EN

PROFI-line

P6000

Position Control System
750 W - 15 kW

Application Manual

watt drive

Drives with system efficiency

Overview of documentation

With delivery (depending on supply package)

Operation Manual P6000	Application Manual
	
Quick and easy initial commissioning	Adapting the drive system to the application

Application Manual P6000

ID no.: 1005.22 B.0-00

Dated: 05 / 2004

Valid from software version Vx.x

Dear User,

This manual is aimed primarily at you as a **programmer** of drive and automation solutions. It describes how you can adapt your new P6000 drive system optimally to your specific application. We assume that your drive is already running – if not, you should first consult the Operation Manual.

Do not worry about the size of the Manual: only sections 1 to 3 contain fundamental information which you need to familiarize yourself with. The remaining sections and the Appendix are provided **as reference resources**: They demonstrate the full scope of functions and flexibility of the P6000's software package in solving a wide variety of drive tasks.

How to use this manual

Pictograms

➢ **Attention!** Misoperation may result in damage to the drive or malfunctions.

➢ **Danger, high voltage!** Improper behaviour may endanger human life.

➢ **Danger from rotating parts!** The drive may start running automatically.

➢ **Note:** Useful information

➢ **Cross-reference:** More information in other sections of the Application Manual or additional documentation

➢ **Step 1:** Step-by-step guide

Abbreviations

FS ➢ **Factory setting**

Table of Contents

6 General software functions

1 Safety

1.1 Measures for your safety

The P6000 position controller is fast and safe to use. For your own safety and for the safe functioning of your device, please be sure to observe the following points:

Read the Operation Manual first.

- Follow the safety instructions.

Electric drives are dangerous:

- Electrical voltages > 230 V/400 V: Hazardous voltage levels may still be present even 10 minutes after power-off, so always make sure the system is no longer live!
- Rotating parts.
- Hot surfaces.

Your qualification:

- In order to prevent personal injury or damage to property, only personnel with electrical engineering qualifications may work on the device.
- The qualified personnel must familiarise themselves with the Operation Manual (refer to IEC364, DIN VDE0100).
- Knowledge of national accident prevention regulations (e. g. VBG 4 in Germany, regulations laid down by the employers' liability insurance associations) is essential.

During installation follow these instructions:

- Always comply with the connection conditions and technical specifications.
- Electrical installation standards, such as wire cross-section, grounding lead and ground connections.
- Do not touch electronic components and contacts (electrostatic discharge may destroy components).

1.2 Intended use

Position controllers are components designed for installation in electrical systems or machinery. The P6000 can be used for asynchronous motors. The drive may not be commissioned (i.e. it may not be put to its intended use) until it has been established that the machine as a unit complies with the provisions of the Machinery Directive

(98/37/EC). EN 60204 (Safety of machines) is to be observed.

CE	The P6000 conforms to the Low Voltage Directive DIN EN 50178.
EMC	The following generic standards are complied with in application of the installation instructions: • EN 50081-1 and EN 50081-2 (line-borne and radiated interference emission) • IEC 1000-4-2 to 5 / EN61000-4-2 to 5 (Interference immunity of the position controller) • Product standard EN 61800-3 (Variable-speed drives)

If the position controller is used for special applications, e. g. in areas subject to explosion hazard, the required standards and regulations (e.g. in hazardous areas EN 50014 "General provisions" and EN 50018 "Flameproof enclosure") must always be observed.

Repairs may only be carried out by authorised repair workshops. Unauthorised opening and incorrect intervention could lead to physical injury or material damage. Warranty cover would be rendered void.

1.3 Responsibility

Electronic devices are never fail-safe. The company setting up and/or operating the machine or plant is itself responsible for ensuring that the drive is rendered safe if the device fails. EN 60204-1/DIN VDE 0113 "Safety of machines", in the section on "Electrical equipment of machines", stipulates safety requirements for electrical controls. They are intended to protect personnel and machinery, and to maintain the function capability of the machine or plant concerned, and must be observed.

An emergency stop system does not necessarily have to cut the power supply to the drive. To protect against danger, it may be more beneficial to keep individual drives running or to initiate specific safety sequences. Execution of the emergency off measure is assessed by means of a risk analysis of the machine or plant, including the electrical equipment to EN 1050, and is determined with selection of the circuit category in accordance with DIN EN 954 "Safety of machines - Safety-related parts of controls".

2 Positioning module P6000

This section sets out basic aspects of the device hardware which are essential to understanding and using the Application Manual. For more information on the device hardware refer to the P6000 Operation Manual.

2.1 Device and terminal view

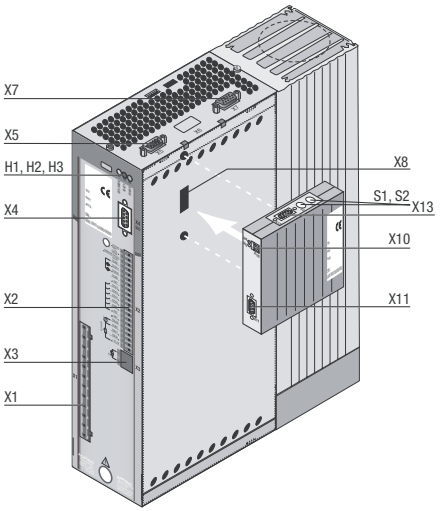


Image 2.1 Layout, P6000

No.	Designation	Function
H1, H2, H3	LEDs	Device status display
X1	Power connection	Mains, motor, DC feed (L+/L-) to < 22 kW: Braking resistor L+/RB, from > 22 kW: Braking resistor +/RB
X2	Control connection	4 digital inputs, 2 analog inputs 3 digital outputs (of which 1 relay) 1 analog output
X3	PTC connection	PTC, thermostatic circuit-breaker or linear temperature transmitter KTY 84-130
X4	RS232 connection	for PROFI-Tool or control unit KP10
X5	CAN interface	Access to integrated CAN interface
X7	TTL-/SSI encoder interface	
X8	Option slot	e.g. option module DPV1 or EA1
X10	Voltage supply for option module	+ 24 V, ground
X11	DPV1	Bus connection input
X13	Address coding plug	Only for option module DPV1
S1, S2	Address coding switch	Only for option module DPV1

Table 2.1 Key to Image 2.1

X1	Designation	X1	Designation
	Motor cable U		Motor cable U
	Motor cable V		Motor cable V
	Motor cable W		Motor cable W
	Grounding lead PE		Grounding lead PE
	Grounding lead PE		Grounding lead PE
	DC-link voltage +		DC-link voltage +
	Braking resistor		Braking resistor
	DC-link voltage -		DC-link voltage -
	Grounding lead PE		Grounding lead PE
	NC		Mains phase L3
	Neutral conductor		Mains phase L2
	Mains phase		Mains phase L1

Table 2.2 Power terminal designation, P6000xxxS and P6000xxxT

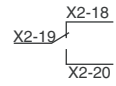
X2	Designation	Function	
20	OSD02/18	Changeover relay make contact	
19	OSD02/19	Changeover relay root	
18	OSD02/20	Changeover relay break contact	
17	DGND	Digital ground	
16	OSD01	Digital output	
15	OSD00	Digital output	
14	DGND	Digital ground	
13	U_V	Auxiliary voltage 24 V	
12	ISD03	Digital input	
11	ISD02	Digital input	
10	ISD01	Digital input	
9	ISD00	Digital input	
8	ENPO	Power stage hardware enable	
7	U_V	Auxiliary voltage 24 V DC	
6	U_V	Auxiliary voltage 24 V DC	
5	OSA00	Analog output	
4	AGND	Analog ground	
3	ISA01	Analog input	
2	ISA00	Analog input	
1	U_R	Reference voltage 10.5V	

Table 2.3 Control terminal designation, P6000

Pin assignment X4

Pin no.	Function
1	+15 V DC for control unit KP10
2	TxD, send data
3	RxD, receive data
4	Do not use
5	GND for +15 V DC of control unit KP10
6	+24 V DC, control pcb power supply
7	Do not use
8	Do not use
9	GND for +24 V DC, control pcb power supply

Table 2.4 Pin assignment of serial interface X4

Pin assignment of X5

Pin no.	Function
2	CAN_LOW
3	CAN_GND
4	Not assigned
5	Not assigned
6	CAN_GND
7	CAN_HIGH
9	CAN_+24V

Table 2.5 Pin assignment of CAN interface X5, 9-pin D-Sub pin connector

Pin assignment X7

Pin	TTL function	SSI function
1 / 2	A- / A+	DATA- / DATA+
3	+5 V	+5 V
6	B-	CLK-
8	GND	GND
9 / 10	R- / R+	
11	B+	CLK+
12	+5V (sensor)	+5V (sensor)
13	GND (sensor)	GND (sensor)
14 / 15	Bridge, wave termination track B	

Table 2.6 Pin assignment of encoder connection X7, 15-pin D-Sub socket

2.2 Specification of control connections

Note: The sampling time of the inputs and outputs is 1 ms. The digital voltages relate to the digital ground and the analog voltages to the analog ground.

Des.	Terminal	Specification	Floating
Analog inputs			
ISA00	X2-2	• U_{IN} = +10 V DC, ±10 V DC; I_{IN} = (0) 4-20 mA DC, switchable by software to: • 24 V digital input, PLC-compatible • Switching level low/high: <4.8 V / >8 V DC • Resolution 10-bit; R_{IN}=110kΩ • Terminal scan cycle = 1ms • Tolerance: U: ±1% v. M. ; I: ±1% v. M.	against digital GND
ISA01	X2-3	• U_{IN} = +10 V DC, software-switchable to: • 24 V digital input, PLC-compatible • Switching level low/high: <4.8 V / >8 V DC • Resolution 10-bit; R_{IN}=110 kΩ • Terminal scan cycle = 1ms • Tolerance: U: ±1% v. M.	against digital GND
Analog output			
OSA00	X2-5	• PWM with carrier frequency 19.8 kHz • Resolution 10-bit; f_{Limit}= 1.1 kHz • R_{out}=100 Ω; U_{out}=+10 V DC; I_{max}=5 mA • Short-circuit-proof • Internal signal delay time ≈ 1ms • Tolerance ±2.5%	✔
Digital inputs			
ISD00	X2-9	• Limit frequency 5 kHz, PLC-compatible • Switching level low/high: <5 V / >18 V DC, range >5 V to <18 V DC undefined • I_{max} at 24 V = 10 mA; R_{IN} = 3 kΩ • Internal signal delay time ≈ 100µs • Terminal scan cycle = 1ms	✔

Table 2.7 Specification of control connections

Des.	Terminal	Specification	Floating
ISD01	X2-10	• Limit frequency 150 kHz, PLC-compatible • Switching level low/high: <5 V / >18 V DC, Range >5 V to <18 V DC undefined • I_{max} at 24 V = 10 mA; R_{IN} = 3 kΩ • Internal signal delay time ≈ 2µs • Terminal scan cycle = 1ms • Data input with reference coupling (Master/ Slave)	✔
ISD02	X2-11	• Limit frequency 500 kHz, PLC-compatible • Switching level low/high: <5 V / >18 V DC, range >5 V to <18 V DC undefined • I_{max} at 24 V = 10 mA; R_{IN} = 3 kΩ • Internal signal delay time ≈ 2µs • Terminal scan cycle = 1ms • A-input with square encoder evaluation for 24V HTL encoder against GND_EXT • Permissible numbers of pulses 32...16384 pulses per rev (2^n where n = 5...14)	✔
ISD03	X2-12	• Limit frequency 500 kHz, PLC-compatible • Switching level low/high: <5 V / >18 V DC, range >5 V to <18 V DC undefined • I_{max} at 24 V = 10 mA; R_{IN} = 3 kΩ • Internal signal delay time ≈ 2µs • Terminal scan cycle = 1ms • B-input with square encoder evaluation for 24V HTL encoder against GND_EXT • Permissible numbers of pulses 32...16384 pulses per rev (2^n where n = 5...14)	✔
ENPO	X2-8	• Power stage enable = High level • Switching level low/high: <5 V / >18 V DC, range >5 V to <18 V DC undefined • I_{max} at 24 V = 10 mA; R_{IN} = 3 kΩ • Internal signal delay time ≈ 20µs • Terminal scan cycle = 1ms • PLC-compatible	✔

Table 2.7 Specification of control connections

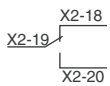
Des.	Terminal	Specification		Floating
Digital outputs				
OSD00	X2-15	• Short-circuit-proof • I_{max} = 50 mA, PLC-compatible • Internal signal delay time ≈ 250µs • Terminal scan cycle = 1ms • Protection against inductive load • High-side driver		✔
OSD01	X2-16	• Short-circuit-proof • I_{max} 50mA, PLC-compatible • Internal signal delay time ≈ 250µs • Terminal scan cycle = 1ms • Protection against inductive load • High-side driver		✔ 1)
Relay output				
OSD02	X2-18 X2-19 X2-20	• Relay 48 V / 1 A AC, changeover contact • Usage category AC1 • Operating delay approx. 10 ms		✔
Voltage supply				
+10.5V	X2-1	• Auxiliary voltage U_R =10.5 V DC • I_{max} = 10 mA, short-circuit-proof		–
+24V	X2-6 X2-7 X2-13	• External auxiliary voltage: U_V = 24 V DC ±25% I_{max} = 500 mA, short-circuit-proof • I_{max} = 200 mA (overall, also includes driver currents for outputs OSD00 and OSD01) • No polarity reversal protection		✔
Analog ground				
AGND	X2-4	• Isolated from DGND		
Digital ground				
DGND	X2-14 X2-17	• Isolated from AGND		

Table 2.7 Specification of control connections

2.3 LEDs

At the top right of the positioning module there are three status LEDs coloured red (H1), yellow (H2) and green (H3).

Device status	Red LED (H1)	Yellow LED (H2)	Green LED (H3)
24 V DC (internal or external) supply voltage for control unit applied, or controller in "parameter setting" mode	❍	❍	●
Ready (ENPO set)	❍	●	●
In operation/motor identification	❍	✳	●
Warning (in "ready" condition)	❍	●	●
Warning (in operation/motor identification)	❍	✳	●
Error	✳ (flash code)	❍	●
❍ LED off, ● LED on, ✳ LED flashing			

Table 2.8 Meanings of LEDs

Note: The parameter-setting mode by control unit is not indicated separately.

Flash code of red LED	Display CONTROL UNIT	Error cause
1x	E-CPU	Collective error message
2x	E-OFF	Undervoltage shut-off
3x	E-OC	Current overload shut-off
4x	E-OV	Voltage overload shut-off
5x	E-OLM	Motor overloaded
6x	E-OLI	Device overloaded
7x	E-OTM	Motor temperature too high
8x	E-OTI	Cooling temperature too high

Table 2.9 Error messages

Error messages can be viewed in more detail using the KP10 control unit or the PROFI-Tool.

2.4 Isolation concept

The analog and digital grounds are isolated from each other in order to avoid transient currents and interference over the connected lines. The analog ground, the supply to the encoder at X7 and the primary side of the CAN interface X5 are connected directly to the positioning module processor. It serves as the reference potential for analog reference input. The digital inputs and outputs are isolated from it. Disturbance variables are thereby kept away from the processor and the analog signal processing function. To enhance operating safety we recommend that the analog and digital grounds should not be interconnected.

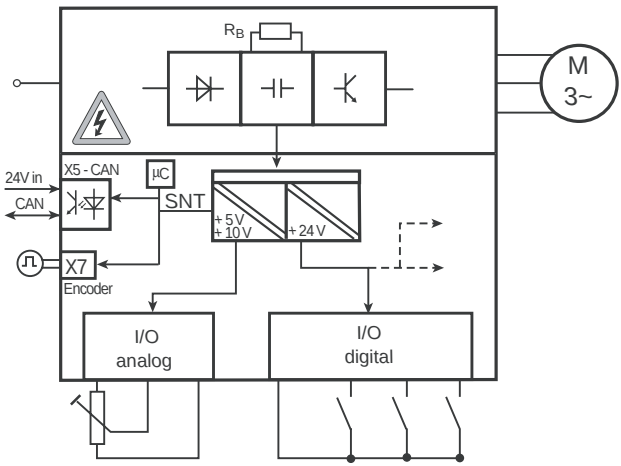


Image 2.2 Voltage supply to I/Os

When selecting the cable, note that the cables for the analog inputs and outputs must always be shielded. The cable or wire core shield on shielded pairs should cover as large an area as possible in respect of EMC considerations. In this way high-frequency interference voltages are safely discharged (Skin effect). EMC-conforming wiring is essential, and must be provided.

Special case: use of an analog input as a digital input

Use of the internal 24 V DC as the supply voltage when using an analog input with the "digital input" function requires connection of analog and digital ground. For the reasons mentioned above, this can lead to interference, and demands extra care in selecting and connecting the control cables.

A bridge is only required when the internal 24 V is used.

X2	Function
1	Reference voltage 10V, 10mA
2	ISA00, as dig. Input
3	ISA01, as dig. Input
4	Analog ground
5	OSA00
6	Auxiliary voltage 24 V, max. 200 mA
7	
13	Auxiliary voltage 24 V
14	Digital ground
15	OSD00
16	OSD01
17	Digital ground

Image 2.3 Removal of isolation when using the analog inputs with the digital function

If more digital inputs and outputs are required than are available on the positioning module, we recommend using option module ULZ-EA1. It ensures safe operation of the P6000 positioning module with no disturbance of the analog signals. Safe operation based on burst immunity to EN 61000-4-4 is not affected by connection of the analog and digital ground. The only effect may be on evaluation of the analog input resulting from interference voltage where long cables are attached to the digital outputs and inputs.

Attention: The ground connection into the system must not be routed via terminal 4. It may only be connected via one of the DGND terminals.

Example: Risk of disturbance

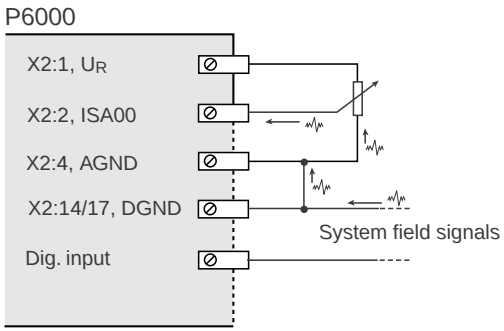


Image 2.4 Disturbance of the analog input in event of incorrect wiring

Note: The analog inputs must be used either both only in analog or both only in digital mode. Combining the analog inputs with one input in analog mode and one in digital mode may result in disturbance of the analog input.

2.5 Reset

The reset function is divided into two areas with differing effects. Parameter reset restores to the last value stored in the device. Device reset restores the entire data set to factory setting (delivery defaults).

Parameter reset with control unit

If you are in the setup mode of a parameter and press the two cursor keys simultaneously, the parameter you are currently editing will be reset to the last setting saved (= saved with parameter 150-SAVE).

Factory setting with control unit

Press both cursor keys simultaneously during inverter module power-up to reset all parameters to their factory defaults and reinitialise the system.

Factory setting with PROFI-Tool

In the "Active device" menu, the "Reset to factory setting" option can be used to restore the delivery defaults of the device. .

Image 2.5 Reset in PROFI-Tool

Note: Attention. The factory setting also resets the selected default solution. Check the terminal assignment and check that the inverter module is working in this operating mode, or load your user data set.

2.6 Loading device software

With the PROFI-Tool a new device software release (firmware) can be loaded into the Flash-EPROM of the P6000. This means the software can be updated without opening up the PROFI-Tool.

1. To do so, establish a link between the PROFI-Tool and the positioning module.
2. From the Tools menu choose "Load device software (firmware) ...". The PROFI-Tool then guides you through the further work steps. LEDs H2 and H3 are lit steadily during transfer of the firmware. When the transfer is completed successfully, LED H2 goes out provided no ENPO signal is applied.

2.7 Ambient conditions

Characteristic		Positioning module	Option module
Temperature range	In operation	-10 ... 45 ° C (A ... E) 0 ... 40 ° C (F ... H)	-10 ... 55 °C
	In storage	-25 ... +55 °C	
	In transit	-25 ... +70 °C	
Relative air humidity		15 ... 85 %, condensation not permitted	
Mechanical strength to IEC 68-2-6	In stationary use	Vibration: 0.075 mm in frequency range 10 ... 58 Hz Shock: 9.8 m/s^2 in frequency range >58 ... 500 Hz	
	In transit	Vibration: 3.5 mm in frequency range 5 ... 9 Hz Shock: 9.8 m/s^2 in frequency range >9 ... 500 Hz	
Protection	Device	IP20 (NEMA 1)	
	Cooling method	Cold Plate IP20 Push-through heat sink IP54 (3 ...15 kW) Push-through heat sink IP20 (22...37 kW)	Convection IP20
Touch protection		VBG 4	
Power reduction			None
Mounting height		Up to 1000 m above MSL, above 1000 m above MSL with power reduction of 1% per 100 m, max. 2000 m above MSL	

Table 2.10 Ambient conditions for the modules

3 User control structure

The user structure of the P6000 is highly flexible, as a result of the various user control variants and wide-ranging parameter-setting facilities. In this way an ordered data structure provides assistance in data handling and in setting the parameters of the P6000 position controller.

The parameters of the position controller can be set using the simple KP10 control unit or the user-friendly ProfiTool PC user software.

3.1 User levels in the parameter structure

By means of the parameters the position controller can be fully adapted to the application task. In addition there are parameters for the internal variables of the position controller which, for the sake of general operating safety, are protected against user access.

The user levels are set by way of a parameter. The number of editable and displayable parameters changes depending on the user level. The higher the user level the greater the number of accessible parameters. In contrast, users are presented with a more concise range of those parameters which are really required, allowing them to find their specific solution more rapidly. Consequently, choosing as low a user level as possible makes operation significantly easier.

Note: The user levels protect against unauthorized access. Consequently, in parameter setting with the KP10 control unit user level 01-MODE=2 is activated approximately 10 minutes after the last key press.

Changing user level

If a higher user level is selected by way of parameter 01-MODE, a prompt for the associated password is automatically delivered. The password can be changed by way of a password parameter (setting "000" = password disabled).

