master/slave board configuration is likewise provided in the [PA8000 Board Parameters] menu of the *mcf*.exe utility program.

3.3 Setting the PC hardware interrupt

Die PA8000 kann bei der Abarbeitung eines Stand-Alone-Applikationsprogrammes (CNC-Task) einen PC-Hardware-Interrupt auslösen. Die Auswahl dieses Interrupts wird softwaremäßig vorgenommen. Hierzu sind Beispielprogramme in der PA8000 TOOLSET-Software enthalten.

Folgende Hardware-Interrupt-Kanäle können ausgewählt werden: 3, 5, 11 und 15.

Es muß darauf geachtet werden, daß keine anderen Baugruppen auf den ausgewählten Unterbrechungskanal geschaltet werden.

Please note: After starting the PC, no hardware interrupts are set.

in the case of multi-axis operation (several PA8000) the hardware interrupt generation function is supported solely with the master board. The hardware interrupts of the slave boards are not required.

3.4 Setting the transputer processor clock pulse

On the PA8000, a processor clock pulse of either 20 MHz (J18 set) or 25MHz (J18 not set) can be selected. This, however, is conditional on the transputer type used being able to process this clock pulse rate, and the dynamic memory chips complying with the appropriate bus timing. To see what clock pulse rate the processor involved can handle, examine the transputer's printed type code IMSTxxxFyyS. The clock-pulse rate is contained in Field yy.

In the factory, the processor clock pulse of the transputer IMST805F25S is set to 25MHz.

3.5 Setting the transputer link transmission speeds

The PA8000's transputer possesses 4 serial high-speed transmission channels, referred to as "transputer links". The transmission speed of these links can be set using jumpers.

Table 5 Transmission speeds of the channels

Transputer / Link channel	Plug Conn. / Position	Transmission rate [Mbit/s]
T1 (U5) / 0	J1 jumpered	10
	J1 open	20 (Standard)
T1 (U5) / 1, 2 and 3	J17 jumpered	10
	J17 open	20 (Standard)

Please note: As you can see in the following block diagram, various links can be connected to each other (several PA8000 or option PA8000-03). The transmission rates of these channels must coincide to enable channel communication to be successful.

3.6 Setting the PA8000 transputer link connections

The various link configuration options for the PA8000 are shown in the block diagram.

Link Channel 0 of Transputer T1 is interfaced to the I/O bus of the personal computer or to Plug Connector X7 using Plug Connectors J19, J21, J22, J23, and J24.

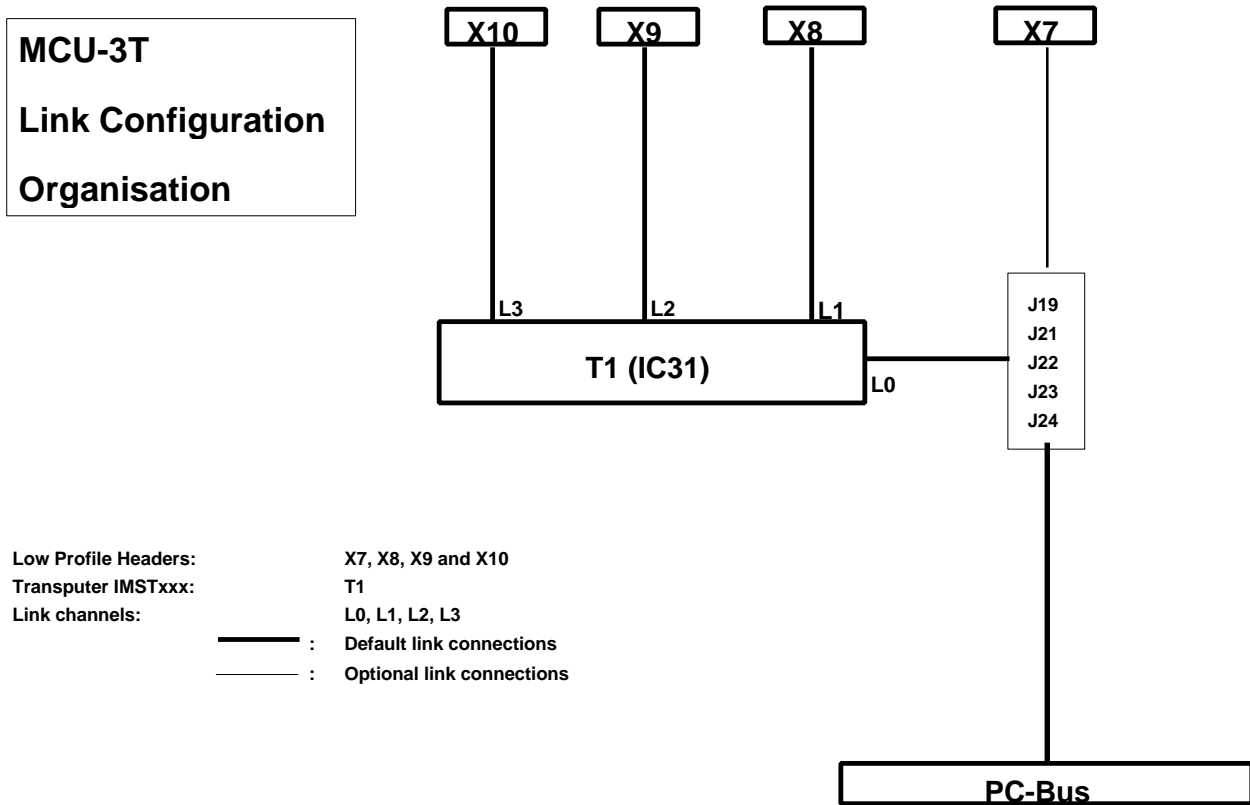
If a PA8000 masterboard is involved, the plug connectors J19 and J21 must be jumpered in position 2-3 and J22, J23 and J24 in position 1-2 (default setting ex works).