Target group	Password parameters	Comments	User level 01-MODE	Password in FS [1]
Layman	No parameter	No access permission, for status monitoring only • No parameter setting, display of basic parameters	1	-
Beginner	362-PSW2	With basic knowledge for minimal operation • Expanded basic parameters editable • Expanded parameter display	2	000
Advanced	363-PSW3	For commissioning and field bus connection • Parameter setting for standard applications • Expanded parameter display	3	000
Expert	364-PSW4	With control engineering skills • All control parameters editable • Expanded parameter display	4	000
Other	365-PSW5	For system integrators	5	-
Specialist personnel	367-PSWCT	For operation and commissioning by KP 10 control unit	CTRL menu	573
[1] FS = Factory setting				

Table 3.1 Setting user levels

If a password is set for user level 2 ... 4, parameter viewing and editing at the relevant user level via the KP10 control unit is retained until the switch is made to a lower user level. For this, a new user level must be selected via parameter 01-MODE.

Changing the password for a user level

A password can only be changed for the authorized levels - passwords to a higher user level cannot be viewed or changed. The password is changed by selecting the parameter, editing it and then saving it by pressing the Enter key on the KP 10 control unit. It can also be changed by way of the ProfiTool. The password is not activated until you switch to a lower user level.

Changing user level in the ProfiTool

The user level can be selected with the "Tools - Select New User Level" menu option.

No password input is required to switch levels.

3.2 Operation with ProfiTool

Connection and startup

- Connect the interface cable and switch on the power supply to the drive unit.
- When the program starts the ProfiTool automatically connects to the attached drive unit (at least V2.3).
- If the connection setup does not occur automatically, check the settings in the **Tools > Options** menu and start the connection setup with the  icon.

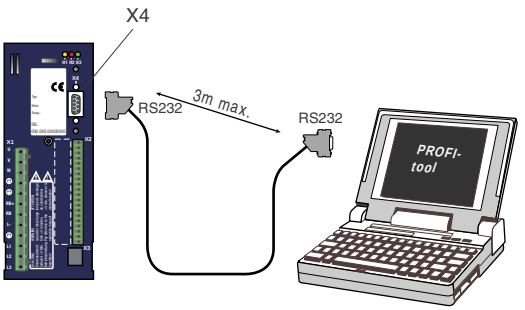


Image 3.1 Connection via RS232 interface cable (9-pin, plug-and-socket)

The key functions

For more information refer to the PROFITOOL Help.

Icon	Function	Menu
	Connect to device	Communication > Connect > Single device
	Change device settings	Active device > Change settings
	Print parameter data set	Active device > Print settings
	Control drive	Active device > Open-loop control > Basic operation modes, no position references
	Digital scope	Active device > Monitoring > Quickly changing digital scope values
	Save settings from device to file	Active device > Save device settings to

Icon	Function	Menu
	Load settings from file into device	Active device > Load device settings from
	Bus initialization (change settings)	Communication > Bus configuration
	Disconnect from device	Communication > Disconnect
	Compare device settings	Active device> Compare settings

Note: For more information refer to the PROFI-Tool Operation Manual.

3.2.1 User screens

ProfiTool Quick access to Set P6000

or from the menu: Active device > Change settings

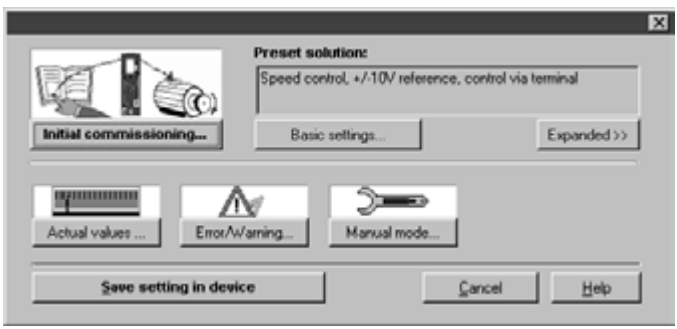


Image 3.2 P6000 setup in minimized view

On the "P6000 setup" screen the position controller parameters can be set.

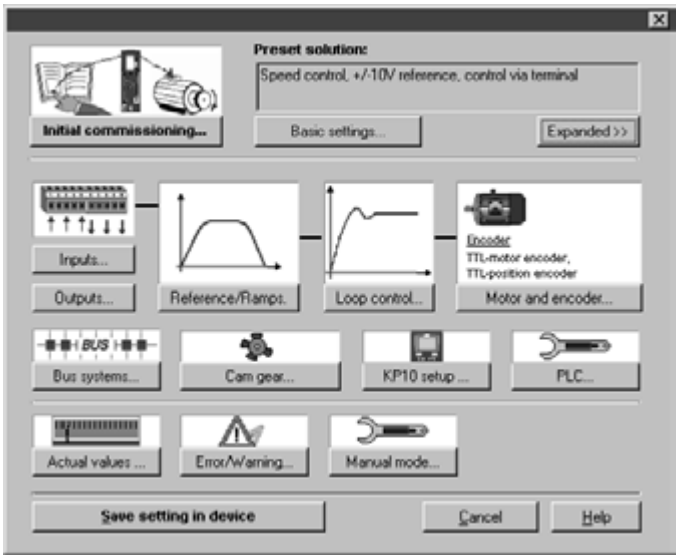


Image 3.3 P6000 setup in expanded view

Note: Any changes to the parameters are effected only in the volatile memory, and must be saved subsequently in the device by way of the **"Save setting in device"** button. The same effect is achieved by simultaneously pressing the two cursor keys on the KP10 control unit for approx. two seconds while at the menu level (see Section 3.3).

Example: Screen operation

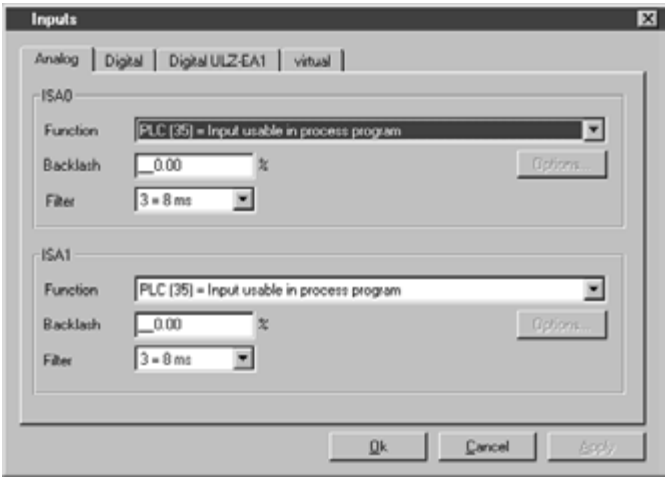


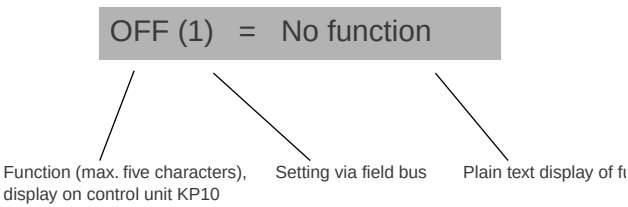
Image 3.4 Example of screen operation

Functions of buttons:

OK	→	Apply change and close screen
Cancel	→	Reject change and close screen
Apply	→	Apply change (activate) and leave screen open
Options	→	Optional settings for the relevant function

Explanation of setting

For example:



Help function

In any input dialog box a Help function providing further information on the parameter can be called up by pressing the **F1** key.

e. g. Function selector analog standard input screen

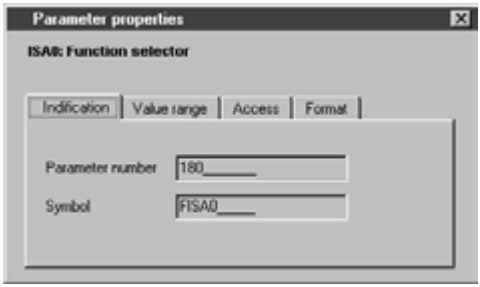


Image 3.5 Identifier

Parameter number:	Number of parameter
Abbreviation:	Name, max. five characters (displayed in KP10)

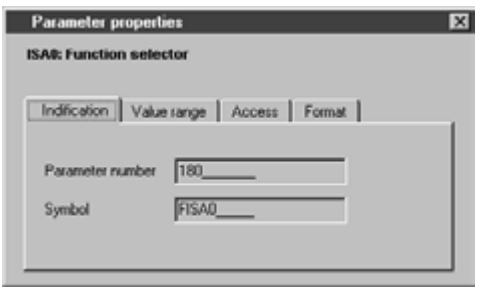


Image 3.6 Value range

Minimum/Maximum:	Value range (here: between OFF and /E-EX).
Factory setting:	After a device reset to factory setting (FS) this value is automatically entered.

3.3 Operation with control unit KP10

Mounting and connection of the control unit

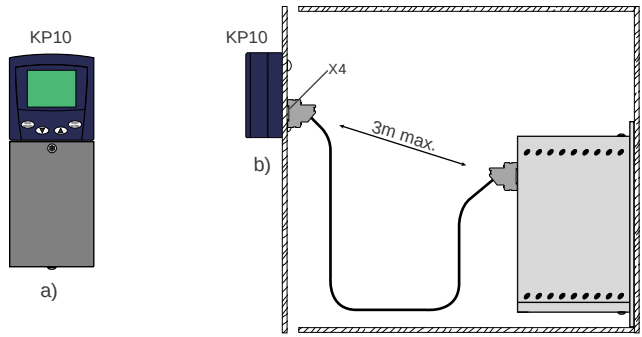
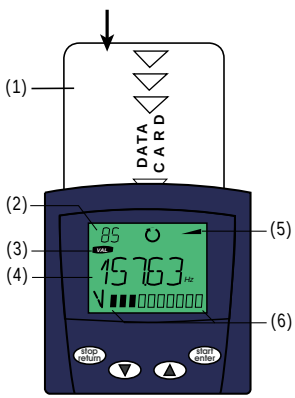


Image 3.7 Mounting of the control unit: a) on position controller P6000 (connector X4) or b) on the cabinet door

Controls and displays



(1) DATACARD chipcard to save and transfer settings

(2) 3-digit display, e. g. for parameter number,

(3) Current menu

(4) 5-digit display for parameter name and value

(5) Acceleration or braking ramp active

(6) Bar graph display, 10-character

start enter — Call up menu branches or parameters; Save changes; Control start in drive

stop return — Quit menu branches; Cancel changes; Control stop in drive

▲ — Select menu, subject area or parameter; Increase setting

▼ — Select menu, subject area or parameter; Reduce setting

Image 3.8 Operating and display elements of the control unit KP10

Menu structure

The KP10 control unit offers a user-friendly menu structure.

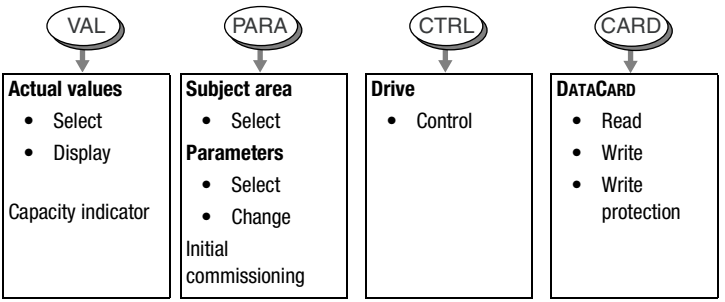


Image 3.9 Menu functions

On the menu level ("MENU" display) you can use the cursor keys to switch between menus. Press the **Start/Enter** key to open a menu and the **Stop/ Return** key to quit the menu.

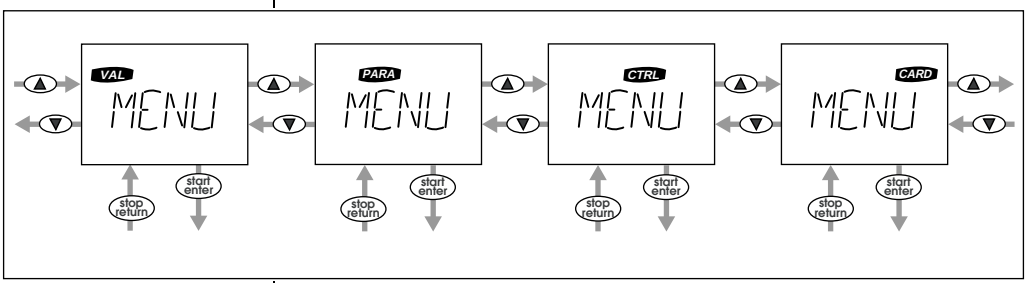
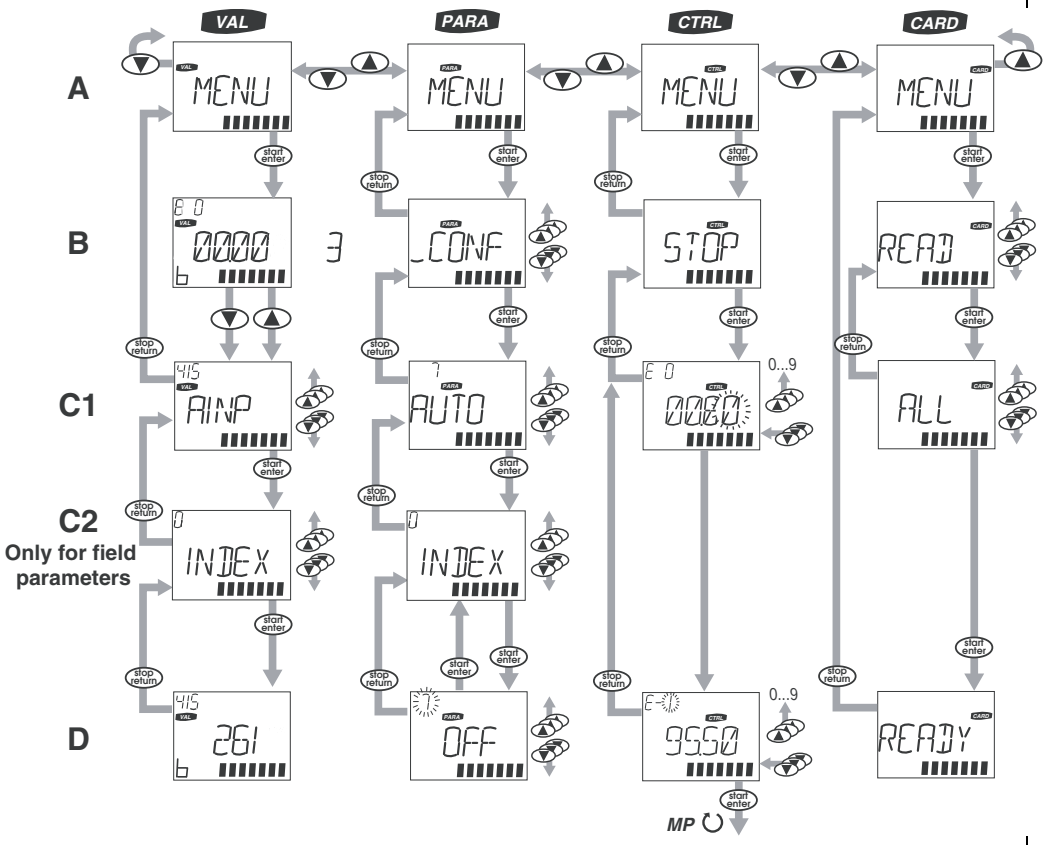


Image 3.10 Navigation at menu level

Note: Any change of parameters in the "PARA" menu branch is made only in the RAM, and at the end must be saved to the ROM. At the menu level, this is done by simultaneously pressing the two cursor keys for approx. 2 seconds.



A	Select VAL menu (display actual values)	Select PARA menu (parameter setting)	Select CTRL menu (control drive)	Select CARD menu (load/save with DATACARD)
W	Display continuous actual value, use cursor key to switch to ...	Select subject area	Drive stopped (where appropriate password prompt with display PASSW, factory setting = no password)	READ = load DC, possible to select individual data sets WRITE = save all data sets to DC LOCK = + write protection UNLOCK = – write protection
C1 **C2**	Next actual value Select parameter index	Select parameter Select parameter index	Enter reference	Select parameter area
D	Display actual value	Display parameter value and change as necessary	Start drive with **Start/Enter**, use cursor keys to change reference value (MP = MOP function)	Function terminated without error

Table 3.2 Menu structure of the KP10 control unit at a glance

Exponential value display

The five-digit parameter value display is in exponential format. The reference input in the CTRL menu is likewise entered and displayed in exponential format.

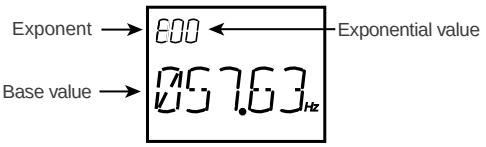


Image 3.11 Exponential representation on the KP10 display

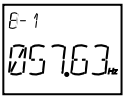
The exponential format is easy to work with if you view the exponential value as a "decimal point shift factor".

Exponential value	Direction of decimal point shift in base value
Positive	to right ⟹ value increases
Negative	to left ⟹ value decreases

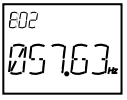
Table 3.3 Exponential value as "decimal point shift factor"

The decimal point is shifted in the base value by the number of places according to the exponential value.

Example:



decimal point shifted by one place to the left
⟹ 57.63 *10^{-1} Hz = 5.763 Hz



decimal point shifted by two places to the right
⟹ 57.63*10^{2} Hz = 5763 Hz

DATACARDS

DATACARDS are written depending on the firmware of the P6000 drive controller. In the event of a firmware upgrade when updating to a new device software version, the upgraded features are automatically saved to the DATACARD during the "WRITE" operation. DATACARDS are always upward-compatible as a result.

3.4 Commissioning

Procedure for commissioning with the aid of the Application Manual

1. Initial commissioning based on Operation Manual:

The precondition is initial commissioning with the aid of the Operation Manual.
The user manual only covers adaptation of the software functions.

If the settings from the initial commissioning based on the Operation Manual are not adequate for your application:

2. Selection of the optimum preset solution

The preset solutions log the typical application cases of the P6000.

The data set which best covers the specific application is selected.

3. Custom adaptation of preset solution to application

The preset solution serves as the starting point for application-oriented adaptation.
Other function adaptations are made to the parameters in the function-oriented subject areas. Save your settings in the device.

4. Checking the set application solution

To preserve the safety of personnel and machinery, the application solution should only be checked at low speed. Make sure the direction of rotation is correct. In case of emergency the inverter power stage can be disabled, and the drive stopped, by removing the ENPO signal.

5. Concluding commissioning

When you have successfully completed commissioning, save your settings (using the DATACARD or ProfiTool) and store the data set in the device.

4 P6000 as speed controller

4.1 Preset solutions

Preset solutions are complete parameter data sets which are provided to handle a wide variety of typical application movement tasks. Setting the preset solution automatically configures the position controller. The parameters are set for the following:

- the control location of the drive controller,
- the reference source,
- the assignment of the inputs and outputs for the signal processing and
- the control mode.

Using an application data set makes commissioning the position controller much quicker and easier. By changing individual parameters, the preset solutions can be adapted to the needs of the specific task.

A total of 11 preset solutions cover the typical areas of application for torque/speed control with the P6000 controller.

Abbreviation	Reference source	Control location / Bus control profile	Section	Additionally required documentation
TCT_1	+/-10V-analog - torque	I/O terminals	4.8.1	
SCT_1	+/-10V-analog	I/O terminals	4.8.1	
SCT_2	Fixed speeds table	I/O terminals	4.5	
SCC_2	Fixed speeds table	CAN_{open} field bus interface - EasyDrive profile "Basic"	4.5	CAN_{open} data transfer protocol
SCB_2	Fixed speeds table	Field bus options module (Profibus) - EasyDrive profile "Basic"	4.5	Profibus data transfer protocol
SCC_3	CAN_{open} field bus interface	CAN_{open} field bus interface - EasyDrive profile "Basic"	4.6	CAN_{open} data transfer protocol
SCB_3	Field bus options module (Profibus)	Field bus options module (Profibus) - EasyDrive profile "Basic"	4.6	Profibus data transfer protocol
SCP_3	PLC	PLC	4.7	PLC-Motion Application Manual
SCT_4	PLC	I/O terminals	4.7	PLC-Motion Application Manual
SCC_4	PLC	CAN_{open} field bus interface - EasyDrive profile "Basic"	4.7	CAN_{open} data transfer protocol
SCB_4	PLC	Field bus options module (Profibus) - EasyDrive profile "Basic"	4.7	Profibus data transfer protocol

Table 4.1 Preset solutions for speed control with P6000

All preset solutions have their own individual basic setting window in the PROFITOOL. Tabs or buttons contained in it are differentiated in general and special functions. The general functions are detailed in section 4.2, and the special functions under the relevant presets in sections 4.4 to 4.7 .

4.2 General functions

4.2.1 Torque/speed profile generator

The speed profile generator generates the appropriate acceleration and deceleration ramps to attain the specified speed reference.

With parameter JTIME linear ramps can be smoothed at the end points to limit jerk.

Movement mode	Setting
dynamic, bucking	JTIME = 0, linear ramps without smoothing
Low impact on mechanism	JTIME ≠ 0, smoothed ramps based on smoothing by x [ms].

Table 4.2 Jerk limitation

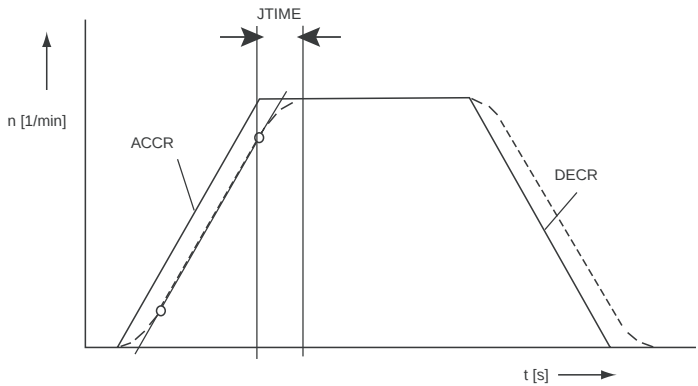


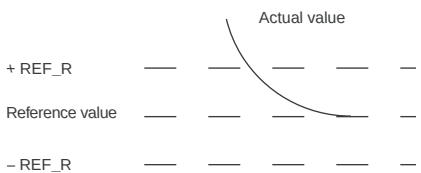
Image 4.1 Speed profile generator

As a result of the jerk limitation the acceleration and deceleration times are increased by the smoothing time JTIME. The speed profile is set in the PROFITOOL as per Image 4.2.

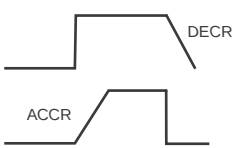
Image 4.2 Speed profile

ProfiTool	Value range	FS	Unit	Parameter
Acceleration	0 ... 32760	0	rpm/s	590_ACCR (_SRAM)
Deceleration	0 ... 32760	0	rpm/s	591_DECR (_SRAM)
Smoothing	0 ... 2000	100	ms	596_JTIME (_SRAM)
"Reference reached" range	0 ... 32760	20	rpm	230_REF_R (_OUT)

With parameter 230-REF_R a speed range can be defined in which the actual value may deviate from the reference without the "Reference reached" (REF) message being deactivated. This allows reference value fluctuations due to reference setting via analog inputs to be taken into account.



The ramp settings can be made independently of each other. A ramp setting of zero signifies reference step.



4.2.2 Limits/stop ramps

These functions are detailed under the general software functions in sections 6.2.2 and 6.2.3.

4.3 Torque control with reference via analog input

With preset solution TCT_1, the scaleable torque reference is set via analog input ISA0. For further information see section 6.1.2.

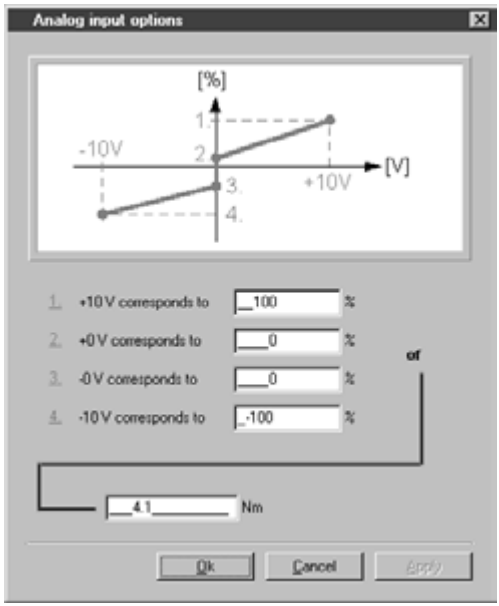


Image 4.3 Torque control setting

4.4 Speed control with reference via analog input

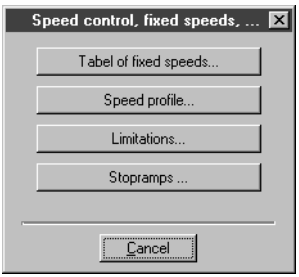
With preset solution SCT_1, the scaleable speed reference is set via analog input ISA0.

see Section 6.1.2
see Section 4.2.1
see Section 6.2.2
see Section 6.2.3

Image 4.4 Basic setting: "speed control, +/-10V reference"

4.5 Speed control with reference from fixed speeds table

The fixed speeds table is the reference source for preset solutions SCT_2, SCC_2 and SCB_2. There are 16 driving sets (0-15), displayed and entered on the "Fixed speeds" screen Image 4.6. The specific settings of the inputs and outputs for the control locations via I/O terminals (SCT_2), CANopen (SCC_2) or Profibus (SCB_2) are set out in section 4.8.



see Section 4.2.1
see Section 6.2.2
see Section 6.2.3

Image 4.5 Basic setting: "speed control, fixed speeds"

Fixed speeds table L

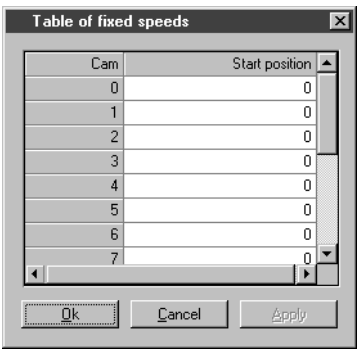


Image 4.6 "Fixed speeds" screen

ProfiTool	Value range	FS	Unit	Parameters
Speed	-32764.0 ... 32764.0	0.0	rpm	269.x-RTAB (_RTAB) x = fixed speed 0-15

The speed profile is the same for all fixed speeds. A variable speed profile dependent on the speed can be implemented with a PLC program. For an example see section 7.6.4.

Fixed speed selection

The fixed speeds can be selected via terminals or field bus. The number of the active fixed speed is displayed in a parameter, and binary coded via the outputs (if the parameters are set).

The inputs for fixed speed selection are configured with FIxxx = TABx. The selection is made in binary coded format.

The binary significance (2^0, 2^1 , 2^2 , 2^3) is produced from the TABx assignment. The setting TAB0 has the lowest significance (2^0), and TAB3 the highest (2^3). A logical-1 level at the input activates the significance. A new fixed speed is activated when the status of the terminal changes.

Examples:

IE07	IE06	IE05	IE04	IE03	IE02	IE01	IE00	IS03	IS02	IS01	IS00	**Selectable driving sets**
	TAB3 = 2^3	TAB2 = 2^2	TAB1 = 2^1	TAB0 = 2^0								0-15
			TAB1 = 2^1			TAB0 = 2^0				TAB3 = 2^3		0-3, 8-11

Table 4.3 Examples of fixed speed selection via terminal

To select and display the active driving set the following parameters are used:

ProfiTool	Meaning	Value range	FS	Unit	Parameter
-	Selection of driving set fixed speed. Selection via inputs is written to this parameter. Field bus: Selection of table set	0 - 15	0	-	278-TIDX (_RTAB)
-	Display parameter Displays the current selected fixed speed.	0-15	0	-	776-ATIDX (_RTAB)

By way of the STOP logic (feed hold) (terminal or bus) an ongoing positioning action can be stopped and resumed with the programmed speed profile

4.6 Speed control with reference and control via field bus

For preset solutions SCC_3 and SCB_3 the field bus is preset as the reference source. The specific settings of the inputs and outputs for the control locations CAN_{open} (SCC_3) and Profibus (SCB_3) are set out in section 4.8.1.

The reference input for speed control is entered either via the internal CAN_{open} field bus interface in the device (SCC_3) or via the Profibus option module (SCB_3).

see Section 4.2.1
see Section 6.2.2
see Section 6.2.3

Image 4.7 Basic setting: "speed control, reference and control via bus"

4.6.1 CAN_{open}

By way of the internal isolated CAN_{open} interface X5 in the device the drive controller is integrated into the automation network.

Communication is based on profile DS301. The control and target positioning is based on the proprietary EasyDrive profile "Basic".

If speed control conforming to DSP402 is required, the **Profile-Velocity mode** should be used to control the speed of the drive. This mode represents a special form of positioning. For it, please select the preset *"PCC_1-Positioning, driving set input and control via CAN bus".*

You will find detailed information on network configuration of the drive controller in the separate "CAN_{open} data transfer protocol" document.

4.6.2 Profibus

For driving set input and control via Profibus the external communication module ULZ-DPV1 is required.

The control and positioning is based on the EasyDrive profile "DirectPos".

You will find detailed information on network configuration of the drive controller in the separate "Profibus data transfer protocol" document.

4.7 Speed control with reference via PLC

The PLC is set as the reference source for preset solutions SCP_3, SCT_4 SCC_4 and SCB_4. The specific settings for the control locations I/O terminals (SCT_4), CAN_{open} (SCC_4) and Profibus (SCB_4) are set out in section 4.8.

see PLC-Motion Application Manual

see Section 4.2.1

see Section 6.2.2

see Section 6.2.3

Image 4.8 Basic setting: "speed control with PLC"

For these presets the speed reference is set by way of the command SET REFVAL = [x]. If the control location is also set to PLC (SCP_3), the command SET ENCTRL = 0/1 can be used to activate or deactivate control.

Note: For detailed information on use of the PLC and on programming and operation with the PLC Editor see Section 7 "User programming".

4.8 Control location for presets

The control location for speed control (I/O terminals, CAN_{open}, Profibus or PLC) is configured according to the selected preset solution. Control requires special control and status information via the field bus as well as an appropriate terminal assignment.

4.8.1 Terminal assignment

Depending on the selected preset, the input and output parameters are changed relative to the factor setting - see Table 4.4. Once the preset has been selected the terminal parameter setting can be adapted as required to the application.

I/O	Parameters	Function	152-ASTER						
			TCT_1 SCT_1 (FS)	SCT_2	SCC_2 SCB_2	SCC_3 SCB_3	SCP_3	SCT_4	SCC_4 SCB_4
ISA00	180-FISA0	Function selector analog standard input ISA00	PM10V	OFF	OFF	OFF	PLC	PLC	PLC
ISA01	181-FISA1	Function selector analog standard input ISA01	OFF				PLC	PLC	PLC
ISD00	210-FIS00	Function selector digital standard input ISD00	START		OFF	OFF	PLC		PLC
ISD01	211-FIS01	Function selector digital standard input ISD01	OFF				PLC	PLC	PLC
ISD02	212-FIS02	Function selector digital standard input ISD02	OFF	TAB0			PLC	PLC	PLC
ISD03	213-FIS03	Function selector digital standard input ISD03	OFF	TAB1			PLC	PLC	PLC
OSA00	200-FOSA0	Function selector for analog output OSA00	ACTN				PLC	PLC	PLC
OSD00	240-FOS00	Function selector digital standard output OSD00	REF						
OSD01	241-FOS01	Function selector digital standard output OSD01	ROT_0						
OSD02	242-FOS02	Function selector digital standard output OSD02	S_RDY						

Table 4.4 Presetting of control inputs and outputs in speed control

4.8.2 Field bus control

If a drive is controlled via field bus and the driving set is specified from a different source (e.g. driving set table or PLC), special proprietary bus control and status words are used. They are listed in Table 4.5.

Reference source	Field bus profile
Fixed speeds table	EasyDrive profile "Basic"
PLC	EasyDrive profile "PLCPos"

Table 4.5 Field bus control profiles

You will find detailed information on network configuration of the drive controller in the relevant "Profibus data transfer protocol" or "CAN_{open} data transfer protocol" document.

5 P6000 as position controller

5.1 Preset solutions

Preset solutions are complete parameter data sets which are provided to handle a wide variety of typical application movement tasks.

Loading a preset solution into the RAM automatically configures the position controller. The parameters are set for the following:

- the control location of the drive controller,
- the reference source,
- the assignment of the inputs and outputs for the signal processing and
- the control mode.

Using an application data set makes commissioning the position controller much quicker and easier. By changing individual parameters, the preset solutions can be adapted to the needs of the specific task. These modified preset solutions are stored in the device as customer-specific data sets. In this way, you can arrive more rapidly at your desired movement solution.

A total of nine preset solutions cover the typical areas of application for positioning with the P6000 controller.

Abbreviation	Reference source	Control location / Bus control profile	Section	Additionally required documentation
PCT_2	Tables driving set	I/O terminals	5.3	-
PCC_2	Tables driving set	CAN_{open} field bus interface - EasyDrive profile "TabPos"	5.3	CAN_{open} data transfer protocol
PCB_2	Tables driving set	Field bus options module (Profibus) - EasyDrive profile "TabPos"	5.3	Profibus data transfer protocol
PCC_1	CAN_{open} field bus interface	CAN_{open} field bus interface - DSP402-profile position mode - DSP402-profile velocity mode	5.4	CAN_{open} data transfer protocol
PCB_1	Field bus options module (Profibus)	Field bus options module (Profibus) - EasyDrive profile "DirectPos"	5.4	Profibus data transfer protocol
PCP_1	PLC	PLC	5.5	PLC-Motion Application Manual
PCT_3	PLC	I/O terminals	5.5	PLC-Motion Application Manual
PCC_3	PLC	CAN_{open} field bus interface - EasyDrive profile "PlcPos"	5.5	CAN_{open} data transfer protocol
PCB_3	PLC	Field bus options module (Profibus) - EasyDrive profile "PlcPos"	5.5	Profibus data transfer protocol

Table 5.1 Preset solutions for positioning with P6000

All preset solutions have their own individual basic setting window in the PROFITOOL. Tabs or buttons contained in it are differentiated in general and special functions. The general functions are listed in section 5.2.

The special functions, i.e. the reference sources of the respective presets, are detailed in sections 5.3 to 5.5 .

In section 5.6 the properties of the control location and the device control, including the terminal assignment, are defined.

Note: Following selection of the preset solution, the units and the scaling of the drive must first be set, as described in section 5.2.1. They form the basis for all subsequent settings.

5.2 General functions

Choosing the "Basic settings" option button on the PROFITOOL opens up the window:

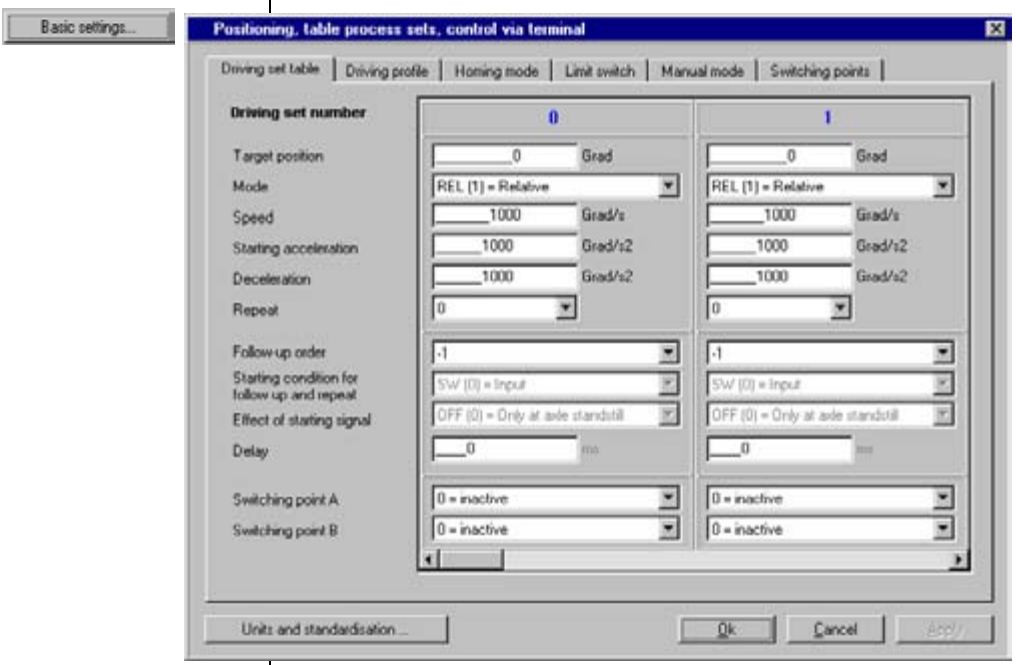


Image 5.1 Preset solution "Positioning..."

This section details the functions (buttons and tabs):

- Units and scaling
- Driving profile
- Referencing
- Limit switches
- Manual mode

5.2.1 Units and scaling

Note: Following selection of the preset solution, the units and the scaling of the drive must first be set. They form the basis for all subsequent settings. These settings can only be made by way of the PROFITOOL.

1.

Units

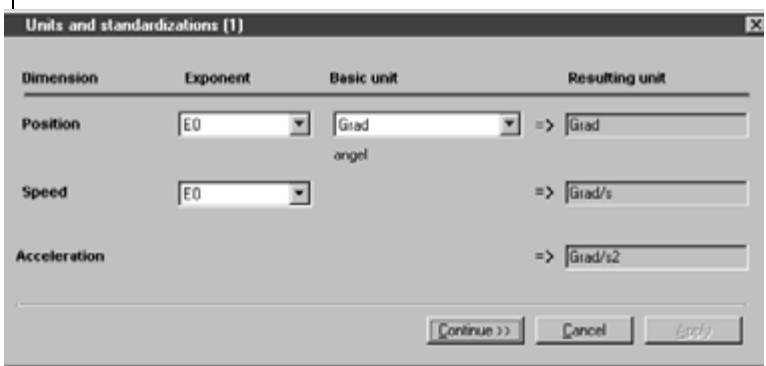
For positioning, the units for the position, velocity and acceleration can be set. Unless otherwise stipulated, all positioning parameters are based on those units. The following basic units can be preset:

- Translational unit: m
- Rotational unit: degrees, rev, rad, sec, min
- Special units Incr, Steps
- Unit with user-defined text (max. 20 characters): User

The time base of the velocity is automatically set to [Exp*distance unit]/s, and that of the accelerations to [Exp*distance unit]/s^2.

All parameters are integers. No floating-point settings can be made. If it is necessary to enter a lower value than is possible with the basic unit, it is set with the units exponents for the position and velocity/acceleration. Then the basic unit (e.g. [m]) and exponent (e.g. E-2) produce the resultant unit (e.g. [cm]).

Units and standardisation ...



The parameters for the resultant units are:

ProfiTool	Value range	FS	Unit	Parameter
Position	-	degrees	variable	792_FGPUN (_FG)
Velocity	-	degrees/s	variable	793_FGVUN (_FG)
Acceleration	-	degrees/s2	variable	796_FGAUN (_FG)

Following definition of the units the mechanical drive variables are entered.

Feed constant and gearing factor

2.

Continue >>

The feed constant translates the preset distance unit into revolutions of the output shaft. It is also possible to enter the gear transmission ratio in fractions. This ensures that the position on the output shaft is at all times converted onto the motor shaft with no rounding error.

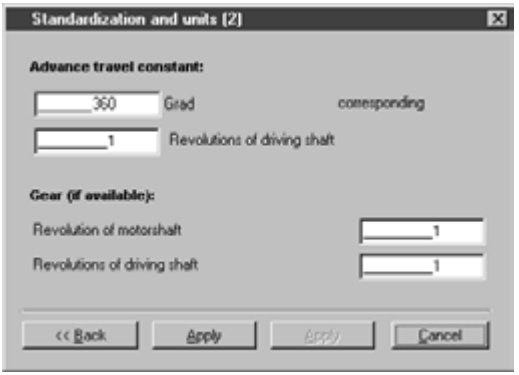


Image 5.2 Settings for units and scaling

ProfiTool	Value range	FS	Unit	Parameter
Feed constant / distance for n revolutions	0 ... 4294967295	360	variable	789.0_FGFC (_FG)
Feed constant / revolutions of output shaft	0 ... 4294967295	1	-	789.1_FGFC (_FG)
Gearing/ revolution of motor shaft	0 ... 4294967295	1	-	788.0_FGGR (_FG)
Gearing/ revolutions of output shaft	0 ... 4294967295	1	-	788.1_FGGR (_FG)

Apply

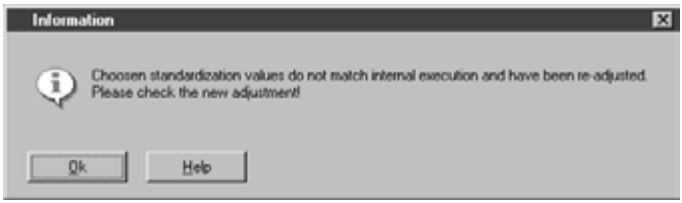
Following input of the parameters choose "Finished" to check the settings. Choose the "Back" button to return to the unit input.

3.

Checking settings

The settings for the units and scaling are checked for plausibility and device-internal value ranges and applied.

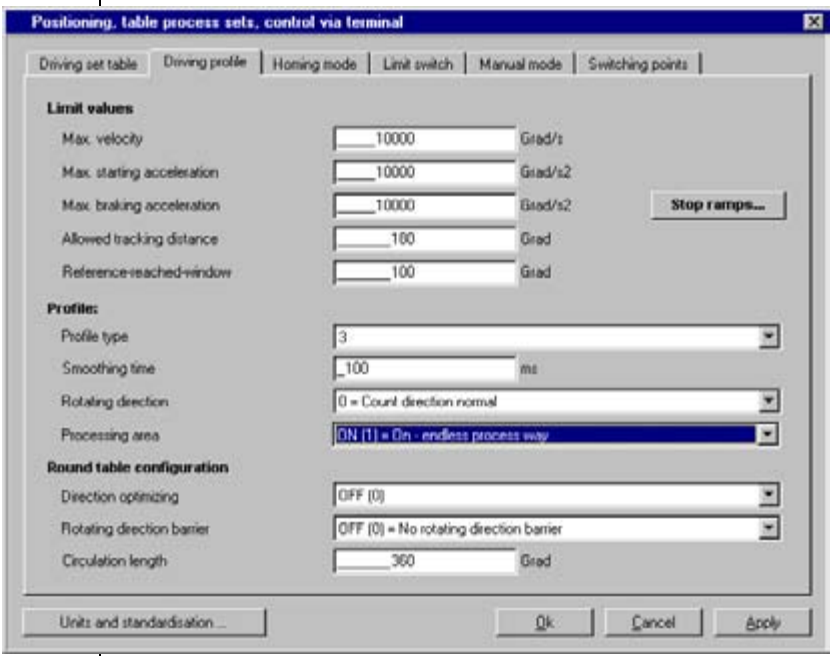
In rare cases the message appears:



Colliding value ranges or scalings in the controller. The Units and Scaling wizard then suggests a different power or exponent for the units and prompts you to check, accept or edit them in the Units window, which is accessed directly when you click OK. If the new setting is accepted, the feed constant is also adapted.

5.2.2 Driving profile

In this screen the limit values for the driving set, the profile form and the indexing table setup are configured. The units have already been defined, see Section 5.2.1.