In this case, the PA8000 is programmed using the personal computer.

If, however, J19 and J21 are jumpered in position 1-2, and J22, J23 and J24 are jumpered in position 2-3, the PA8000 functions as a slave system, and is programmed via the 10 pole connector for ribbon cable X7.

This is the case, for example, if several PA8000 are being used in a multi-axis system.

3.7 Block diagram for the PA8000 link connections



3.8 Installing the PA8000 in the PC

Before the PA8000 can be installed in a computer, you must first check the settings for the base address and the PC hardware interrupt channel. If other modules are likewise being addressed inside the same address range, or are using the same hardware interrupt channel, this may cause damage to the PA8000 or other PC modules. For this reason, you should study Chapters 3.10 and 3.11 carefully.

The PA8000 may be installed only when the device has been switched off. optical fibre transceivers are plugged in, the PA8000 must be secured in place with the board holder at the PC housing.

Before the PA8000 can be installed in a computer, you must first check the settings for the base address and the PC hardware interrupt channel. If other modules are likewise being addressed inside the same address range, or are using the same hardware interrupt channel, this may cause damage to the PA8000 or other PC modules. For this reason, you should study Chapters **Fehler! Verweisquelle konnte nicht gefunden werden.** und 3.10 carefully.

The PA8000 may be installed only when the device has been switched off.

To prevent the module being shifted when the SUB-D connector X1 is plugged in, the PA8000 must be secured in place with the board holder at the PC housing.

In certain cases, we recommend additionally fixing the board in position with a PCB clamp (industrial PC).

3.9 PC I/O address space assignments

Table 7: PC I/O address space assignments

Address range (hex)	Function
200 - 207	'Game I/O adapter (joystick, etc.)'
278 - 27F	'LPT2 port'
2E8 - 2EF	'COM4 component, 8250 (PC) or 16450 (AT)'
2F8 - 2FF	'COM2 component, 8250 (PC) or 16450 (AT)'
300 - 307	'Prototype board'
378 - 37F	'LPT1 port'
380 - 38F	'SDLC bisynch board 2'
3A0 - 3AF	'Bisynch board 1'
3B0 - 3BB	'Monochrome or Hercules board' or 'EGA' in monochrome mode
3BC - 3BE	'LPT port on monochrome board'
3BF - 3BF	'Configuration switch on Hercules board'
3CE - 3CF	'EGA board'
3D0 - 3DB	'Colour graphics board (CGA)' or 'EGA' in colour mode
3DC - 3DF	'Amstrad PC1512'
3E8 - 3EF	'COM3 component, 8250 (PC) or 16450 (AT)'
3F0 - 3F7	'Floppy disk controller'
3F8 - 3FF	'COM1 component, 8250 (PC) or 16450 (AT)'

Please note: The PA8000 can be set to all base addresses between 200 hex and 3E0 hex, with a step size of 20 hex. You must, however, be careful to use only free address spaces, i.e. ones not used by other boards.

3.10 PC hardware interrupt assignments

HardwareInterrupt	Function
IRQ 0	System clock (Timer 0)
IRQ 1	Keyboard interrupt
IRQ 2	AT: cascaded to second interrupt controller PC: sometimes COM3, otherwise free
IRQ 3	COM2 interrupt (not used by the BIOS)
IRQ 4	COM1 interrupt (not used by the BIOS)
IRQ 5	LPT2 interrupt (not used by the BIOS) PC: sometimes COM4 or another module
IRQ 6	Floppy disk controller
IRQ 7	LPT1 interrupt (not used by the BIOS)
IRQ 8	Real-time clock
IRQ 9	Calls up INT 0Ah and simulates IRQ2
IRQ 10	COM3 interrupt
IRQ 11	COM4 interrupt
IRQ 12	Reserved
IRQ 13	Coprocessor
IRQ 14	Hard disk controller
IRQ 15	Reserved

Please note: The PA8000 can generate the interrupt sources IRQ3, IRQ5, IRQ11 and IRQ15.
. You must, however, be careful to use only free interrupt signals, i.e. interrupts not used by the BIOS.

4 Configuring and wiring of the PA8000

4.1 Installation, commissioning and replacement

If the module is recommissioned or replaced, various system data from the *system.dat* system file have to be saved on the PA8000. This is done using the *mcfg.exe* utility program in the [Save Changes] menu.

If the saved informations are not conform to those saved in the system file *system.dat*, the *cef* flag is set.

4.1.1 Environment

The PA8000 interfacing module has been specially designed for use in industrial applications. All inputs are available in potential-free form. The output signals are likewise electrically isolated from the logic supply, and have a common earth reference potential. This means that disturbances from the peripheral electronics are suppressed almost completely.

Since the PA8000 is fitted with a microprocessor module, avoid installing it in environments subject to severe electromagnetic interference. Otherwise, there is a definite possibility that the microcontroller will exhibit uncontrolled process behaviour. In such a case, you must expect the watchdog logic of the PA8000 module to be triggered, and cause a hardware reset.