Limit values of driving set:

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Max. Velocity	Maximum velocity of driving set. All velocities are limited to it.	0 ... 4294967295	10000	variable	724_POSMX (_PRAM)
Max. startup acceleration	Maximum startup acceleration of positioning set	0 ... 4294967295	10000	variable	722_POACC (_PRAM)
Max. braking acceleration	Maximum braking acceleration of positioning set	0 ... 4294967295	10000	variable	723_PODEC (_PRAM)
Permissible lag distance	Max. difference between reference and actual position of profile generator. If the maximum is exceeded the error response E-FLW is executed (see Section 6.9)	0 ... 4294967295	180	variable	PODMX (_PBAS)
Reference-reached window	Hysteresis for the target position for display of the status "Target position reached". If the actual position is in this window the status is set to 1.	0 ... 4294967295	10	variable	POWIN (_PBAS)

Table 5.2 Driving profile - basic settings

Profile

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Profile type	0: Linear acceleration profile, i.e. no jerk limitation 3: Jerk-limited acceleration profile with programmed smoothing time 596-JTIME 1,2: no function	0 - 3	0	-	597-MPTYP (_SRAM)
Smoothing time with jerk limitation	The run-up and run-down time increases by the smoothing time. This limits the jerking.	0 - 2000	100	ms	596-JTIME (SRAM)
Direction of rotation	0: Normal - positive position values = motor rotates clockwise 1: Inverted - positive position values = motor rotates anti-clockwise NOT IMPLEMENTED	0 / 1	0	-	795-FGPOL (_FG)
Positioning range	OFF (0): limited travel, e.g. for linear axes ON (1): infinite travel, e.g. for circular axes. A rotation must be defined. Further settings are made in configuration of the indexing table.	OFF / ON	OFF		773-PORTA (_PBAS)

Indexing table configuration

With an infinite positioning range further detailed settings can be made.

ProfiTool	Meaning	Value range	FS	Parameter
Directional optimization	OFF (0) ON (1) For further explanation see below	OFF... ON	OFF	775_PODOP (_PBAS)
Direction block	OFF (0): No directional block POS (1:) Positive direction blocked NEG (2): Negative direction blocked For further explanation see below	OFF ... NEG	OFF	308_DLOCK (_CTRL)
Rotation	The rotation specifies the position range. Then (in event of overflow) the count resumes at 0.	0 ... 4294967295	360	774_PONAR (_PBAS)

With active directional optimization the destination is always approached by the shortest route.

Example: a rotation of 360 degrees is defined; the axle is positioned at 270 degrees. When a new position of 10 degrees is entered the axle is moved in positive to within 10 degrees, as that is the shortest distance with relative 100 degrees. With the optimization function inactive the axle would be moved in negative direction (relative travel 260 degrees).

A directional block always has priority in indexing table configuration. If, in the above example, the positive direction was blocked, the axle would be moved in negative direction despite the directional optimization being active.

5.2.3 Referencing

The reference run is used to establish an absolute position (referred to the overall axle) and must usually be performed once after power-on. A reference run is necessary when absolute positioning operations are executed without a multi-turn encoder. In all other positioning operations (relative, infinite) no referencing is necessary. There are 40 different types, which can be preset according to application.

By the selection of a reference run (type -4 to 35) and input of the settings:

- the reference signal (positive limit switch, negative limit switch, reference cam)
- the direction of actuation and
- the position of the zero pulse

are defined. The sequence of the referencing corresponds to the graphically represented reference run type.

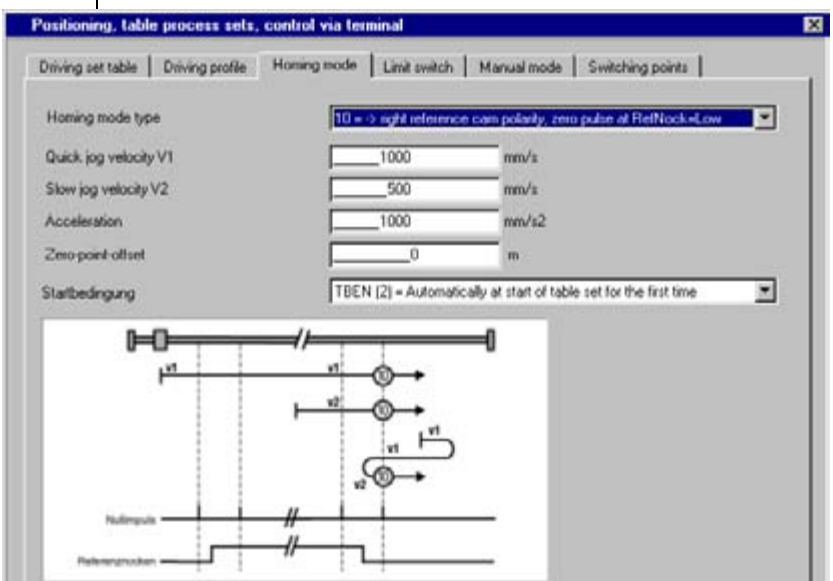


Image 5.3 Reference run selection window

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Reference run type	The reference run type specifies the event to set the reference point. For further explanatory notes see below	-4 ... 35	-1		730_HOMDT (_HOM)
Quick jog speed V1	Reference run speed until first referencing event (reference cam, zero pulse)	0 ... 4294967295	20	degrees/s	727_HOSPD (_HOM)
Slow jog speed V2	Reference run speed as from first event for slow approach to the referencing position	0 ... 4294967295	20	degrees/s	727_HOSPD (_HOM)
Acceleration	Acceleration over the entire reference run	0 ... 4294967295	10	degrees/s^2	728_HOACC (_HOM)
Zero offset	The reference point is always set with the zero offset.	-2147483648 ... 2147483647	0	degrees	729_HOOFF (_HOM)
Start condition	Start condition for reference run. For further explanatory notes see below.	OFF ... TBEN	OFF		731_HOAUT (_HOM)

Table 5.3 Reference run settings

Start reference run

The start conditions are programmable.

BUS	Setting	Effect
0	OFF	The reference run is started on request via - field bus (DSP402 Homing mode or EasyDrive control word), - terminal (ISxx=HOMST) or - PLC (command G0 0) Referencing is started in response to every request.
1	AUTO	Referencing is executed once automatically the first time loop control is started. If the referencing conditions remain operative at further control starts, no more referencing is executed.
2	TBEN	Applicable only in case of positioning with table driving sets. Referencing is executed once automatically the first time a driving set is selected. If the referencing conditions remain operative when other driving sets are selected, no more referencing is executed.

The various types are detailed in the following. The individual reference points, corresponding to the zero, are numbered in the graphics. The different velocities (v1-quick jog, v2-slow jog) and the directions of movement are also shown.

The four information sources for the reference signal are:

- Negative (left-hand) hardware limit switch
- Positive (right-hand) hardware limit switch
- Reference cam
- Zero pulse of encoder

Type -4, Operative referencing, neg. reference cam

As reference run type 22, with subsequent facility for continuous referencing. For further explanatory notes see "Type -3".

Type -3, Operative referencing, pos. reference cam

As reference run type 20, with subsequent facility for continuous referencing.

Types "-3" and "-4" are usable only in the case of infinite travel ranges (773-PORTA=ON). They are used for fully automated compensation of slip or an inexact transmission ratio. Following the first reference run the actual position is overwritten with the zero offset (729-HOOFF) on every rising edge of the reference switch. The remaining travel is corrected, so the axle is able to execute any number of relative movements in one direction without drifting, even on slipping drives.

The rotation (774-PONAR) must correspond as closely as possible to the distance between two reference signals. In other words: the same position must be displayed again after one rotation, for example; otherwise disturbing movements may occur during a correction. The permissible lag distance (757-PODMX) must be greater than the maximum mechanical inaccuracy.

Type -2, No referencing

No referencing, e.g. when using multi-turn encoders

No reference run is carried out.

Type -1, Actual position = 0

The current actual position corresponds to the zero; it is set as 0, i.e. the controller performs a reset of the actual position. A zero offset is added on.

Type 0

Not defined.

Type 1, Negative limit switch and zero pulse

The initial movement, as per Image 5.4, is in the direction of the negative (left-hand) hardware limit switch (which is inactive) and the direction is reversed when an edge is active. The first zero pulse after a falling edge corresponds to the zero point.

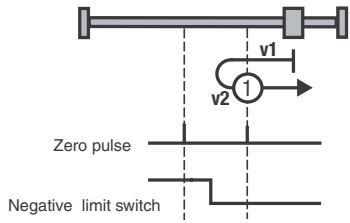


Image 5.4 Type 1, Negative limit switch and zero pulse

Type 2, Positive limit switch and zero pulse

The initial movement, as per Image 5.5 , is in the direction of the positive (right-hand) hardware limit switch (which is inactive) and the direction is reversed when an edge is active. The first zero pulse after a falling edge corresponds to the zero point.

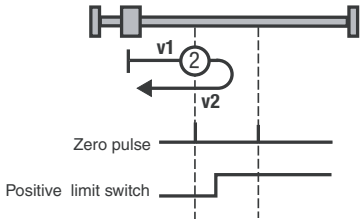


Image 5.5 Type 2, Positive limit switch and zero pulse

Type 3+4, Positive reference cam and zero pulse

The initial movement, as per Image 5.6, is in the direction of the positive (right-hand) hardware limit switch, if the reference cam is inactive. See symbol A in Image 5.6:

With type 3, as soon as the reference cam is active the direction is reversed.

The first zero pulse after a falling edge corresponds to the zero point. With type 4, the first zero pulse after a rising edge corresponds to the zero point.

The initial movement is in the direction of the negative (left-hand) hardware limit switch, and the reference cam is active. See symbol B in Image 5.6:

If the reference cam becomes inactive, with type 3 the first zero pulse corresponds to the zero point. With type 4, the direction changes as soon as the reference cam becomes inactive. The first zero pulse after a rising edge corresponds to the zero point.

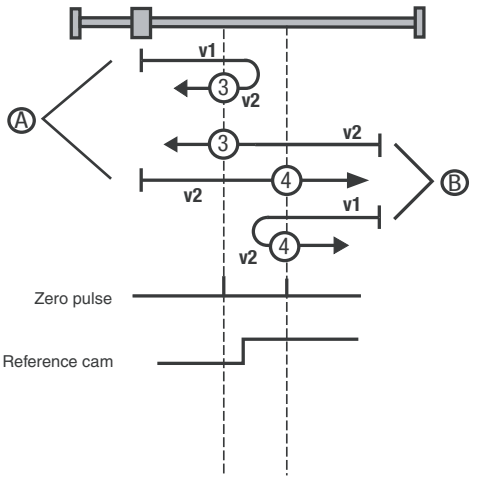


Image 5.6 Type 3+4, Positive reference cam and zero pulse

Type 5+6, Negative reference cam and zero pulse

The initial movement is in the direction of the positive (right-hand) hardware limit switch, and the reference cam is active. See symbol A in Image 5.7:

With type 5, the first zero pulse after a falling edge corresponds to the zero point. With type 6, if the reference cam becomes inactive the direction is reversed and the first zero pulse after a rising edge corresponds to the zero point.

The initial movement is in the direction of the negative (left-hand) hardware limit switch, and the reference cam is inactive. See symbol B in Image 5.7:

With type 5, the direction changes as soon as the reference cam becomes active and the first zero pulse after a falling edge corresponds to the zero point. With type 6, the first zero pulse after a rising edge corresponds to the zero point.

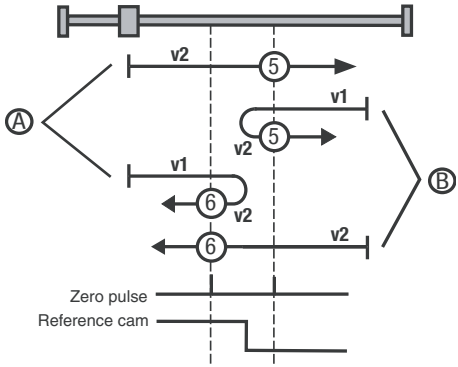


Image 5.7 Type 5+6, Negative reference cam and zero pulse

Type 7 to 10, Reference cam, zero pulse and positive limit switch

The initial movement is in the direction of the positive (right-hand) hardware limit switch. It and the reference cam are inactive. See symbol A in Image 5.8:

Type 7 changes the direction of movement after an active reference cam. The zero corresponds to the first zero pulse after a falling edge. With type 8, the zero corresponds to the first zero pulse with an active reference cam. Type 9 changes the direction of movement when the reference cam has been passed. The zero corresponds to the first zero pulse after a rising edge. With type 10, the reference cam is passed and the first zero pulse thereafter corresponds to the zero point.

The initial movement is in the direction of the negative (left-hand) hardware limit switch. The positive limit switch is inactive and the reference cam is active. See symbol B in Image 5.8:

With type 7, the zero point is at the first zero pulse after a falling edge of the reference cam. Type 8 changes the direction of movement after a falling edge of the reference cam. The zero corresponds to the first zero pulse after a rising edge of the reference cam.

The initial movement is in the direction of the positive (right-hand) hardware limit switch. It is inactive and the reference cam is active. See symbol C in Image 5.8:

Type 9 changes the direction of movement when the reference cam becomes inactive. The zero corresponds to the first zero pulse after a rising edge. With type 10, after a rising edge of the reference cam the first zero pulse is the zero point.

The initial movement is in the direction of the positive (right-hand) hardware limit switch. It and the reference cam are inactive. As soon as the positive limit switch becomes active the direction changes. See symbol D in Image 5.8:

With type 7, the first zero pulse after the reference cam has been passed corresponds to the zero point.
Type 8 changes the direction of movement when the reference cam has been passed. The zero corresponds to the first zero pulse after a rising edge. With type 9, the zero corresponds to the first zero pulse with an active reference cam. Type 10 changes the direction of movement after an active reference cam. The zero corresponds to the first zero pulse after a falling edge.

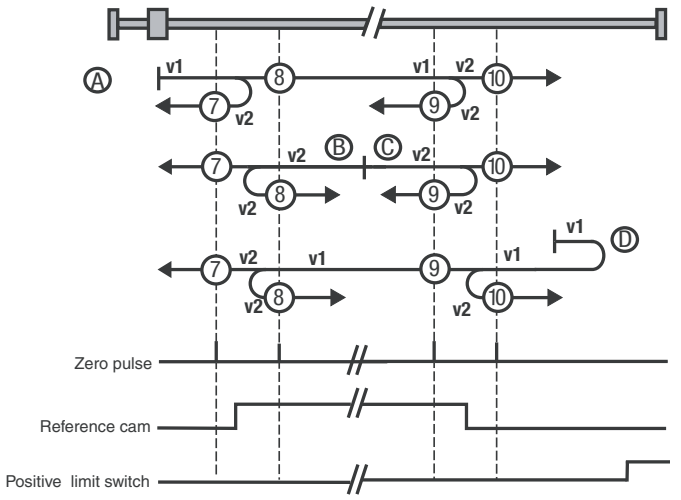


Image 5.8 Type 7 to 10, Reference cam, zero pulse and positive limit switch

Type 11 to 14, Reference cam, zero pulse and negative limit switch

The initial movement is in the direction of the negative (left-hand) hardware limit switch. It and the reference cam are inactive. See symbol A in Image 5.9:

Type 11 changes the direction of movement after an active reference cam. The zero corresponds to the first zero pulse after a falling edge. With type 12, the zero corresponds to the first zero pulse with an active reference cam. Type 13 changes the direction of movement when the reference cam has been passed. The zero corresponds to the first zero pulse after a rising edge. With type 14, the reference cam is passed and the first zero pulse thereafter corresponds to the zero point.

The initial movement is in the direction of the negative (left-hand) hardware limit switch. It is inactive and the reference cam is active. See symbol B in Image 5.9:

Type 13 changes the direction of movement when the reference cam becomes inactive. The zero corresponds to the first zero pulse after a rising edge. With type 14, after a falling edge of the reference cam the first zero pulse is the zero point.

The initial movement is in the direction of the positive (right-hand) hardware limit switch. The negative limit switch is inactive and the reference cam is active. See symbol C in Image 5.9:

With type 11, the zero point is at the first zero pulse after a falling edge of the reference cam. Type 12 changes the direction of movement after a falling edge of the reference cam. The zero corresponds to the first zero pulse after a rising edge of the reference cam.

The initial movement is in the direction of the negative (left-hand) hardware limit switch. It and the reference cam are inactive. As soon as the negative limit switch becomes active the direction changes. See symbol D in Image 5.9:

With type 11 the reference cam must have been passed. Then the first zero pulse corresponds to the zero point. Type 12 changes the direction of movement when the reference cam has been passed. The zero corresponds to the first zero pulse after a rising edge. With type 13, the zero corresponds to the first zero pulse with an active reference cam. Type 14 changes the direction of movement after an active reference cam. The zero corresponds to the first zero pulse after a falling edge.

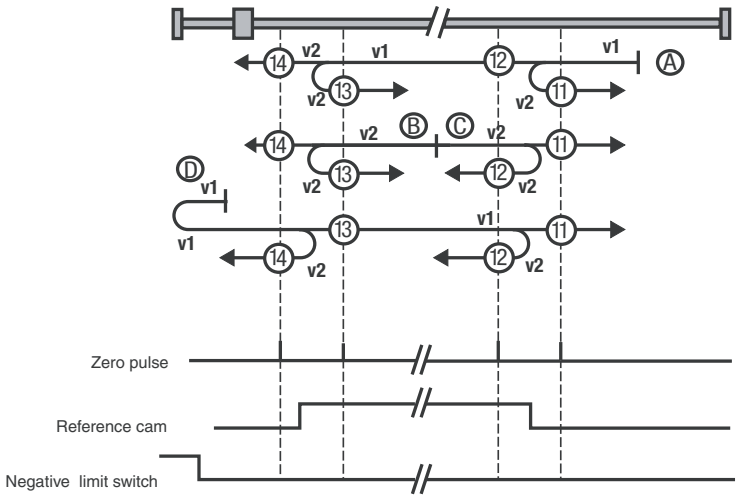


Image 5.9 Type 11 to 14, Reference cam, zero pulse and negative limit switch

Types 15 and 16

These reference runs are not defined.

Type 17 to 30, Reference cam

Reference run types 17 to 30 are similar to types 1 to 14. The determination of the zero point is not dependent on the zero pulse, but merely on the reference cam or the limit switches.

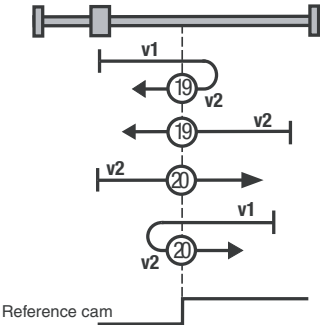


Image 5.10 Type 17 to 30, Reference cam

Type 1	Type 17
Type 4	Type 20
Type 8	Type 24
Type 12	Type 28
Type 14	Type 30

Table 5.4 Type matching of the individual reference runs

Types 31 and 32

These reference runs are not defined.

Types 33 and 34, Zero pulse

The zero corresponds to the first zero pulse in the direction of movement.

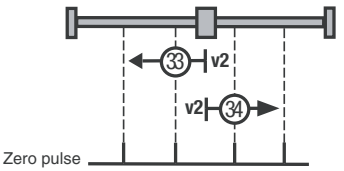


Image 5.11 Types 33 and 34, Zero pulse

Type 35

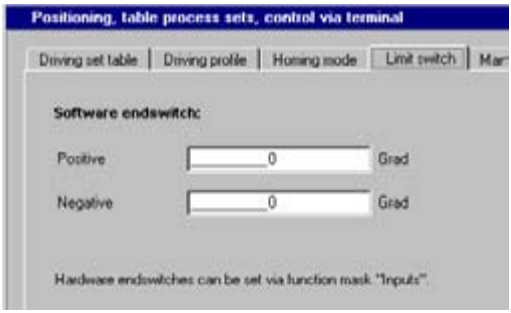
The current actual position corresponds to the zero point. No reset is performed.

5.2.4 Limit switches

Software limit switches

The software limit switches are only applicable to positioning. They only become active once referencing has been successfully completed.

The software limit switches are deactivated by setting them equal (limit switch+ = limit switch– = 0) .



ProfiTool	Meaning	Value range	FS	Unit	Parameter
Positive	Software limit switch in positive direction of rotation	-2147483648 ... 2147483647	0	variable	759-SWLSP (_PBAS)
Negative	Software limit switch in negative direction of rotation	-2147483648 ... 2147483647	0	variable	760-SWLSN (_PBAS)

The behaviour/response is dependent on the configured error response (see Section 6.9) and on the positioning mode.

Positioning mode	Behaviour/response
Absolute	Before an absolute driving job is enabled a check is made whether the destination is within the valid range - that is, inside the software limit switches. If the destination is outside, no driving job is sent and the programmed error response as per 543-R-SWL is executed.
Relative	
Infinite (velocity-controlled)	The drive moves until a software limit switch is detected. Then the programmed error response as per 543-R-SWL is executed. In response to R-SWL=NOERR or WARN, too, an emergency stop is executed.

Table 5.5 Response of software limit switches

Hardware limit switches

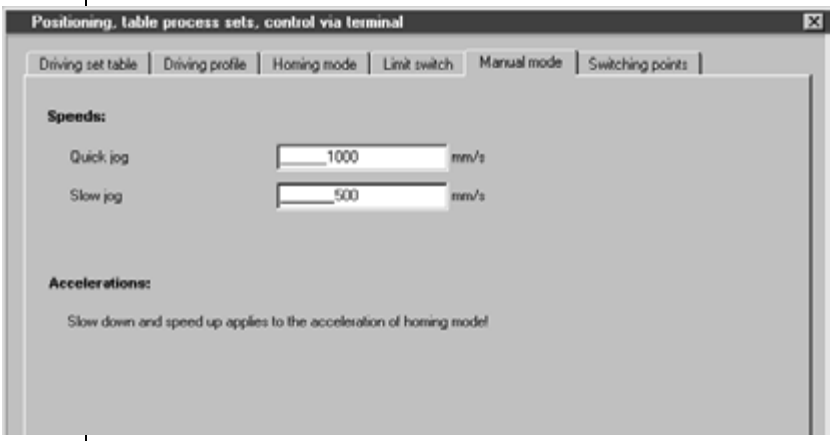
The hardware limit switches are applicable to all control modes.