4.1.2 Hardware interfaces, connection assignments

4.1.2.1 Digital inputs/outputs, setpoint value channels, supplies

4.1.2.1.1 Connector X1: 50 pole SUB-D pin connector

Pin	Row D	Group
1	SERVO1 / PULSE1+	Setpoint value 1 / Stepper 1
2	AGND1 / PULSE1-	Setpoint value 1 / Stepper 1
3	CHA1+ / CLKSSI1+	Actual value 1
4	CHA1- / CLKSSI1-	Actual value 1
5	CHB1+ / DATSSI1+	Actual value 1
6	CHB1- / DATSSI1-	Actual value 1
7	NDX1+ / SIGN1+	Actual value 1 / Stepper 1
8	NDX1- / SIGN1-	Actual value 1 / Stepper 1
9	I1	dig. input
10	I2	dig. input
11	I3	dig. input
12	I4	dig. input
13	I5	dig. input
14	I6	dig. input
15	I7	dig. input
16	I8	dig. input
17	+24V	Supply voltage dig. outputs 24V
18	SERVO2 / PULSE2+	Setpoint value 2 / Stepper 2
19	AGND2 / PULSE2-	Setpoint value 2 / Stepper 2
20	CHA2+ / CLKSSI2+	Actual value 2
21	CHA2- / CLKSSI2-	Actual value 2
22	CHB2+ / DATSSI2+	Actual value 2
23	CHB2- / DATSSI2-	Actual value 2
24	NDX2+ / SIGN2+	Actual value 2 / Stepper 2
25	NDX2- / SIGN2-	Actual value 2 / Stepper 2
26	O1	dig. output
27	O2	dig. output
28	O3	dig. output
29	O4	dig. output
30	O5	dig. output
31	O6	dig. output
32	O7	dig. output
33	O8	dig. output
34	SERVO3 / PULSE3+	Setpoint value 3 / Stepper 3
35	AGND3 / PULSE3-	Setpoint value 3 / Stepper 3
36	CHA3+ / CLKSSI3+	Actual value 3
37	CHA3- / CLKSSI3-	Actual value 3
38	CHB3+ / DATSSI3+	Actual value 3
39	CHB3- / DATSSI3-	Actual value 3
40	NDX3+ / SIGN3+	Actual value 3 / Stepper 3
41	NDX3- / SIGN3-	Istwert 3 / Stepper 3
42	I9	dig. input
43	I10	dig. input
44	I11	dig. input
45	I12	dig. input
46	I13	dig. input
47	I14	dig. input
48	I15	dig. input
49	I16	dig. input
50	GND-D	Supply voltage dig. inputs / outputs 24V

4.1.2.1.2 Counting for the 50 pole SUB-D pin connector (Stift) X1

▪ 17		▪ 50	top
	▪ 33		
▪ 16		▪ 49	
	▪ 32		
▪ 15		▪ 48	
	▪ 31		
▪ 14		▪ 47	
	▪ 30		
▪ 13		▪ 46	
	▪ 29		
▪ 12		▪ 45	
	▪ 28		
▪ 11		▪ 44	
	▪ 27		
▪ 10		▪ 43	
	▪ 26		
▪ 9		▪ 42	
	▪ 25		
▪ 8		▪ 41	
	▪ 24		
▪ 7		▪ 40	
	▪ 23		
▪ 6		▪ 39	
	▪ 22		
▪ 5		▪ 38	
	▪ 21		
▪ 4		▪ 37	
	▪ 20		
▪ 3		▪ 36	
	▪ 19		
▪ 2		▪ 35	
	▪ 18		
▪ 1		▪ 34	bottom / PC bus connector

4.1.2.2 Setpoint value channels

The PA8000 system electronics support the operation of either three stepping and three servomotor axes, or a combination of both. You plan and select the motor system you want using the TOOLSET program *mcfg.exe*.

4.1.2.2.1 Setpoint value channels for servo axes

The three analog output signals are used for controlling power amplifiers connected as speed controllers or torque controllers (current amplifiers). The offset of these setpoint value channels has been stored in the PA8000's EEPROM in the factory, and allowed for at outputting in the software as well. Analog setpoint value outputting is supported only with SERVO-planned axes.

4.1.2.2.1.1 Pin assignments for Plug Connector X1, Axis Channel 1

Pin	Name	Group	Description
1	SERVO1	Setpoint 1	Analog output signal 1 for controlling a power amplifier (+/-10 V, 5 mA). This signal is electrically isolated from the PA8000's system electronics, and has the reference potential AGND1.
2	AGND1	Setpoint 1	Reference potential for SERVO1. This potential is electrically isolated from the PA8000's system electronics

Important: Jumpers J2 and J3 must be set in position 1-2 if you want these signals to be available on the connector X1!

4.1.2.2.1.2 Pin assignments for Plug Connector X1, Axis Channel 2

Pin	Name	Group	Description
18	SERVO2	Setpoint 2	Analog output signal 2 for controlling a power amplifier (+/-10 V, 5 mA). This signal is electrically isolated from the PA8000's system electronics, and has the reference potential AGND2
19	AGND2	Setpoint 2	Reference potential for SERVO2. This potential is electrically isolated from the PA8000's system electronics

Important: Jumpers J4 and J5 must be set in position 1-2 if you want these signals to be available on the connector X1!