The hardware limit switches are connected via inputs of the drive controller. For this, two inputs need to be configured as described in section 6.1.1.

5.2.5 Manual mode / Jog mode

Jog mode is only applicable to positioning. When jog mode is active the drive is operated in velocity-controlled mode (infinite).

For manual mode two jog speeds can be set. They can be activated by way of the ProfiTool Manual Mode window or via terminal and field bus. The precondition for their activation is that the drive is stopped.



ProfiTool	Value range	FS	Unit	Parameter
Velocity Quick jog	0 ... 4294967295	1000	variable	721_VQJOG (_PRAM)
Velocity Slow jog	0 ... 4294967295	500	variable	720_VSJOG (_PRAM)

Job mode via terminal or field bus

In jog mode the drive is controlled either in positive or negative direction by way of two signals and two inputs. If one of the signals is active and loop control is active, the drive moves in slow jog mode. Quick jog is activated by additionally actuating the second jog input while in slow jog mode.

5.3 Positioning with table driving sets

For preset solutions PCT_2, PCC_2 and PCB_2 the driving set table is set as the reference source. The specific settings for open-loop control via I/O terminals or field bus are set out in section 5.6.

5.3.1 Driving set table

There are 16 driving sets (0-15). A driving set comprises:

1. Target position
2. Mode for absolute/relative/infinite positioning
3. Velocity
4. Startup acceleration
5. Braking acceleration
6. Downstream job with programmable condition
7. Driving set dependent switching points, see Section 5.3.2

For jerk limitation there is a smoothing time in ms, programmable in the driving profile. It applies to all driving sets. The driving sets can only be programmed by way of the PROFITOOL PC user interface or via field bus.

Note: The driving sets have the pre-defined standard units. Consequently, prior to setting the driving set parameters the units and scaling must first be set - see Section 5.2.1.

Driving set selection

The driving sets can be selected and activated via terminals or field bus. The number of the active driving set is displayed in a parameter, and binary coded via the outputs (if the parameters are set).

The inputs for driving set selection are configured with FIxxx = TABx - see example in Table 5.6. The selection is made in binary coded format.

The binary significance (2^0, 2^1, 2^2, 2^3) is produced from the TABx assignment. The setting TAB0 has the lowest significance (2^0), and TAB3 the highest (2^3). A logical-1 level at the input activates the significance.

Examples:

IE07	IE06	IE05	IE04	IE03	IE02	IE01	IE00	IS03	IS02	IS01	IS00	**Selectable driving sets**
	TAB3 = 2^3	TAB2 = 2^2	TAB1 = 2^1	TAB0 = 2^0								0-15
					TAB2 = 2^2		TAB1 = 2^1				TAB0 = 2^0	0-7
			TAB1 = 2^1			TAB0 = 2^0				TAB3 = 2^3		0-3, 8-11

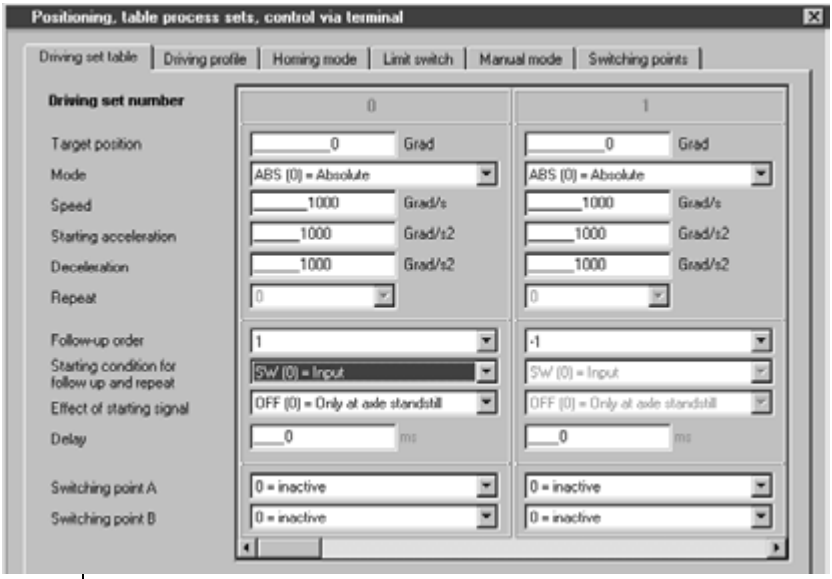
Table 5.6 Examples of driving set selection via terminal

To activate a driving set via terminal a separate enable signal via an input (FIxx = TBEN, FOSW), field bus or parameter is required (trigger). A new driving set always interrupts an ongoing positioning operation.

To select and display the active driving set the following parameters are used:

ProfiTool	Meaning	Value range	FS	Unit	Parameter
-	Selection of driving set. The selection via inputs is written to this parameter. Field bus: selection of table set	0 - 15	0	-	278-TIDX (_RTAB)
-	Display parameter Displays the current driving set being processed.	0-15	0	-	776-ATIDX (_RTAB)

By way of the STOP logic (feed hold) (terminal or bus) an ongoing positioning action can be aborted and then resumed either with the programmed or the emergency-stop ramp (see Section 6.2.3).



Flowchart

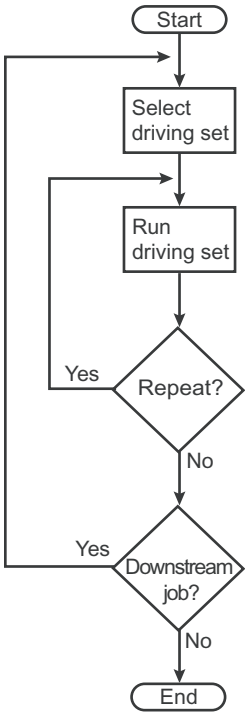


Image 5.12 Principle of function: Driving set sequencing

Target position

The target position parameters can be set in a user-defined distance unit.

ProfiTool	Value range	FS	Unit	Parameter
Target position	-2147483648 ... 2147483647	0	variable	272.x-PTPOS (_RTAB) x = driving set 0-15

Mode

The mode provides a defined reference for the target position

ProfiTool	Value range	FS	Unit	Parameter
Mode	ABS ... SPEED	REL		274.x_PTMOD (_RTAB) x = driving set 0-15

Mode settings:

BUS	Setting	Effect
0	ABS	The target position always relates to a fixed reference zero point
1	REL	A relative driving job is always referred to a variable position. Depending on the start condition for repetition or a downstream job, this may be the last target position or the current position.
2	SPEED	The axle always moves with the velocity profile programmed in the selected driving set. The target position is not relevant.

Velocity

The velocity can be signed. A negative setting is only evaluated in infinite positioning. The velocity is limited by the maximum velocity in the driving profile.

ProfiTool	Value range	FS	Unit	Parameter
Velocity	-2147483648 ... 2147483647	1000	variable	273.x_PTSPD (_RTAB) x = driving set 0-15

Acceleration

The startup and braking acceleration parameters can be set independently of each other. An input of 0 signifies an acceleration with maximum ramp steepness and maximum torque. The accelerations are limited by the maximum values in the driving profile

ProfiTool	Value range	FS	Unit	Parameter
Startup acceleration	0 ... 4294967295	10000	variable	276.x_PTACC (_RTAB) x = driving set 0-15
Braking acceleration	0 ... 4294967295	10000	variable	277.x_PTDEC (_RTAB) x = driving set 0-15

Repetition

A driving set with relative positioning can be repeated a number of times with the programmed value. The repetitions of the driving set are started, like the downstream job, dependent on the start condition. The execution of any repetitions has priority over execution of a downstream job.

ProfiTool	Value range	FS	Unit	Parameter
Repetition	0 ... 255	0		762.x_FOREP (_RTAB) x = driving set 0-15

Downstream job

Programming a downstream job in a driving set enables short automated sequencing programs to be implemented.

The setting "-1" signifies that no further positioning set (downstream job) is to be activated.

ProfiTool	Value range	FS	Unit	Parameter
Downstream job	-1 ... 15	-1		761.x_FONR (_RTAB) x = driving set 0-15

Start condition - activation condition "WHEN"

When the downstream job or a driving set repetition is activated can be programmed with the start condition.

ProfiTool	Value range	FS	Unit	Parameter
Start condition	SW ... WSTP	SW		764.x_FOST (_RTAB) x = driving set 0-15

Description of setup:

BUS	Setting	Meaning
0	SW	SWitch- digital input or control bit start sequence
1	DT	A repetition or the downstream job is started with a programmable delay once the target position has been reached.
2	SW-DT	A repetition or the downstream job is started via a digital input or control bit, but no later than after a defined delay.
3	WSTP	The drive moves at the velocity v1 of the current driving set to the target position and then accelerates without stopping to v2 of the repetition or downstream job.

Effect of start condition - activation condition "HOW"

The "HOW" condition parameter is set dependent on the setting of the pre-selected "WHEN" activation condition:

ProfiTool	Value range	FS	Unit	Parameter
Effect of start signal	OFF ... NEXT	OFF		765.x_FOSWC (_RTAB) x = driving set 0-15

Start condition = SW:

The downstream job or the repetition is activated by edge triggering (high level). The effect of a start signal during ongoing positioning can be programmed - see Table 5.7.

Bus	Setting	Meaning
0	OFF	Signals during positioning are ignored. This means a signal never interrupts a driving job while it is in progress.
1	STORE	Signals during positioning result in an immediate change of the current target position. A relative component is added to the previous target position and is approached with no interim stop. The number of downstream jobs to be executed is dependent on the cumulative signal edges. This function is useful in relative positioning.
2	NEXT	Signals during positioning result in an immediate change of the current target position. A relative component is added to the actual position at the time of the change and is approached with no interim stop. This function is suitable for remaining distance compensation.

Table 5.7 Effect of start condition for repetition and downstream job

If no driving set is being processed, or if a repetition is active, the signal to activate the downstream job starts the driving set selected via the terminal or the field bus system.

Start condition = DT:

If the downstream job is activated after a delay, the delay time must be defined.

Start condition = SW-DT:

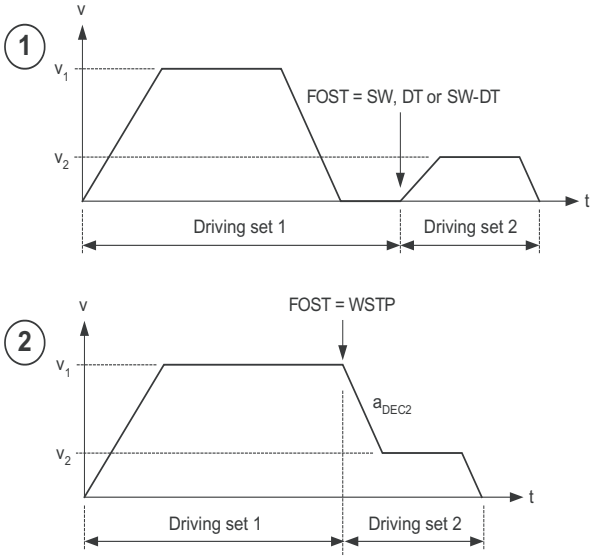
The effect of start signal (FOSWC) and delay time (FODT) parameters are set as described above.

Delay

This field is only activated if the delay time (DT, SW-DT) for the downstream job was selected under Start condition.

ProfiTool	Value range	FS	Unit	Parameter
Delay	0 ... 65535	0	ms	763.x_FODT (_RTAB) x = driving set 0-15

The following diagram illustrates two examples of positioning with downstream job (driving set 2).



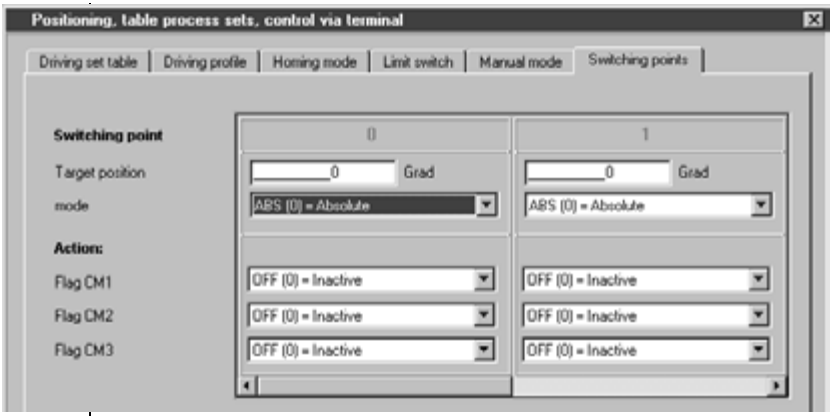
Switching points A and B

Two switching points per driving set can be evaluated. Switching points 0-3 are selected by way of two parameters. A 0 entry causes no switching point to be selected (inactive).

ProfiTool	Value range	FS	Unit	Parameter
Switching point A	0 ... 4	0		771.x_PTSP1 (_RTAB) x = driving set 0-15
Switching point B	0 ... 4	0		772.x_PTSP2 (_RTAB) x = driving set 0-15

5.3.2 Switching points

Four switching points can be defined. Each switching point can modify up to three flags. The switching points can be used in all driving sets. In each driving set a maximum of two switching points can be used. They are configured by way of the driving set-dependent switching point configuration. Each switching point has the following settings.



Target position

The target position takes effect dependent on the switching point mode and the link to a driving set.

ProfiTool	Value range	FS	Unit	Parameter
Target position	-2147483648 ... 2147483647	0	variable	766.x_CPOS (_RTAB) x = switching point 0-3

Mode

ProfiTool	Value range	FS	Unit	Parameter
Mode	ABS ... RELE	ABS		767.x_CREF (_RTAB) x = switching point 0-3

Mode setting:

BUS	Setting	Meaning
0	ABS	Switching point relates to reference position or absolute position of system.
1	RELS	Relative to start position of driving set: switching point is tripped after a relative distance referred to the start position.
2	RELE	Relative to end position of driving set: switching point is tripped a relative distance before the end position is reached.

Flags

ProfiTool	Value range	FS	Unit	Parameter
Flag 1	OFF ... INV	OFF		768.x_CM1CF (__RTAB) x = switching point 0-3
Flag 2	OFF ... INV	OFF		769.x_CM2CF (__RTAB) x = switching point 0-3
Flag 3	OFF ... INV	OFF		770.x_CM3CF (__RTAB) x = switching point 0-3

Flag functions:

BUS	Setting	Meaning
0	OFF	Inactive
1	SET	Flag set to 1
2	CLEAR	Flag set to 0
3	INV	Flag inverted

5.3.3 Teach in

PROFITOOL:

The actual position is imported into the relevant table with the aid of the PROFITOOL.

Terminals:

If an input is programmed for "Teach in" (FIxx = TBTEA), at a rising edge at the input concerned the current position is applied as the target position in the current selected table driving set.

5.4 Positioning and control via field bus

The field bus is the reference source for preset solutions PCC_1 and PCB_1. The specific settings of the I/O terminals are set out in section 5.6.

Positioning via field bus is executed either by way of the device's internal CAN_{open} field bus interface or the Profibus option module. All general positioning functions as described under 5.2 can be used for this.

5.4.1 CAN_{open}

By way of the internal isolated CAN_{open} interface X5 in the device the drive controller is integrated into the automation network.

Communication is based on the DS301 profile. Standard communication with the device profile for variable-speed drives DSP402 is also guaranteed. The following profiles are supported:

- **Homing mode** (referencing) with 40 different reference run types
- **Profile-Position mode** for direct driving set input with device-internal jerk-limited profile generation
- **Profile-Velocity mode** for speed control of the drive. This mode is a special form of positioning in which the only movement is infinite. A target position is irrelevant.

It is possible to switch between these modes online - that is, with the loop control active. Also, the scaling and units are executed according to the **Factor Group** and the open-loop control according to the DRIVECOM state machine.

You will find detailed information on network configuration of the drive controller in the separate "CAN_{open} data transfer protocol" document.

5.4.2 Profibus

For driving set input and control via Profibus the external communication module ULZ-DPV1 is required.

The control and positioning is based on the EasyDrive profile "DirectPos".

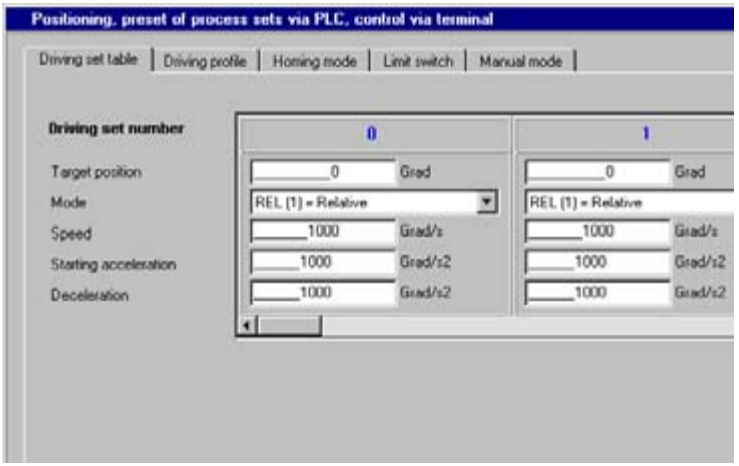
You will find detailed information on network configuration of the drive controller in the separate "Profibus data transfer protocol" document.

5.5 Positioning with PLC

The PLC is set as the reference source for preset solutions PCP_1, PCT_3, PCC_3 and PCB_3. The specific settings of the inputs and outputs for the control locations PLC (PCP_1), terminal (PCT_3), CAN_{open} (PCC_3) or Profibus (PCB_3) are set out in section 5.6.

With these presets the various positioning commands GO [x] and STOP [x] can be used. If the control location is also set to PLC (PCP_1), the command SET ENCTRL = 0/1 can be used to activate or deactivate loop control.

All general positioning functions as described under 5.2 can be used. The driving set table can be accessed by way of special GO T [x] positioning commands. However, automatic sequencing by way of repetitions and downstream jobs, as well as the switching points, cannot be used when reference values are entered via PLC.



For detailed information on use of the PLC and on programming and operation with the PLC Editor see Section 7 "User programming".

5.6 Control location for presets

The control location for positioning (I/O terminals, CAN_{open}, Profibus or PLC) is configured according to the selected preset solution. Open-loop control requires special control and status information via the field bus as well as appropriate terminal assignments.

5.6.1 Terminal assignment

Depending on the selected preset, the input and output parameters are changed relative to the factor setting - see Table 5.8. Once the preset has been selected the terminal parameter setting can be adapted as required to the application.

I/O	Parameter	Function	152-ASTER						
			SCT_1 (FS)	PCC_1 PCB_1	PCP_1	PCT_2	PCC_2 PCB_2	PCT_3	PCC_3 PCB_3
ISA00	180-FISA0	Function selector analog standard input ISA00	PM10V	OFF	PLC	OFF	OFF	PLC	PLC
ISA01	181-FISA1	Function selector analog standard input ISA01	OFF		PLC			PLC	PLC
ISD00	210-FIS00	Function selector digital standard input ISD00	START	OFF	PLC		OFF		PLC
ISD01	211-FIS01	Function selector digital standard input ISD01	OFF		PLC	FOSW		PLC	PLC
ISD02	212-FIS02	Function selector digital standard input ISD02	OFF		PLC	TAB0		PCL	PCL
ISD03	213-FIS03	Function selector digital standard input ISD03	OFF	HOMSW	HOMSW	HOMSW	HOMSW	HOMSW	HOMSW
OSA00	200-FOSA0	Function selector for analog output OSA00	ACTN		PLC			PLC	PLC
OSD00	240-FOS00	Function selector digital standard output OSD00	REF						
OSD01	241-FOS01	Function selector digital standard output OSD01	ROT_0						
OSD02	242-FOS02	Function selector digital standard output OSD02	S_RDY						

Table 5.8 Presetting of control inputs and outputs

5.6.2 Field bus control

If a drive is controlled only via field bus and the driving set is specified from a different source (e.g. driving set table or PLC), special proprietary bus control and status words are used. They are listed in the Table 5.9.

Reference source	Field bus profile
Tables driving set	EasyDrive profile "TabPos"
PLC	EasyDrive profile "PLCPos"

Table 5.9 Field bus control profiles

You will find detailed information on network configuration of the drive controller in the relevant "Profibus data transfer protocol" or "CAN_{open} data transfer protocol" document.

6 General software functions

6.1 Inputs and outputs

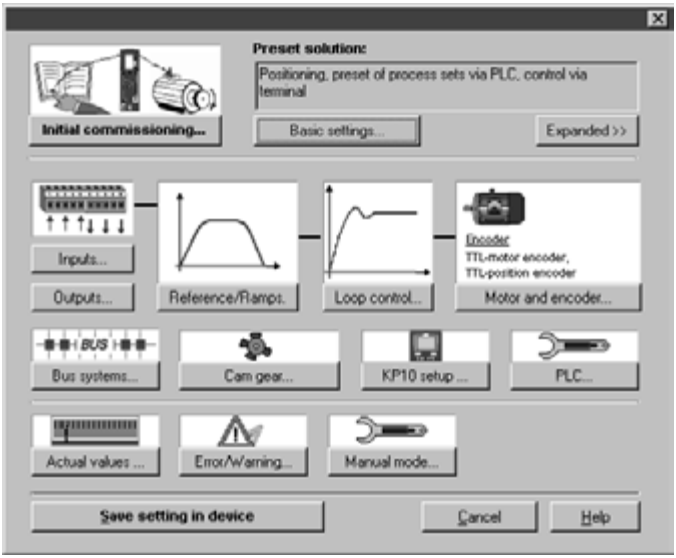


Image 6.1 "Setup" user screen with Inputs/Outputs

The P6000 position controller includes:

- two analog inputs (ISA0, ISA1)
- four digital inputs (IS00 to IS03)
- two virtual (digital) inputs (FIF0, FIF1)
- optionally a further eight digital inputs (IE00 to IE 07)

Each input of the position controller has a parameter which assigns it a function. These parameters are termed function selectors and are located in the relevant subject areas of the inputs.