4.1.2.2.1.3 Pinbelegung Stecker X1, Achskanal 3

Pin	Name	Group	Description
34	SERVO3	Setpoint 3	Analog output signal 3 for controlling a power amplifier (+/-10 V, 5 mA). This signal is electrically isolated from the PA8000's system electronics, and has the reference potential AGND3.
35	AGND3	Setpoint 3	Reference potential for SERVO3. This potential is electrically isolated from the PA8000's system electronics

Important: Jumpers J6 and J7 must be set in position 1-2 if you want these signals to be available on the connector X1!

4.1.2.2.2 Setpoint value channels for stepping motor axes

Four output signals are available at each axis channel for controlling stepping motor power modules. These comprise one pulse signal, one directional signal, and their inverted signals to EIA Standard RS 422. All outputs supply a typical output current of -60 mA (max. -150 mA). The maximum pulse frequency of the stepping signals is 10MHz.

Important: The determinant factor for the correct number of steps to be performed is the positive edge of the stepping signal PULSx+ (x=1, 2) or the negative edge of the stepping signal PULSx-.

4.1.2.2.2.1 Pin assignments for Plug Connector X1, Axis Channel 1

Pin	Name	Group	Description
1	PULS1+	Stepper 1	Pulse signal
2	PULS1-	Stepper 1	Pulse signal, inverted
7	SIGN1+	Stepper 1	Directional signal
8	SIGN1-	Stepper 1	Directional signal, inverted

Important: Jumpers J2 and J3 must be set in position 2-3 if you want these signals to be available on the connector X1!

4.1.2.2.2.2 Pin assignments for Plug Connector X1, Axis Channel 2

Pin	Name	Group	Description
18	PULS2+	Stepper 2	Pulse signal
19	PULS2-	Stepper 2	Pulse signal, inverted
24	SIGN2+	Stepper 2	Directional signal
25	SIGN2-	Stepper 2	Directional signal, inverted

Important: Jumpers J4 and J5 must be set in position 2-3 if you want these signals to be available on the connector X1!

4.1.2.2.2.3 Pin assignments for Plug Connector X1, Axis Channel 3

Pin	Name	Group	Description
34	PULS3+	Stepper 3	Pulse signal
35	PULS3-	Stepper 3	Pulse signal, inverted
40	SIGN3+	Stepper 3	Directional signal
41	SIGN3-	Stepper 3	Directional signal, inverted

Important: Jumpers J6 and J7 must be set in position 2-3 if you want these signals to be available on the connector X1!

4.1.2.3 Pin assignments for Plug Connector X1, digital inputs

Die Prinzipschaltbilder der nachfolgend aufgelisteten digitalen Eingänge I1..I13 sind im [Kapitel 4.1.2.5] und Eingänge I14..I16 im [Kapitel 4.1.2.6] abgedruckt.

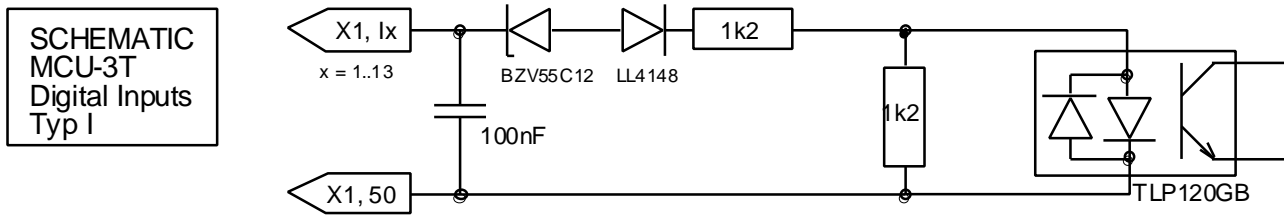
Input Ix / Pin	Function
I1 / 9	Dig. Input 1
I2 / 10	Dig. Input 2
I3 / 11	Dig. Input 3
I4 / 12	Dig. Input 4
I5 / 13	Dig. Input 5
I6 / 14	Dig. Input 6
I7 / 15	Dig. Input 7
I8 / 16	Dig. Input 8
I9 / 42	Dig. Input 9
I10 / 43	Dig. Input 10
I11 / 44	Dig. Input 11
I12 / 45	Dig. Input 12
I13 / 46	Dig. Input 13
I14 / 47	Dig. Input 14 and hardware latch signal for saving actual position of axis channel 1
I15 / 48	Dig. Input 15 and hardware latch signal for saving actual position of axis channel 2
I16 / 49	Dig. Input 16 and hardware latch signal for saving actual position of axis channel 3

4.1.2.4 Pin assignments for Plug Connector X1, digital outputs

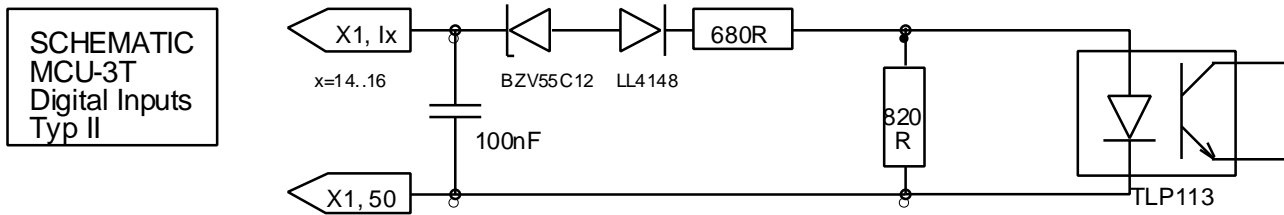
You will find the block diagram of the following digital outputs O1..O8 in [chapter 4.1.2.7].

Output Ox / Pin	Function
O1 / 26	Dig. Output 1
O2 / 27	Dig. Output 2
O3 / 28	Dig. Output 3
O4 / 29	Dig. Output 4
O5 / 30	Dig. Output 5
O6 / 31	Dig. Output 6
O7 / 32	Dig. Output 7
O8 / 33	Dig. Output 8

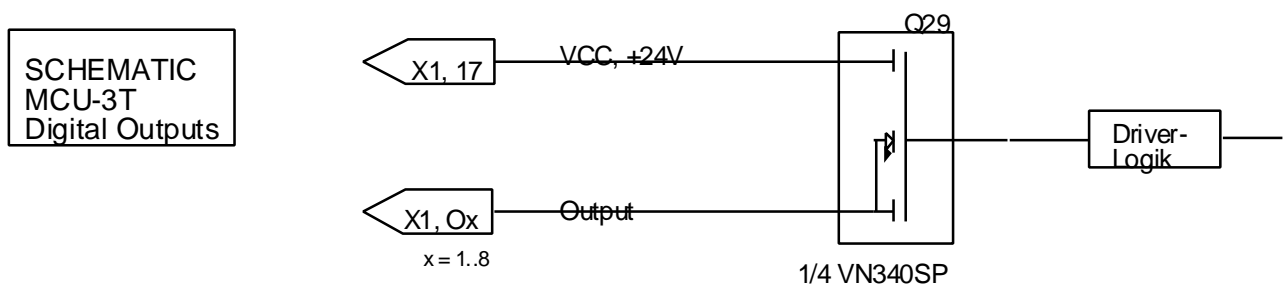
4.1.2.5 Block diagram for the digital PA8000 inputs I1..I13



4.1.2.6 Block diagram for the digital PA8000 inputs I14..I16



4.1.2.7 Block diagram for the digital PA8000 outputs O1..O8



4.1.2.8 Pinbelegung 10-poliger FB-Stecker X11, Freigabe-Relais, CNC-Bereit-Relais

Am Steckverbinder X10 werden Relais-Kontakte für die CNC-Bereit-Abfrage und Verstärkerfreigaben zur Verfügung gestellt. Es handelt sich hierbei um Schließer. Alle Relais sind nach Einschalten des PC, nach einem Rücksetzvorgang oder nach einem Fehler abgeschaltet.

Das CNC-Bereit-Relais wird nach dem Bootvorgang (*mcbt.exe*) aktiviert.

Die Freigabe-Relais werden beim PCAP-Befehl *cl()* und beim SAP-Befehl *CL()* für die entstprechend selektierten Achskanäle aktiviert.

Pin	Function
1	Relais 1, opening contact
2	Relais 1, closing contact, CNC ready
3	Relais 2, opening contact
4	Relais 2, closing contact, release of power amplifier axis channel 1
5	Relais 3, opening contact
6	Relais 4, closing contact, release of power amplifier axis channel 2
7	Relais 4, opening contact
8	Relais 4, closing contact, release of power amplifier axis channel 3
9	not connected
10	not connected

4.1.2.9 Pulse acquisition channels

The PA8000 is fitted with three identical pulse acquisition channels. An diese lassen sich unterschiedliche Enkodertypen wie beispielsweise Längenmaßstäbe oder Inkremental- oder Absolut-Drehgeber anschließen. The input signals processed are two quadrature signals out of phase by 90°, with a maximum pulse frequency of 5 MHz and TTL level. . A zero track (index signal) can also be evaluated. The signal levels detected by the encoders are electronically quadrupled, and processed internally with a resolution of 32 bits (31 bits plus a sign). This value range gives a traverse path of more than 2000 m, with a resolution of 1 µm, for example.

4.1.2.9.1 Incremental encoder with inverted signals

The incremental encoders with symmetric outputs are particularly well suited to industrial applications, since the output signals are available with inverted and non-inverted signal levels for all tracks, thus enabling pulses to be detected reliably even in environments subject to severe electromagnetic interference.

When these encoder types are used, **do not set** following jumpers: J8, J9 and J10 for channel 1, J11, J12 and J13 for channel 2 and J14, J15 and J16 for channel 3.

4.1.2.9.2 Incremental encoder without inverted signals

It is also possible to process encoder types without inverted pulse trains. However, these should be used only in environments not subject to significant electromagnetic interference, e.g. in laboratory applications. You should also make sure that the encoder cable is only a few metres long, especially when high pulse frequencies are involved.

If these encoder types are interfaced at Channel 1, set jumpers J8, J9 and J10. The encoder signals are connected to Pins 3, 5 and 7 of X1.

If these encoder types are interfaced at Channel 2, set jumpers J11, J12 and J13. The encoder signals are connected to Pins 20, 22 and 24 of X1.

If these encoder types are interfaced at Channel 3, set jumpers J14, J15 and J16. The encoder signals are connected to Pins 36, 38 and 40 of X1.

4.1.2.9.3 Optical decoupling of the pulse acquisition channels

All pulse acquisition channels of the PA8000 can be optically decoupled. We recommend this particularly in environments with severe electromagnetic interference.