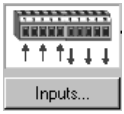
The P6000 position controller includes:

- one analog output (OSA0)
- three digital outputs (OS00 to OS02)
- two virtual (digital) inputs (OV00, OV01)
- optionally four additional digital outputs (OE00 to OE03)

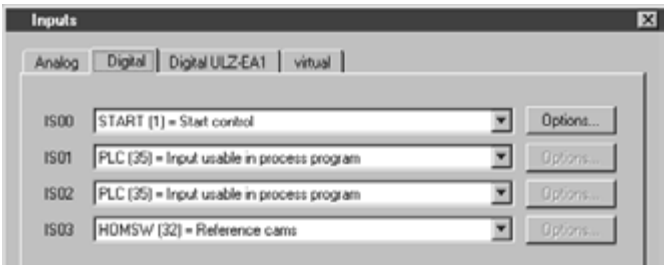
For information on the hardware of the inputs and outputs refer to section 2.2 "Specification of control connections".

6.1.1 Digital inputs

1.



2.



With the function selectors the function of the digital inputs is determined. This means the functions of all digital inputs are freely assignable.

ProfiTool	Value range	FS	Unit	Parameter
IS00	OFF ... PLCGO	START		210_FIS00 (_IN)
IS01	OFF ... PLCGO	OFF		211_FIS01 (_IN)
IS02	OFF ... ENC	OFF		212_FIS02 (_IN)
IS03	OFF ... ENC	OFF		213_FIS03 (_IN)

3.

Settings, IS00 and IS01:

BUS	Setting	Function	Effect
0	OFF	No function	Input off
1	START	Start loop control	
2	STR	Start clockwise	Start enable for motor clockwise running
3	STL	Start anti-clockwise	Start enable for motor anti-clockwise running
4	INV	Reverse direction	Reference is inverted, causing a reversal of direction
5	/STOP	/Emergency stop	Emergency stop via stop ramp (Low active)
6	SADD1	Offset for reference selector 280 -RSSL1	Reference selector 280-RSSL1 is offset by the value in 289-SADD1 to a different reference source.
7	SADD2	Offset for reference selector 281 -RSSL2	Reference selector 281-RSSL2 is offset by the value in 290-SADD2 to a different reference source.
8	E-EXT	External error	Error messages from external devices produce a fault signal with response as defined in parameter 524-R-EXT.
9	/E-EX	External error	External error in another device (Low active)
10	RSERR	Reset error message	Error messages are reset if the error is no longer present.
11	TBTEA	Driving set positioning	Teach in
12	HOMST	Start referencing	
13	TAB0	Driving set selection (significance 2^0)	Binary driving set selection (bit 0), frequency with acceleration and deceleration ramp.
14	TAB1	Driving set selection (significance 2^1)	Binary driving set selection (bit 1), fixed frequency with acceleration and deceleration ramp.
15	TAB2	Driving set selection (significance 2^2)	Binary driving set selection (bit 2), fixed frequency with acceleration and deceleration ramp.
16	TAB3	Driving set selection	(significance 2^3)
17	/LCW	Limit switch clockwise	Limit switch evaluation without override protection, response to error message in case of reversed limit switches as defined in parameter 534-R-LSW.
18	/LCCW	Limit switch anti-clockwise	Limit switch evaluation without override protection, response to error message in case of reversed limit switches as defined in parameter 534-R-LSW.
19	SIO	Input appears in status word of serial interface (X4)	Status of input readable via status word parameter 550-SSTAT of serial interface.
20	OPTN		Reserved for option module
21	CAN		Reserved for CAN-Bus
22	USER0	Reserved for modified software	Input can be used by modified software
23	USER1	Reserved for modified software	Input can be used by modified software
24	USER2	Reserved for modified software	Input can be used by modified software
25	USER3	Reserved for modified software	Input can be used by modified software

Table 6.1 Digital inputs

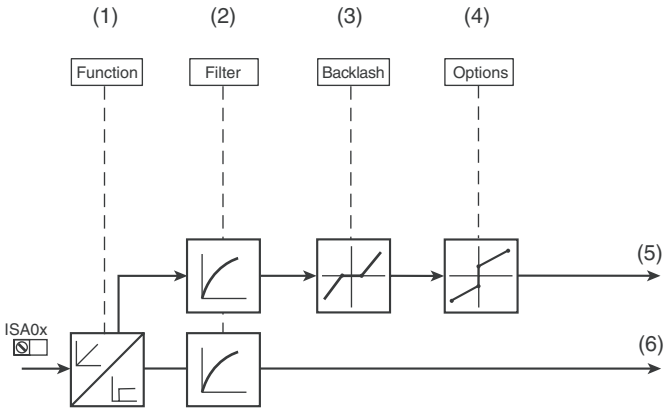
BUS	Setting	Function	Effect
26	MAN	Manual mode activation	In field bus operation
27	TIPP	Jog, positive direction:	In manual mode the axle can be moved at slow or quick jog speed.
28	TIPN	Jog, negative direction:	In manual mode the axle can be moved at slow or quick jog speed.
29	TBEN	Enable table position	Transfer the binary code and run the relevant driving set
30	/STOP	Feed hold	The ongoing positioning operation is interrupted and resumed following resetting.
31	PLCIS	Start PLC program sequence	
32	HOMSW	Reference cam evaluation	For zero determination in positioning
33	FOSW	Execution downstream job	In driving set positioning
34	CAMRS	Reset cycle of cam contactor group	
35	PLC	Input used in sequence program	
36	PLCGO	Start sequence program	

Table 6.1 Digital inputs

The settings for IS02 and IS03 are the same as those for inputs IS00 and IS01, plus:

BUS	Setting	Function	Effect
37	ENC	HTL encoder	A-track ISD02 and B-track ISD03

6.1.2 Analog inputs



(1) Analog reference input or use as a digital input
(2) Input filter for fault isolation from 0 to 21 s
(3) Backlash function for fault isolation around zero
(4) Options for scaling of the analog input
(5) Analog value
(6) Digital value

x Number of the input

Image 6.2 Function block for adaptation of the analog inputs

Configuration options, ISA0x

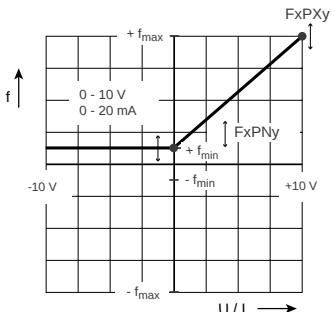


Image 6.3 Scaling in unipolar operation

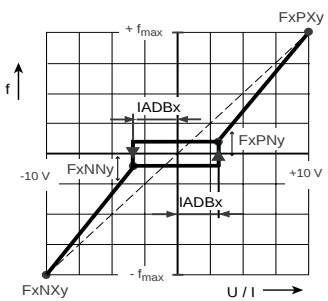
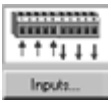


Image 6.4 Backlash function in bipolar operation

1.



2.

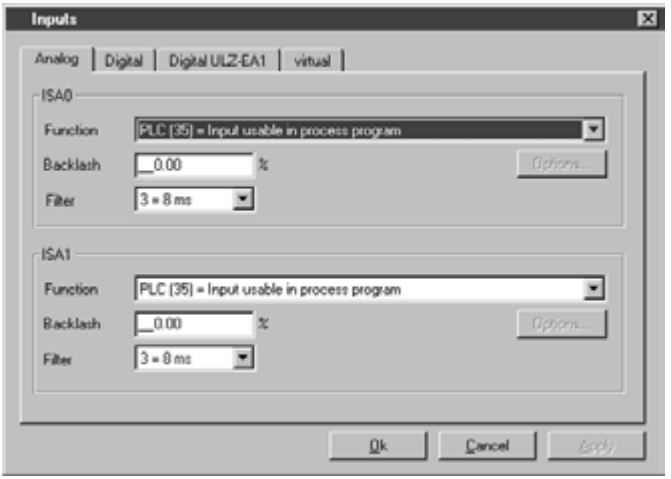


Image 6.5 Analog inputs

Function selectors ISA0 and ISA1:

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Function	Definition of the internal processing of the analog input signals	OFF ... 4-20	PM10V OFF		180_FISA0 181_FISA1 (_IN)
Backlash	Backlash around zero	0.00 ... 999.95	0.00	%	192_IADB0 193_IADB1 (_IN)
Filter	Filter time of the analog input	0 ... 7	3	ms	188_AFIL0 189_AFIL1 (_IN)

Settings, AFIL0 and AFIL1:

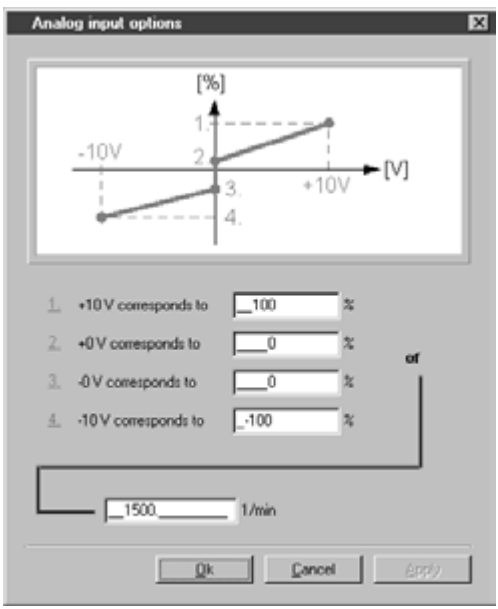
ProfiTool	Meaning
0	0 ms
1	2 ms
2	4 ms
3	8 ms
4	16 ms
5	32 ms
6	64 ms

3.

Options...

"Options" is selected depending on the "Function" setting.

Analog reference input



Parameters for analog input ISA0

ProfiTool	Meaning	Value range	FS	Unit	Parameter
1.	+ 10 V	-1000 ... 1000	100	%	182_F0PX (_IN)
2.	+ 0 V	-1000 ... 1000	0	%	183_F0PN (_IN)
3.	- 0 V	-1000 ... 1000	0	%	185_F0NN (_IN)
4.	- 10 V	-1000 ... 1000	-100	%	184_F0NX (_IN)
Motor nominal speed		0 ... 100000	1500	rpm	157_MOSNM (_MOT)

Parameters for analog input ISA1

ProfiTool	Meaning	Value range	FS	Unit	Parameter
1.	+ 10 V	-1000 ... 1000	100	%	186_F1PX (_IN)
2.	+ 0 V	-1000 ... 1000	0	%	187_F1PN (_IN)
Motor nominal speed		0 ... 100000	1500	rpm	157_MOSNM (_MOT)

Note: The resolution of the analog inputs is 10 bits with a sampling rate of 250 µs.

The setting 37_ENC is only applicable to IS02 and IS03

37	ENC	HTL encoder	A-track ISD02 or B-track ISD03

Analog input functions, only for FISA0 and FISA1

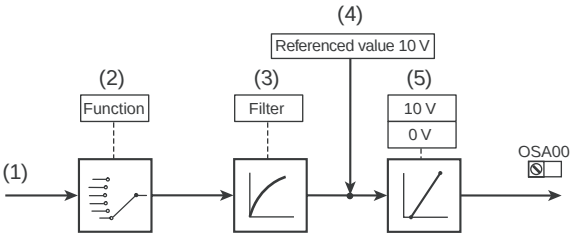
38	0-10V	Analog reference input 0-10 V	Reference input 0-10 V. Pay attention to scaling, and adapt reference structure using reference selector
39	SCALE	Torque scaling	0 - 100%

Table 6.2 Settings, Inputs FISA0 and FISA1

40	PM10V only ISA0	Analog reference input -10 V ... +10 V	Reference input 0-10 V. Pay attention to scaling, and adapt reference structure using reference selector
41	0-20V	Current input	0 ... 20 mA
42	4-20V	Current input 4 ... 20 mA	If the current falls below 4 mA, the wire-break monitor is tripped. Response to error message is defined via parameter 529-R-WBK

Table 6.2 Settings, Inputs FISA0 and FISA1

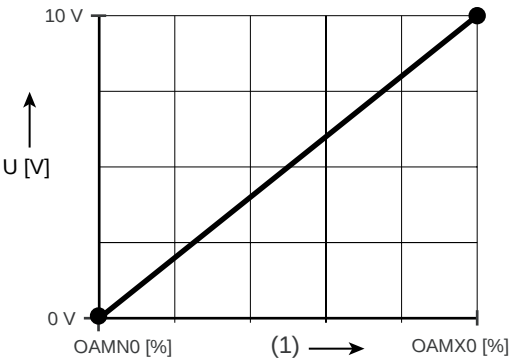
6.1.3 Analog output



(1) Actual value
(2) Selection of the analog actual value
(3) Output filter for fault isolation from 0 to 64 ms
(4) Referenced value 10 V
(5) Scaling of the analog output

Image 6.6 Function block for adaptation of the analog output

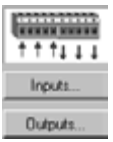
Configuration options, OSA00



(1) Output variable, e.g. Frequency

Image 6.7 Scaling of the analog output

1.



2.

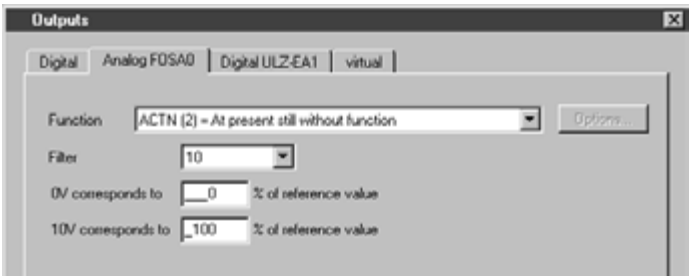


Image 6.8 "Analog outputs FOSA0" tab

ProfiTool	Value range	FS	Unit	Parameter
Function	OFF ... PLC	ACTN		200_FOSA0 (_OUT)
Filter	0 ... 64	4	ms	203_OATF0 (_OUT)
0V corresponds to	-200 ... 200	0	%	201_OAMN0 (_OUT)
10V corresponds to	-200 ... 200	100	%	202_OAMX0 (_OUT)

Setting, FOSA0:

BUS	Setting	Function	Reference value
0	OFF	No function, the input is switched off.	
1	ACTT	Current actual torque	
2	ACTN	Current actual speed	FMAXx * 60 / number of pole pairs
3	AACTN	Amount of current actual speed	FMAXx * 60 / number of pole pairs
4	APCUR	Current apparent current	2 * I_N
5	ISA00	ISA00	10 V / 20 mA
6	ISA01	ISA01	10 V
7	MTEMP	Current motor temperature	200 °C
8	KTEMP	Current heat sink temperature	200 °C
9	DTEMP	Current interior temperature	200 °C
10	PLC	Specify value from sequencer	

6.1.4 Digital outputs

With parameter 230-REF_R a range can be defined in which the reference value (control mode: VFC/SFC) and the actual value (control mode: FOR) may deviate from the reference without deactivating the "Reference reached" (REF) message. This enables reference value fluctuations resulting from reference input via analog inputs to be taken into account.

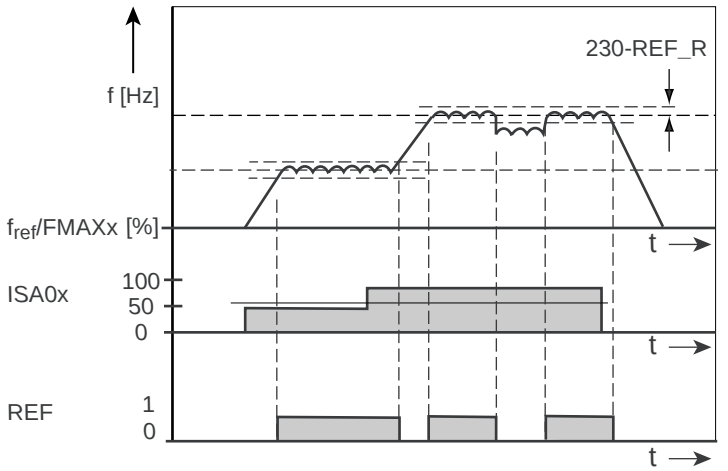
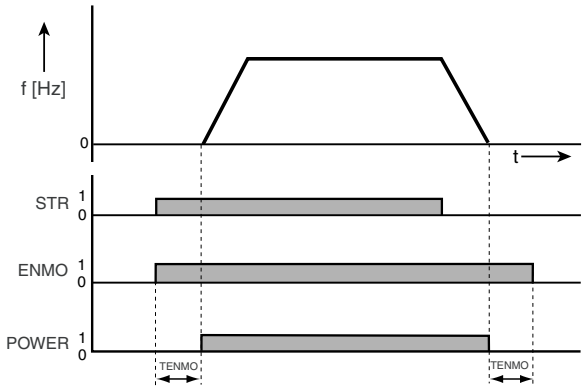


Image 6.9 Digital output with "reference reached" setting when using the "reference-reached window"

Explanatory notes

- "Clockwise" (ROT_R) and "anti-clockwise" (ROT_L) are detected dependent on parameter 230-REF_R.

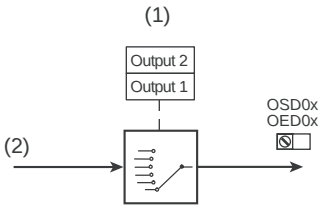


ENMO Motor power contactor
POWER Position controller power stage

Image 6.10 Motor contactor control via digital output with setting ENMO

- With the setting TENMO=0 the motor contactor functionality is disabled.
- When the ENMO function is activated the motor contactor is automatically closed during auto-tuning.
- The motor contactor functionality is active when one of the function selectors of the digital outputs OSD0x or OED0x has the value ENMO or /ENMO.

Note: If a switch is made with the power stage still active in the motor cable, to avoid error message E-OC resulting from transient currents in the switching phase a motor choke should be used. Also, in the event of error message E-OC1, a check is made prior to outputting as to whether the hardware enable ENPO is present. If it is not, an intentional switch in the motor cable by a motor contactor is assumed, and the error message is suppressed.

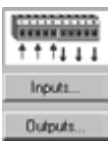


(1) Selection of function of digital output
(2) Digital value

Image 6.11 Function block for adaptation of the digital outputs

Function	Effect
• The function selectors determine the function of the digital outputs.	• Free function assignment of all digital outputs

1.



2.

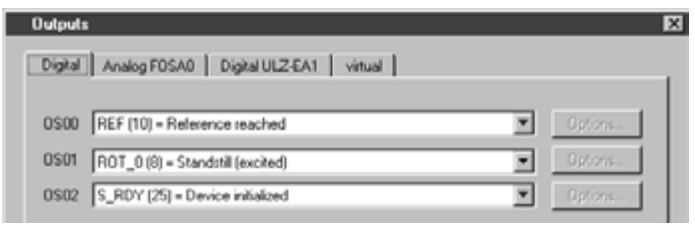


Image 6.12 "Digital outputs" tab

ProfiTool	Value range	FS	Unit	Parameter
OS00	OFF ... CM16	REF		240_FOS00 (_OUT)
OS01	OFF ... CM16	ROT_0		241_FOS01 (_OUT)
OS02	OFF ... CM16	S_RDY		242_FOS02 (_OUT)

Settings for FOS00, ... FOS02

BUS	Setting	Function	Effect
0	OFF	No function	Output off.
1	ERR	Collective error message	Device in error state. The error must be eliminated and acknowledged before operation can be restarted.
2	WARN	Collective warning message	Parameterizable warning limit exceeded, device still ready.
3	/ERR	Collective error message negated	Device in error state. The error must be eliminated and acknowledged for operation to be restarted.
4	/WARN	Collective warning message negated	Parameterizable warning limit exceeded, device still ready. Wire-break-proof output.
5	ACTIV	Control in function	Power stage active and closed-loop/open-loop control in function.
6	ROT_R	Clockwise rotation	Motor running clockwise.
7	ROT_L	Anti-clockwise rotation	Motor running anti-clockwise.
8	ROT_0	Motor at standstill	Motor in standstill window (f_{ref}=0 Hz). Control mode FOR: dependent on actual value Control mode SFC: dependent on reference value Control mode VFC: dependent on reference value Refer to the information given under "Explanatory notes".
9	LIMIT	Reference limitation active	The internally processed reference value exceeds the reference limit and is restricted to the limit value.

Table 6.1 Settings for function selector FOxxx of the digital outputs

BUS	Setting	Function	Effect
10	REF	Reference reached	The preset reference has been reached. Control mode FOR: dependent on actual value Control mode SFC: dependent on reference value Control mode VFC: dependent on reference value Refer to the information given under "Explanatory notes".
11	SIO	Access by control word of RS232	Output can be set via the serial interface by the WattBus control word.
12	OPTN	Reserved for option module	Output available to option module.
13	CAN	Reserved for CAN-Bus	Output available to option module.
14	BRK1	Holding brake function 1 (without motor current monitoring)	Output is activated if actual speed in control modes FOR/SFC has exceeded value in parameter FBCxx. In open-loop control mode VFC the reference infringement is evaluated.
15	BRK2	Holding brake function 2	Output is set if, in VFC (SFC), the control reference or, in FOR, the control actual value has exceeded the value in parameter SSCxx (clockwise: SSCW, anti-clockwise: SSCCW).
16	WUV	Warning: undervoltage in DC link	Warning message when DC-link voltage has fallen below value in parameter 503-WLUV. Device ready.
17	WOV	Warning: voltage overload in DC link	Warning message when DC-link voltage has exceeded value in parameter 503-WLUV. Device still ready.
18	WIIT	Warning, I^2t integrator started (device)	Warning message when integrator of current I^2 over time t has tripped to protect the device.
19	WOTM	Warning: motor temperature	Warning message when motor temperature has exceeded value in parameter 502-WLTM.
20	WOTI	Warning: heat sink temperature of device	Warning message when the heat sink temperature of the device has exceeded the value in parameter 500-WLTI.
21	WOTD	Warning: interior temperature of device	Warning message when device interior temperature has exceeded value in parameter 501-WLTD.
22	WLIS	Warning message: apparent current limit	Warning message when apparent current has exceeded value in parameter 506-WLIS.
23	WLS	Warning message: speed limit	Limit exceeded.
24	WIT	Warning: ixt integrator started (motor)	Warning message when integrator for current I over time t has tripped to protect the motor.