4.1.2.9.4 Plug connector assignments for the pulse acquisition channels with incremental encoders

4.1.2.9.4.1 Plug Connector X1, channel 1

Pin	Name	Function
3	CHA1+	Incremental signal (TTL square-wave pulse trains), Track A
4	CHA1-	Inverted incremental signal, Track A
5	CHB1+	Incremental signal, Track B with 90° electrical phase offset to Track A
6	CHB1-	Inverted incremental signal, Track B
7	NDX1+	Reference signal, Track 0
8	NDX1-	Inverted reference signal, Track 0

4.1.2.9.4.2 Plug Connector X1, channel 2

Pin	Name	Function
20	CHA2+	Incremental signal (TTL square-wave pulse trains), Track A
21	CHA2-	Inverted incremental signal, Track A
22	CHB2+	Incremental signal, Track B with 90° electrical phase offset to Track A
23	CHB2-	Inverted incremental signal, Track B
24	NDX2+	Reference signal, Track 0
25	NDX2-	Inverted reference signal, Track 0

4.1.2.9.4.3 Plug Connector X1, channel 3

Pin	Name	Function
36	CHA3+	Incremental signal (TTL square-wave pulse trains), Track A
37	CHA3-	Inverted incremental signal, Track A
38	CHB3+	Incremental signal, Track B with 90° electrical phase offset to Track A
39	CHB3-	Inverted incremental signal, Track B
40	NDX3+	Reference signal, Track 0
41	NDX3-	Inverted reference signal, Track 0

4.1.3 Connection and wiring instructions

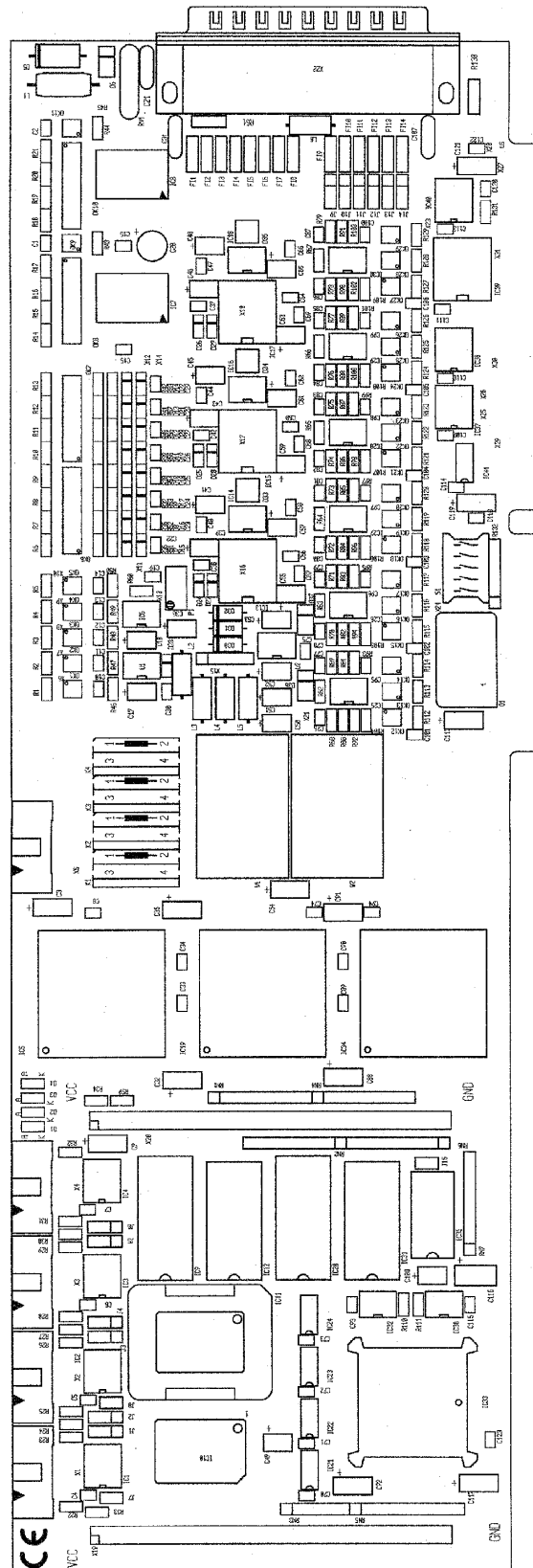
4.1.3.1 Earth and power supplies

The PA8000 is divided up electrically into three zones. Each of them having its own earth and power supplies, with all zones being electrically isolated from each other. The first of these zones accommodates the PA8000's system logic (CPU, memory, etc.), the second the pulse acquisition feature (encoder) and setpoint value generation function, the third the digital input/output logic. This separation offers maximized protection for the different boards, prevents earth loops, and provides a high degree of interference immunity from spurious signals, which often creep in from the drives via signal and earth connections.

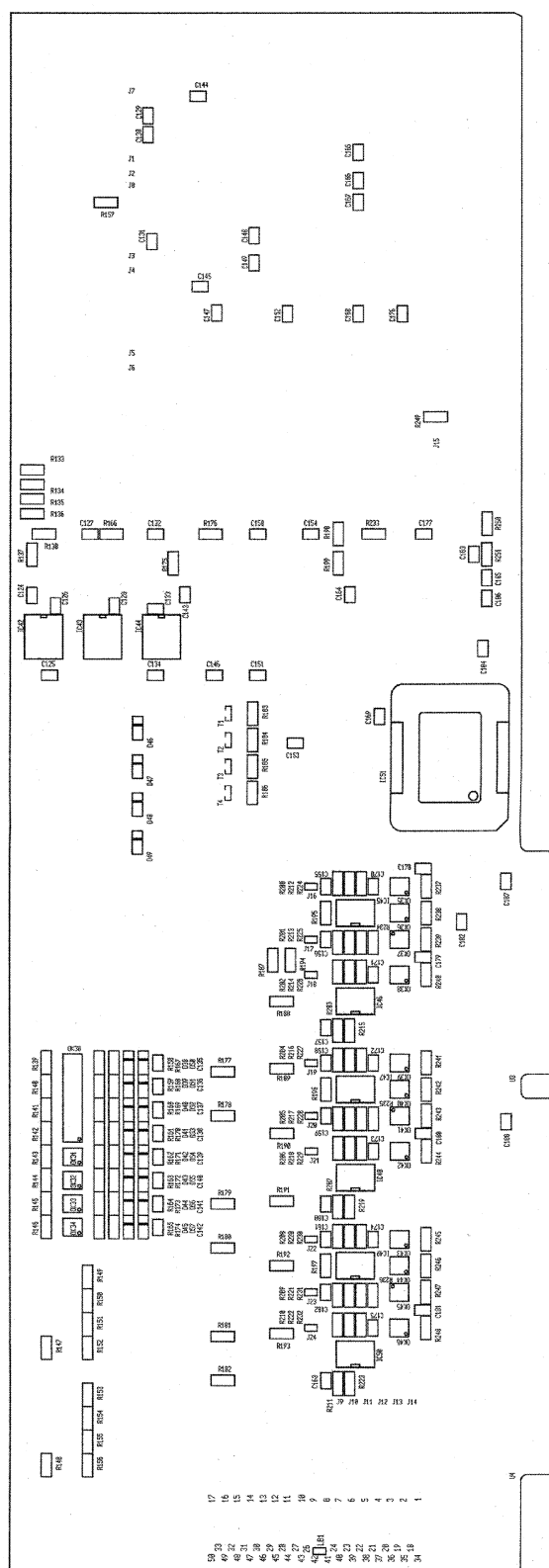
4.1.3.2 Equipotential bonding

Since the above-mentioned supply zones are completely electrically isolated from each other, potential differences of several kV may build up between these zones. To prevent this, a capacitive, high-impedance equipotential bonding feature should be provided between the individual zones.

4.2 Component mounting diagram for the PA8000 (part 1)



4.3 Component mounting diagram for the PA8000 (part 2)



4.4 Technical data for the PA8000

Axes:	1, 2, or 3 Gemischter Betrieb von Servo- oder Schrittmotoren möglich
Axis processor:	Transputer IMST805 (25MHz, 32 bits, Spitzen-Instruktionsrate: 25Mips and. 3.5MFlops)
Memory:	per transputer 1 Megabyte (4 MB optional) EEPROM for hardware system parameters
Bus:	IBM PC/XT/AT/IPC
Addressing:	32 I/O addresses selectable through DIP switch
Sensor inputs:	Richtungsdiskriminator für Inkrementalgeber mit 2 um 90° phasenverschobenen Impulsspuren und Nullimpuls, wahlweise deren invertierte Impulsspuren (6 Kanäle) SSI-Absolutwertgeber
Pulse levels:	5V, TTL
Incremental encoder evaluation:	4-fold, 32 bits with sign, 5.0 MHz (20MHz after quadrupling)
SSI encoder evaluation:	1..32 bits, Gray-/Binary codes, variable frequency 30kHz .. 10MHz
Encoder supply:	External auxiliary voltage depending on encoder type (5..30V)
Setpoint value outputs for servo power output stages:	14(16) bits DA converter, +/-10V, 5mA, potential-free
Setpoint value outputs for stepping motor output stages:	RS422 pulse and directional signals and their inverted pulse sequences, output current typically: -60mA (max. -150mA) Pulse frequency: max. 10MHz
Digital inputs:	16 inputs, optically decoupled 18..36V, input current at 24V approx. 10mA. Function mode user-programmable
Digital outputs:	8 outputs optically decoupled, output type: PNP 24V, 500mA (internal current limitation at 1A) Function mode user-programmable, setpoint state after reset programmable
Safety functions:	Watchdog circuit, Power On Reset
Power supply:	5V/1.5A, 24V power consumption, depending on output load
Construction:	Long plug-in board, 6-fold multilayer, 1 slot required
PC current supply:	5V/1.5A in maximal configuration
Cascading:	up to 18 axes (3 PA8000 with option PA8000-03) with standard TOOLSET, 19 axes and more on request
Controller software:	PIDF (PID controller with forward compensation)
Control time:	1.28ms, delay time approx. 0.3ms
Interpolation:	2D .. 3D linear, 2D circular, 3D helical, asynchrone and synchrone Interpolation with auxiliary axes
Interpolation cycles:	1.28ms
Plug connector:	50-pole SUB-D pin connector, complete peripheral connection 10-pole connector for ribbon cable with 3 potential-free relay contacts 10-pole connector for ribbon cable to others transputer boards
In preparation:	Spline and CAD interpolation, electronic gear, G Code programmiug
Manufacturing:	The board is manufactured according to DIN ISO 9001.
Test:	The board is tested according to CE directives

5 Adjustment and planning routines

After all PA8000 hardware and software components have been correctly installed, the axis-specific and motor-specific adjustment and planning routines can be performed using the *mcfg.exe* TSW program, as described in the sections below.