Table 6.1 Settings for function selector FOxxx of the digital outputs

BUS	Setting	Function	Effect
25	S_RDY	Device initialized	Output is activated if the device is initialized after power-on.
26	C_RDY	Device ready	Output is activated if by setting the signal ENPO the device is "ready to start", parameters for a UDS switchover have been completely reset and there are no error messages.
27	USER0	Reserved for modified software	Output can be used by modified software.
28	USER1	Reserved for modified software	Output can be used by modified software.
29	USER2	Reserved for modified software	Output can be used by modified software.
30	USER3	Reserved for modified software	Output can be used by modified software.
31	WLTQ	Warning message: torque limit exceeded	Warning message when torque has exceeded value in parameter 507-WLTQ.
32	ENMO	Switch motor contactor	Output is activated on start of control and remains active extended by the time 247-TENMO when the start is cancelled and the drive is stopped.
33	/ENMO	Switch motor contactor, negated function	Output is deactivated on start of control and remains inactive extended by the time 247-TENMO when the start is cancelled and the drive is stopped.
34	PLC	Output is usable in sequence program	
35	REFOK	Referencing	Referencing completed successfully.
36	TAB0	Active driving set	(significance 2^0)
37	TAB1	Active driving set	(significance 2^1)
38	TAB2	Active driving set	(significance 2^2)
39	TAB3	Active driving set	(significance 2^3)
40	TBACT	Driving set active	Driving set positioning active.
41	/EFLW	No tracking error	
42	STOP	Emergency stop active	
43	CM1	Switching point 1	Cam contactor group, flag CM1.
44	CM2	Switching point 2	Cam contactor group, flag CM2.
45	CM3	Switching point 3	Cam contactor group, flag CM3.
46	CM4	Switching point 4	Cam contactor group
47	CM5	Switching point 5	Cam contactor group

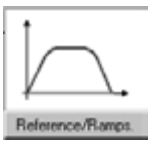
Table 6.1 Settings for function selector FOxxx of the digital outputs

BUS	Setting	Function	Effect
48	CM6	Switching point 6	Cam contactor group
49	CM7	Switching point 7	Cam contactor group
50	CM8	Switching point 8	Cam contactor group
51	CM9	Switching point 9	Cam contactor group
52	CM10	Switching point 10	Cam contactor group
53	CM11	Switching point 11	Cam contactor group
54	CM12	Switching point 12	Cam contactor group
55	CM13	Switching point 13	Cam contactor group
56	CM14	Switching point 14	Cam contactor group
57	CM15	Switching point 15	Cam contactor group
58	CM16	Switching point 16	Cam contactor group

Table 6.1 Settings for function selector FOxxx of the digital outputs

6.2 Reference generation

Function	Effect
• The reference generation function processes the reference value. Here the application-dependent reference structure is supplied with the "raw data" and limited. • The reference is modified dependent on various system states (errors, warnings, etc).	• All system states affect the reference value

1. 

2. The screen displays all the functions of reference processing. The functions are detailed in the following. If this screen is opened with a positioning preset, the "Speed profile" function is not displayed.

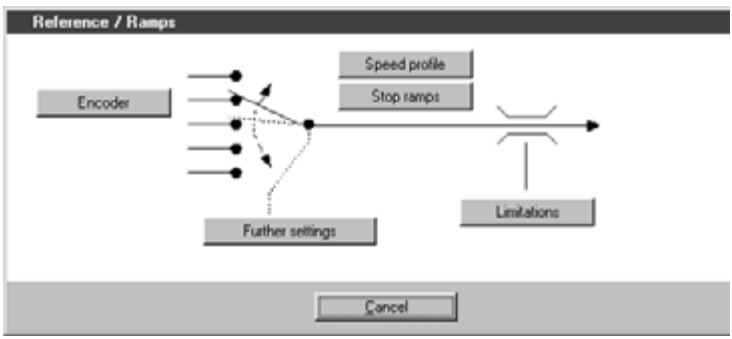


Image 6.13 Reference/Ramps tab

6.2.1 Speed profile generator

Function	Effect
• Setting of the acceleration and deceleration ramps for the speed profile • Setting of a smoothing of the start and end point of the linear ramp	• Adaptation of the motor dynamics to the application • Reduced drive jerking

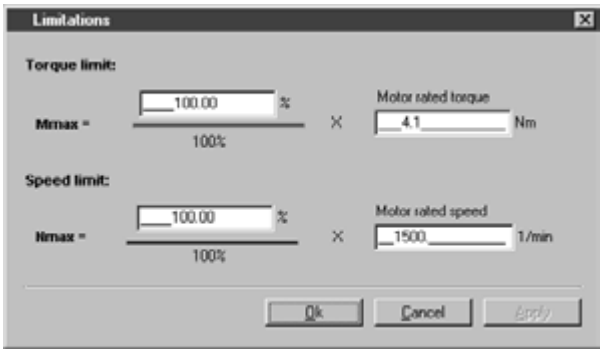
This function is only applicable to speed-controlled presets. It is detailed in section 4.2.1.

6.2.2 Limits

Function	Effect
• Limitation of torque and speed	• Setting of maximum and minimum values

The maximum permissible torque and speed are set as percentages of their nominal values.

Note: The percentage scaling of the torque is automatically reduced during controller initialization to the maximum torque to which the drive controller can be set, if the setting is greater



ProfiTool	Value range	FS	Unit	Parameter
Torque limitation	0.00 ... 999.95	100.00	%	803_TCMMX (_CTRL)
Motor rated torque	0.001 ... 5000	4.1	Nm	852_MOMNM (_MOT)
Speed limit	0.00 ... 999.95	100.00	%	813_SCSMX (_CTRL)
Motor rated speed	0 ... 100000	1500	rpm	157_MOSNM (_MOT)

There are two ways of variably limiting the torque during active loop control:

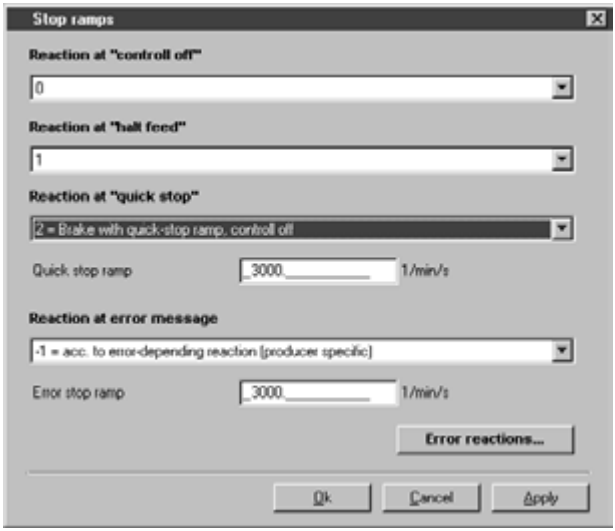
1. Torque limitation via analog input ISA1
   With the setting FISA1=SCALE the preset maximum torque is reduced from 0% (0 V) - 100% (10 V).
2. Torque limitation via parameter 805-SCALE
   By way of the setting the preset maximum torque is reduced from 0% - 100%. The parameter is saved to the non-volatile memory, meaning that after power-on the setting is always 100%.
   With this function the maximum torque can be altered dynamically via field bus or PLC.

If the analog input is set to FISA1=SCALE, a setting of parameter 805-SCALE has no effect.

Function	Value range	FS	Unit	Parameter
Torque scaling	0.00 ... 100.00	100.00	%	805_SCALE (_CTRL)

6.2.3 Stop ramps

Function	Effect
• Deceleration ramps dependent on different system states	• Differing ramp settings are possible



ProfiTool	Value range	FS	Unit	Parameter
Response to "Control off"	-1 ... 1	0		661-_QSOPC (_SRAM)
Response to "Stop feed"	0 ... 4	1		663-SDOPC (_SRAM)
Response to emergency stop	0 ... 8	2		664-HAOPC (_SRAM)
Emergency stop ramp	0 ... 32760	3000	rpm	592-STOPR (_SRAM)
Response to error message	-1	-1		662-FROPC (_SRAM)
Error stop ramp	0 ... 32760	0	rpm/s	593-ERR_R (_SRAM)

Responses to "Control off":

BUS	Setting	Response
-1	-1	Same as response to emergency stop
0	0	Power stages disabled - drive "trundles to a stop"
1	1	The drive brakes with the programmed deceleration ramp. Then the power stage is disabled.

Responses to "Stop feed":

The "Stop feed" state brakes an ongoing movement while the state is active. During braking the drive can be accelerated back to the former state. When deactivated, the drive accelerates with the programmed acceleration ramp.

BUS	Setting	Response
0	0	No function - please do not set
1	1	Braking with programmed deceleration ramp
2	2	Braking with emergency stop ramp
3	3	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0
4	4	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0

Responses to emergency stop:

The emergency stop brakes an ongoing movement. During braking the drive cannot be accelerated back to the former state.

BUS	Setting	Response
0	0	Power stages disabled - drive "trundles to a stop"
1	1	Braking with programmed deceleration ramp. Then the power stage is disabled.
2	2	Braking with emergency stop ramp. Then the power stage is disabled.
3	3	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0. Then the power stage is disabled.
4	4	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0. Then the power stage is disabled.
5	5	Braking with programmed deceleration ramp. The drive remains in the emergency stop state, the axle is held.

BUS	Setting	Response
6	6	Braking with emergency stop ramp. The drive remains in the emergency stop state, the axle is held.
7	7	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0. The drive remains in the emergency stop state, the axle is held.
8	8	Braking with max. dynamics at voltage limit. The speed reference is set equal to 0. The drive remains in the emergency stop state, the axle is held.

The response of the error stop ramp is always dependent on the corresponding error response. They are detailed in section 6.9.

6.2.4 Master encoder

Encoder

Function	Effect
• TTL or HTL master encoder input as reference source • Isolated connection when using the HTL input • A/B incremental or pulse directional signals • Transmission ratio can be set as fraction	• Slave axle • Speed or angle synchronicity referred to a master axle

The master encoder input is configured in the "Reference/Ramps" function under "Master encoder".

Note: The master encoder input configuration uses the same parameters as the configuration of the motor encoders. Consequently, modifying the master encoder parameters directly influences the configuration of the encoders.

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Master encoder	Selection of master encoder channel: OFF (0): no master encoder required. The TTL/HTL encoder interfaces are usable for motor encoders. TTLSI (1): TTL master encoder at X7. This input is not isolated from the control electronics of the controller. HTL (2): HTL master encoder at control terminal X2. Isolated input.	OFF (0) - HTL (2)	OFF (0)	-	475-CFREC (_ENC)

Table 6.2 Selection of master encoder

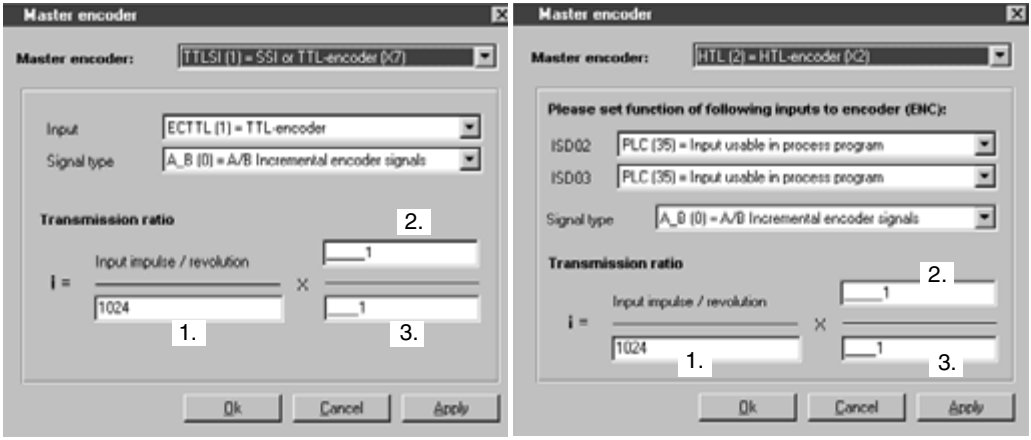


Image 6.14 Master encoder setting for TTL (left-hand) and HTL (right-hand) input

Configuration of a TTL master encoder

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Input	Input configuration at X7: ECTTL (1): Input is evaluated as TTL encoder. The zero pulse of the encoder is not evaluated in the "Master encoder" function. All other settings of the parameter are invalid for master encoder configuration. They are reserved for motor encoder setup and master/slave coupling.	OFF (0) - SSISL (4) Here only ECTTL (1) valid	ECTTL (1)	-	438-CFX7 (_ENC)
Signal type	A_B (0): Input signals are two 90° phase-shifted incremental signals A/B A_DIR (1): Track A is the clock input. Track B defines the direction of counting and rotation (Low: clockwise; High: anti-clockwise)	A_B (0) - A_DIR (1)	A_B (0)	-	484-ECST1 (_ENC)
Transmission ratio - input pulses/ revolution (***1.***)	Pulses of the master encoder	32 - 8192	1024	-	432-ECLN1 (_ENC)

Table 6.3 Configuration of a TTL master encoder

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Transmission ratio - numerator (***2.***)	Numerator of transmission ratio between master and slave axles. If the master and slave axles are to run in opposite directions, a negative numerator should be entered.	-32768 - 32767	1		435-ECNO1 (_ENC)
Transmission ratio - Denominator (***3.***)	Denominator of transmission ratio between master and slave axles.	0 - 65535	1		436-ECDE1 (_ENC)

Table 6.3 Configuration of a TTL master encoder

Configuration of a HTL master encoder

The digital inputs ISD02 and ISD03 should be set to "Encoder input ENC (37)".

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Signal type	A_B (0): Input signals are two 90° phase-shifted incremental signals A/B A_DIR (1): Track A is the clock input. Track B defines the direction of counting and rotation (Low: clockwise; High: anti-clockwise)	A_B (0) - A_DIR (1)	A_B (0)	-	483-ECST2 (_ENC)
Transmission ratio - input pulses/ revolution (***1.***)	Pulses of the master encoder	32 - 8192	1024	-	482-ECLN2 (_ENC)
Transmission ratio - numerator (***2.***)	Numerator of transmission ratio between master and slave axles. If the master and slave axles are to run in opposite directions, a negative numerator should be entered.	-32768 - 32767	1		480-ECNO2 (_ENC)
Transmission ratio - Denominator (***3.***)	Denominator of transmission ratio between master and slave axles.	0 - 65535	1		481-ECDE2 (_ENC)

Table 6.4 Configuration of a HTL master encoder

Master encoder in speed-controlled operation

No preset solution is available for speed control with a master encoder reference source. So select a preset solution which in any case corresponds to your desired control location (e.g. terminal or field bus). Then from the

"Reference/Ramps - further settings" function screen instead of the preset reference source select "RDIG (4)". The Image 6.15 then displays the structure of the selected reference processing.

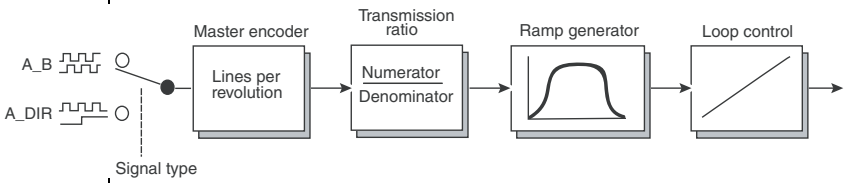


Image 6.15 Structure of reference processing with master encoder as speed reference source

The speed reference is smoothed by way of the speed profile generator (Section 4.2.1). With the "/STOP - feed/speed enable" function the slave axle can be coupled and decoupled by way of a digital input or field bus when motor control is active. For more options for adapting the reference source refer to section 6.2.5.

Master encoder in positioning mode (electronic gearing)

In positioning mode the synchronous running with master encoder reference input is controlled via PLC with special program commands. For this, select a preset solution with reference input via the PLC.

Activating synchronous running (coupling):	GOSYN 1
Deactivating synchronous running (decoupling):	GOSYN 0

Table 6.5 PLC commands for control of synchronous running

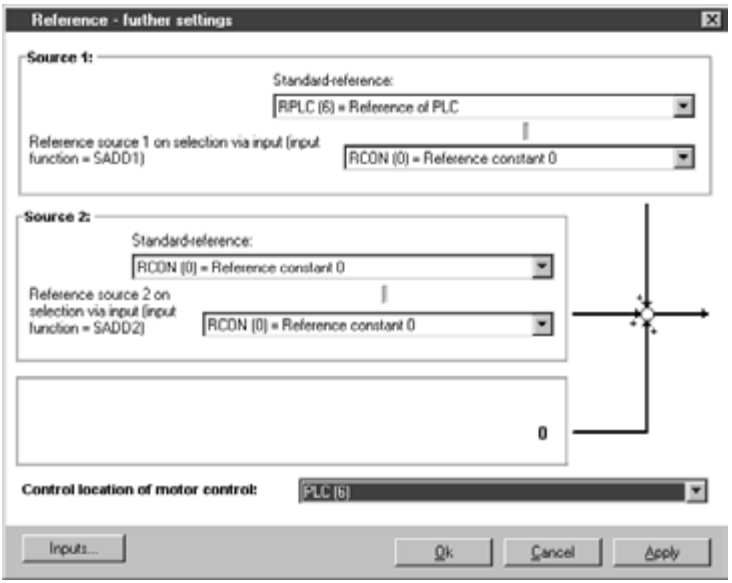
Note: Synchronism is activated hard, without limiting the dynamic of the axle by ramps. Gentle coupling into a moving master axle is not possible.

For detailed descriptions of PLC programming refer to Section 7. For synchronous running Section 7.3.2 on page 7-33

6.2.5 Reference structure - further settings

Function	Effect
• By way of the reference structure the two reference channels are added together. Each channel can draw a reference source from a predefined selection. • There is one reference structure for speed-controlled mode and one for positioning mode	• The reference structure is adjusted to the application by the assistance parameters such that no adaptation is required for most applications. • For special requirements, the internal processing of the reference value can be adapted by way of the flexible reference structure.

Note: This section is intended only for users who are unable to find their drive solution, or any suggested solution, in the preset application data sets.



Settings for source 1 / source 2

ProfiTool	Value range	FS	Unit	Parameter
Default reference	RCON ...ROPT	RA0 RCON		280_RSSL1 281_RSSL2 (_REF)
Reference source 1 Reference source 2 on switchover	RCON ...ROPT	RCON		289_SADD1 290_SADD2 (_REF)

ProfiTool	Value range	FS	Unit	Parameter
Control location of motor control	OFF ... PLC	TERM		260_CLSEL (_CONF)

Settings for RSSL1 / RSSL2 and SADD1 / SADD2:

BUS	Setting	Function
0	RCON	Reference constant zero
1	RA0	Reference of analog input ISA00
2	RA1	Reference of analog input ISA01
3	RSIO	Reference of serial interface
4	RDIG	Reference of digital input in slave mode
5	RCAN	Reference of CAN interface
6	RPLC	Reference of PLC
7	RTAB	Reference of driving set table
8	RFIX	Reference of fixed value
9	RMIN	Reference of minimum value
10	RMAX	Reference of maximum value
11	ROPT	Reference of option module
12	RPARA	Reference of parameter interface

Settings for CLSEL

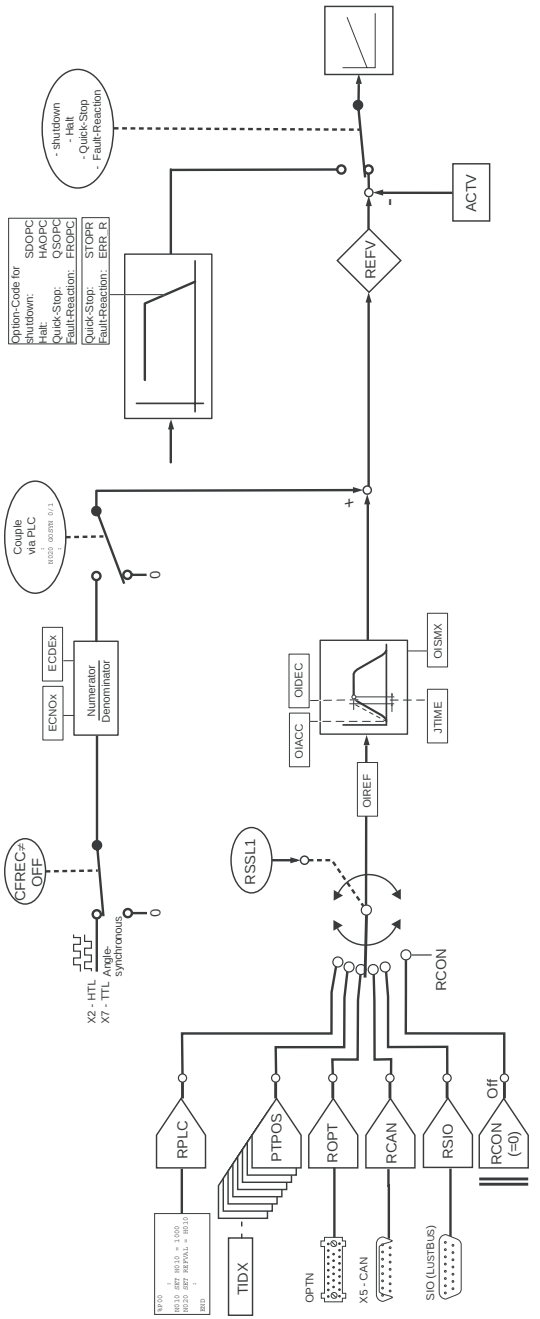
BUS	Setting	Function
0	OFF	No function
1	TERM	Control via terminal strip
2	KPAD	Control via KeyPad
3	SIO	Control via RS232
4	CAN	Control via CAN interface

BUS	Setting	Function
5	OPTN	Control via option module
6	PLC	Control via sequence program
7	PARAM	Control via parameter interface