5.1 Isolating output for power output stage

It is sometimes necessary to isolate the power output stage only when the control loop is closed. This can be done using a programmable PA8000 digital output, which has been configured with a PAE function function [BHB / Kapitel 4.4.3.3]. This output is activated by closing the control loop. In addition, this output can be used, for example, to control a fail-safe brake. If a speed controller is being used, however, the amplifier has to be disabled simultaneously, since otherwise the drift may cause a torque to build up.

5.2 Determining the PIDF filter parameters

The axis-specific and motor-specific filter parameters kp , ki , kd and kpl can be set empirically or analytically. The *mcfg.exe* program offers an option for displaying the system behaviour in graphical form, thus enabling the control response to be accurately assessed. Every time you set the filter parameters, you should check beforehand whether manipulated variable outputting and position checkbacks are being executed with the correct phase angle, since otherwise after the control loop has been closed the motor axis will immediately drift out of control if a system deviation occurs.

With all experimental settings when the motor axis is connected, you must remember that the system may vibrate at considerable amplitudes and with high accelerations. Any danger to persons or the machine itself **must** be prevented by appropriate precautionary measures! In addition, a system which initially appears stable may be caused to oscillate by excitation!

Possible protective measures in this context are an EMERGENCY STOP switch, decoupling the motor from the load, etc.

Please note: You will find more information on the PIDF filter in the PM/Chapter 2.1.2.

5.2.1 Speed controller

For controlling a controlled system with a subordinate speed controller, a proportional controller is basically sufficient. To set this, first set all filter parameters to zero and kp to 1, for example. Now you can use kp to vary the setting until you find a suitable control response. In order to achieve higher controller hardness, the kpl factor can be increased. A permanent system deviation in position control can be prevented, for example, by the speed controller's input offset, using an additional integral-action component (ki).

An additional improvement in response to setpoint changes can be achieved by acceleration and velocity precontrol.

5.2.2 Current amplifier

When using a power module designed as a current amplifier, a PD controller (k_p , k_d , k_{pl}) is basically required. In order to prevent the contouring error during traversing or in the event of static loading on the motor shaft, an integral-action component can additionally be injected here as well. As a rule of thumb, you can assume the following equation:

$$T_N \geq 5 \cdot T_V$$

and

$$T_V \geq 5 \cdot T_A$$

Now you can use k_p to vary the settings, in order to find the best working point. In this working point, you can again vary with k_{pl} . If the system stabilizes but is too soft, the ratio T_V / T_A can be reduced.

5.2.3 Voltage amplifier

When using a power module designed as a voltage amplifier, a P or PD controller is basically required. The position error under static loading can be prevented by an additional integral-action component. Perform experimental adjustment of the filter parameters as for the speed controller. The controller hardness can be improved by the derivative component with which the motor's mechanical or electrical time constant can be compensated.

5.2.4 Stepping motor power amplifiers

5.2.4.1 Stepping motor system in open-loop mode

When using stepping motor power amplifiers in open-loop mode, i.e. without displacement checkback, all that is needed is a proportional controller with an amplification of $k_p = 0.04$. All other filter parameters should be set to 0.

5.2.4.2 Stepping motor system in closed-loop mode

When using stepping motor power amplifiers in closed-loop mode, i.e. with displacement checkback, then the complete PIDF controller can again be used. Various stepping motor manufacturers offer for this operating mode stepping motors with a built-on incremental encoder. For this controlled system, almost all the statements made for the voltage amplifier also apply.

5.2.5 Precontrol

The k_{fca} and k_{fcv} parameters can be used to generate an acceleration and velocity precontrol signal. The precontrol feature enables the contouring error to be reduced during positioning operations. The control loop's stability is not affected by the precontrol function.

5.2.5.1 Determining the coefficients

To determine the precontrol coefficients empirically, first run a short trapezoidal profile, and use the graphical system analysis function to assess it for setting suitable profile data and scaling parameters. Run the profile with medium acceleration and velocity. Acceleration ramp, deceleration ramp and linear traversing range should be more or less evenly distributed on the screen, and depicted in their entirety. The control algorithm is then de-activated by setting the k_p , k_i and k_d parameters to zero. The precontrol parameters can now be altered until the setpoint and actual speed characteristics coincide in a good approximation after the preset profile has been run. After every alteration to the parameters, you must select the [Clear Position] and [Update Filter] menu options, so that the new parameters are also accepted into memory.

When a current amplifier is used, you first set the acceleration precontrol k_{fca} so that the acceleration ramps of setpoint and actual speeds properly coincide. Then set the velocity precontrol function so that the speed in the linear speed range runs parallel. You can now slightly alter the two values alternately until setpoint and actual speed characteristics best coincide.

When a speed controller is used, you begin with the velocity precontrol k_{fcv} .

After the optimum parameters have been found, enter the filter parameters k_p , k_i and k_d again, and check the response once more. Make sure you remember to save the data you have set.

IHB

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[BHB / Kapitel 4.4]

[BHB / Kapitel 4.4.3.3]

[PHB / Kapitel 2.1.2]