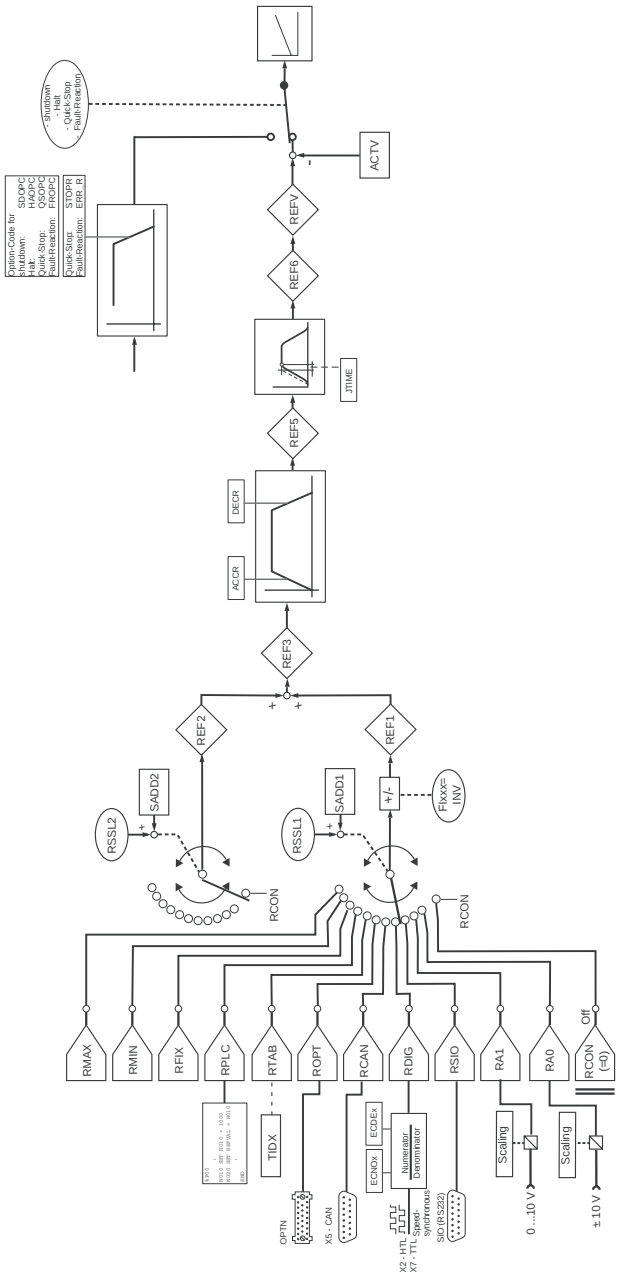
Symbol	Meaning
	Reference source (input), in part with second characteristic data set
	Reference selector (switch)
	Parameter
	Interim reference values (for display only)
	Limitation of reference value
	Mathematical influence

Table 6.6 Symbols used

Reference input block diagram (position control)



Principle of reference input (speed/torque control)



Further parameters of the reference structure

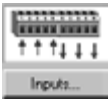
Function	Value range	FS	Unit	Parameter
Analog reference input ISA00	-32764 ... 32764	0		282-RA0
Analog reference input ISA01	-32764 ... 32764	0		283-RA1
Reference of serial interface	-32764 ... 32764	0		284-RSIO
Reference of option slot	-32764 ... 32764	0		287-ROPTN
Reference of CAN bus	-32764 ... 32764	0	Hz	288-RCAN
Reference of reference selector 1	-32764 ... 32764			291-REF1
Reference of reference selector 2	-32764 ... 32764		Hz	292-REF2
REF1 + REF2	-32764 ... 32764	0		293-REF3
Reference after ramp generator	-32764 ... 32764	0		295-REF5
Reference after smoothing	-32764 ... 32764	0		296-REF6

Table 6.7 Display parameters of the reference structure

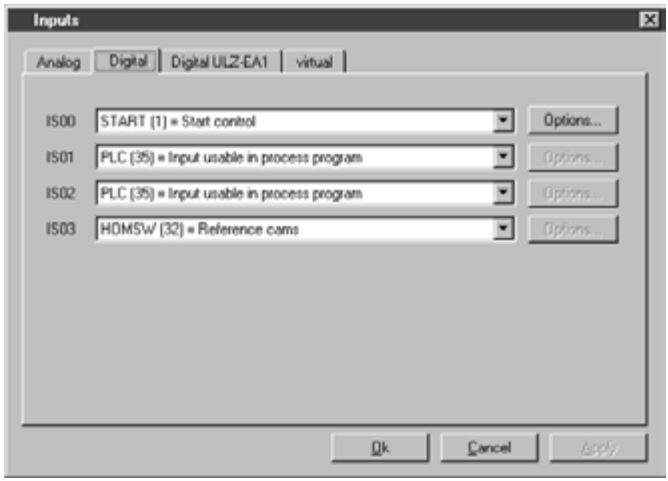
6.2.6 Control location

Function	Effect
• The control location determines the source from which the control commands are given. • Auto-Start after power-up	• Possible control locations are: - Terminals - Control unit - Serial interface - Option slot - PLC • Drive auto-start

1.



2.



3.

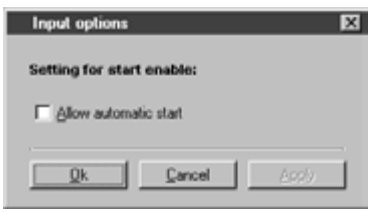


Image 6.16 Setting of Auto-Start function

Parameters for control location

Function	Value range	FS	Unit	Parameter
Auto-Start	OFF/ON	OFF		7-AUTO
Control location selector	(see Table 6.9)	TERM		260-CLSEL

Table 6.8 Parameters: Control location

Explanatory notes

- An auto-start is executed when a start command is received (STR/STL) and the hardware enable ENPO is set.

Attention: The drive starts up automatically after power-up or resetting of an error message dependent on the error response.

Settings of the control location selector 260-CLSEL

BUS	KP/ProfiTool	Function
0	OFF	No function
1	TERM	Control via terminal strip
2	KPAD	Control via control unit
3	SIO	Serial interface RS232 (Serial Input Output)
4	CAN	Control via CAN interface
5	OPTN	Control via option module
6	PLC	Control via sequence program
7	PARAM	Control via parameter interface

Table 6.9 Settings for 260-CLSEL Control location selector

Terminals

The start command for a direction of rotation can be set by way of the terminals of the inverter module. The start commands determine the direction.

CONTROL UNIT KP10

In the CONTROL menu the control unit takes complete control over the inverter. It attunes the control location selector and the reference channel 1 to KP10. The second reference channel is shut off.

By way of the control unit control of the inverter can be seized and a reference value with preceding sign can be set to determine the direction of rotation.

Serial interface

To control the inverter module via the serial interface (terminal X4) a special bus protocol is used. The PROFITOOL user software uses this LustBus protocol for communication and open-loop control of the position controller.

The control location is set to SIO as soon as the "Control device" PROFITOOL function is selected.

At the end of the control window the old setting is restored before the control function is taken over by the PROFITOOL.

Note: If communication between the positioning module and the PROFITOOL is interrupted, the setting can no longer be reset by the PROFITOOL.

Option slot

Activation of the inverter module by way of communication modules can be handled via the DRIVECOM state machine or the manufacturer-specific protocol.

The control location is set to OPTN.

PLC

When the position controller is activated via PLC the control location is set to PLC.

6.3 Motor control

The P6000 position controller works on the principle of field oriented regulation. Field orientation means injecting a current into the motor at the point at which the field is largest.

As a result the injected current is converted optimally into torque, producing optimal utilization of the machine, with the best possible dynamics accompanied by low loss. This results in a very high efficiency.

The digitally regulated drive is suitable for all applications in which the following properties are key:

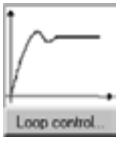
- Constant speed (true running)
- Position accuracy
- Dynamics
- Const. Torque
- Disturbance adjustment

The P6000 position controller can be operated in three control modes:

• Torque control	Torque Control	(TCON)
• Flux Control	Speed Control	(SCON)
• Position control	Position Control	(PCON)

With the PROFITOOL the desired preset solution can be selected, and its parameters set, quickly and easily in the course of initial commissioning. This also includes setting of the control mode. It is possible to switch control modes online.

1.



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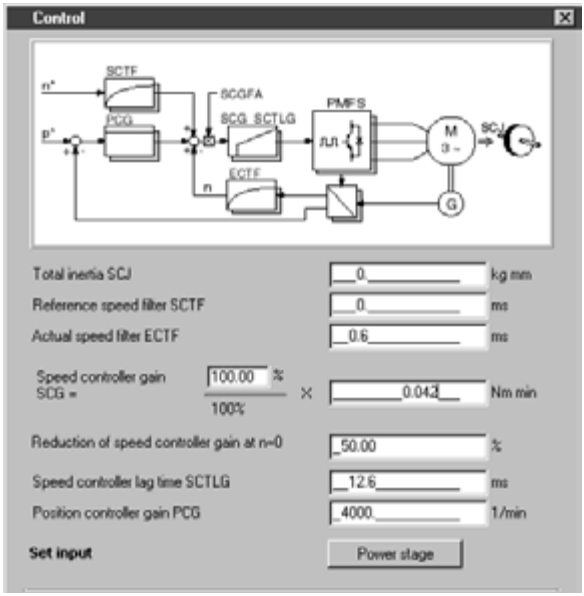


ProfiTool	Value range	FS	Unit	Parameter
Overall mass moment of inertia	0 ... 1000	0	ms	817_SCJ (_CTRL)
Speed reference filter	0 ... 1000	0	ms	816_SCTF (_CTRL)
Actual speed filter	0 ... 100	0.6	ms	818_ECTF (_CTRL)
Speed controller gain	0 ... 999.95	100.00	%	811_SCGFA (_CTRL)
Controller gain	0 ... 1000000000	0.035	Nm min	810_SCG (_CTRL)
Reduction of speed controller gain	0.00 ... 100.00	50.00	%	809_SCGFO (_CTRL)
Speed controller lag time	1 ... 2000	12.6	ms	812_SCTLG (_CTRL)
Position controller gain	1 ... 32000	4000	rpm	473_PCG (_CTRL)
Power stage setting	4 ... 16	8	k Hz	690_PMFS (_CONF)

Setting of parameter PMFS:

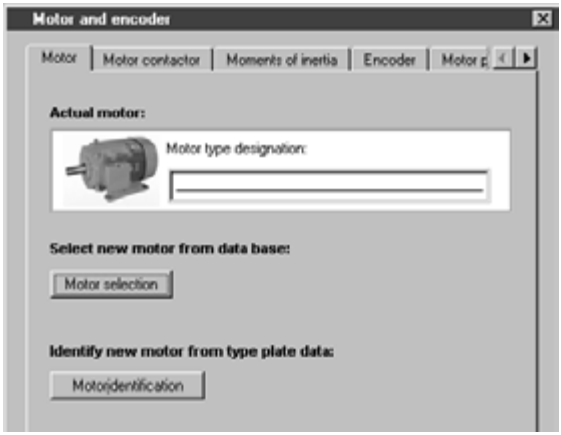
BUS	Setting	Function
0	4	4 kHz
1	8	8 kHz
2	12	12 kHz
3	16	16 kHz

6.4 Motor and encoder

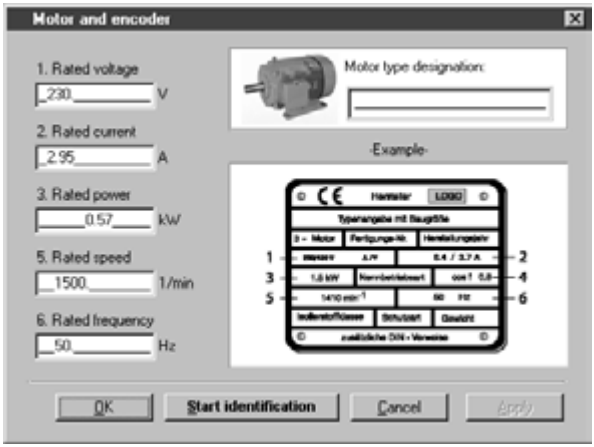
Motor setup

1.

2.



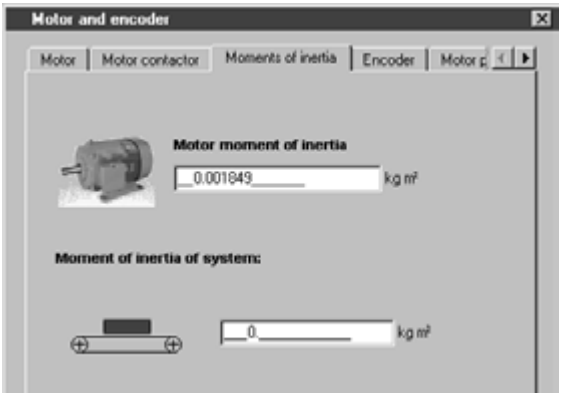
Motoridentification



Setting the motor data

ProfiTool	Value range	FS	Unit	Parameter
Motor type designation				839_MONAM (_MOT)
1. Rated voltage	0 ... 1000	230	V	155_MOVNM (_MOT)
2. Rated current	0.1 ... 64	2.95	A	158_MOCNM (_MOT)
3. Rated power	0.02 ... 1000000	0.57	kW	154_MOPNM (_MOT)
5. Nominal speed	0 ... 100000	1500	rpm	157_MOSNM (_MOT)
6. Rated frequency	0.1 ... 1600	50	Hz	156_MOFN (_MOT)

6.4.1 Moments of inertia



ProfiTool	Value range	FS	Unit	Parameter
Motor moment of inertia	0 ... 100	0	kgm^2	160_MOJNM (_MOT)
Moment of inertia of system	0 ... 1000	0	kgm^2	817_SCJ (_CTRL)

Setting motor mass moment of inertia (160-MOJNM)

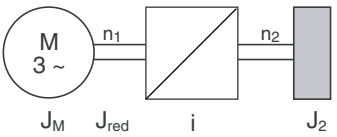
The mass moment of inertia of the motor must be entered under parameter 160-MOJNM in order to ensure optimum running.

If no mass moment of inertia is entered (160-MOJNM=0), a mass moment of inertia matching an IEC standard motor is defined based on the motor data. The mass moment of inertia of the motor is dependent on the number of pole pairs and the related rotor design.

Setting: Mass moment of inertia of system

If no mass moment of inertia is entered for the system, a 1:1 adjustment of the mass moment of inertia is assumed and the mass moment of inertia of the system is set equal to that of the motor.

Reduction of the mass moment of inertia of the system



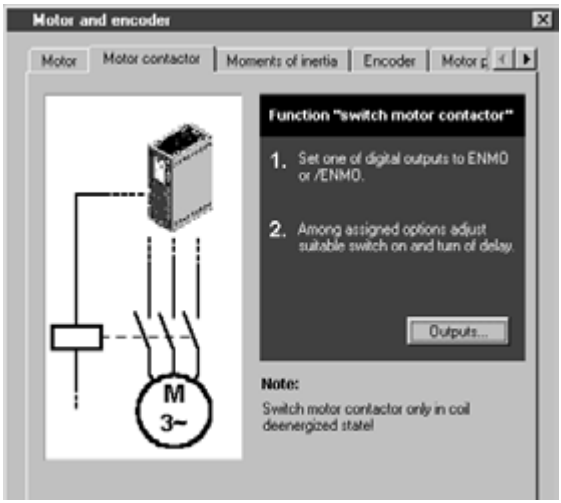
$$J_{red} = \frac{J_2}{i^2} = \frac{J_2}{\left(\frac{n_1}{n_2}\right)^2}$$

J_M = Mass moment of inertia of motor (MOJNM)
J_{red} = Reduced mass moment of inertia of system (SCJx)
i Gear transmission ratio factor

Image 6.17 Reduction of mass moment of inertia

Note: Above a ratio of 01:05 (J_M : J_{red}) the moment of inertia of the application must be specified, otherwise the control response will not be stable.

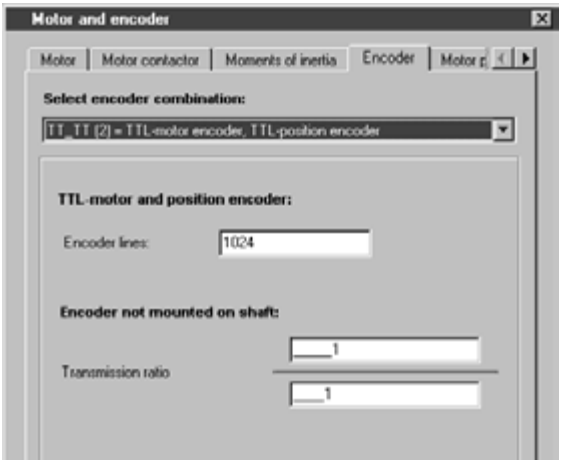
6.4.2 Motor contactor/open-loop control



When using a motor contactor the output should be assigned the ENMO functionality accordingly, and lastly motor identification started.

Setting: Section 6.1.4, "Digital outputs".

6.4.3 Encoder data/ configuration



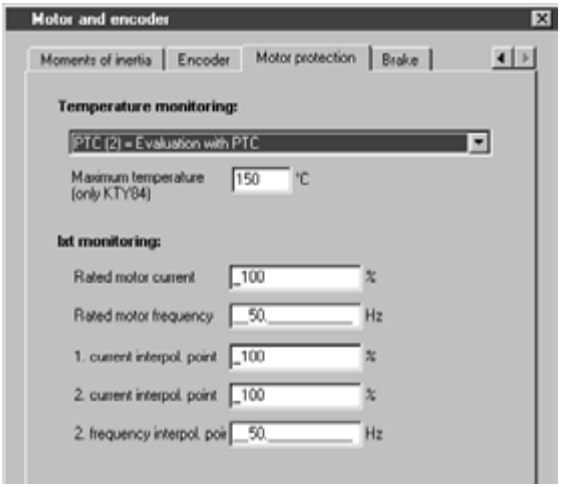
Depending on the selected encoder combination, the following settings can be made:

ProfiTool	Value range	FS	Unit	Parameter
Selection of encoder combinations	USER ... HT_TT	TT_TT	kgm^2	430_ECTYP (_ENC)

BUS	Setting	Function
0	USER	User-defined
1	HT_HT	HTL motor encoder, HTL position encoder
2	TT_TT	TTL motor encoder, TTL position encoder
3	HT_SI	HTL motor encoder, SSI position encoder
4	SI_SI	SSI motor encoder, SSI position encoder
5	HT_TT	HTL motor encoder, TTL position encoder

ProfiTool	Value range	FS	Unit	Parameter
ISD02	OFF ... ENC	OFF		212_FIS02 (_IN)
ISD03	OFF ... ENC	OFF		213_FIS03 (_IN)
Lines per revolution of HTL encoder	32 ... 8192	1024		482_ECLN2 (_ENC)
TTL motor and position encoder	32 ... 8192	1024		432_ECLN1 (_ENC)
Transmission ratio (numerator)	-32768 ... 32767	1		435_ECNO1 (_ENC)
Transmission ratio (denominator)	1 ... 65535	1		436_ECDE1 (_ENC)
Transmission ratio	-32768 ... 32767	1		480_ECNO2 (_ENC)
Transmission ratio	1 ... 65535	1		436_ECDE1 (_ENC)
Transmission ratio	1 ... 65535	1		481_ECDE2 (_ENC)
Multi-turn number of bits	0 ... 16	12		448_SSIMU (_ENC)
Single-turn number of bits	0 ... 20	13		447_SSISI (_ENC)

6.4.4 Motor protection



Monitoring of motor temperature by temperature sensors or by temperature-sensitive switches and Ixt monitoring.

Parameters: Motor protection

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Temperature monitoring		OFF ... KTY	OFF		330_MOPTC (_MOT)
Maximum temperature		10 ... 250	150	°C	334_MOTMX (_MOT)
Rated motor current	Rated motor current (I_N) for motor protection	0 ... 1000	100	%	335_MOPCN (_MOT)
Rated motor frequency	Rated motor frequency (f_N) for motor protection	0.1 ... 1000	50	Hz	336_MOPFN (_MOT)
1. Current interpolation point	1. Current interpolation point (I_a) of the motor protection characteristic (referred to the max. characteristic current)	0 ... 1000	100	%	332_MOPCA (_MOT)
2. Current interpolation point	2. Current interpolation point (I_b) of the motor protection characteristic (referred to the max. characteristic current)	0 ... 1000	100	%	331_MOPCB (_MOT)
2. Frequency interpolation point	2. Frequency interpolation point (f_b) of the motor protection characteristic	0.1 ... 1000	50	Hz	333_MOPFB (_MOT)

Settings for MOPTC:

BUS	ProfiTool	Function
0	OFF	Monitoring off
1	PTC	Evaluation with PTC to DIN 44082
2	TSS	Klixon (temperature switch as break contact)
3	KTY	Linear evaluation with KTY84-130

Table 6.10 Settings for type of motor PTC evaluation

Explanatory notes

- The position controller shuts off the motor with the error message E-OTM if the temperature exceeds a limit value.
  In evaluation by KTY84-130 the limit value can be set by parameter 334-MOTMX "Maximum motor temperature".
- The following temperature sensors can be evaluated:
  - Linear PTC (KTY 84-130, tolerance band yellow)
  - Threshold PTC (to DIN 44081, DIN 44082)
  - Thermostatic circuit-breaker (Klixon)
- With "KTY 84 -130" evaluation the current motor temperature is displayed in actual value parameter 407-MTEMP in °C.

Typical resistance values of a linear PTC (KTY 84 - 130)

Temperature (°C)	Typical resistance values (Ω) Tolerance ~ +/- 6%
-20	424
0	498
20	581
50	722
80	852
100	1000
150	1334

Table 6.11 Typical resistance values of a linear PTC of type KTY 84-130

Typical resistance range of a DIN PTC

Temperature (°C)	Typical resistance values (Ω)
-20 ... 150	50 ... 4000

Table 6.12 Typical resistance values of a DIN PTC with a TNF from 90 ... 160 °C

Diagram of a DIN PTC

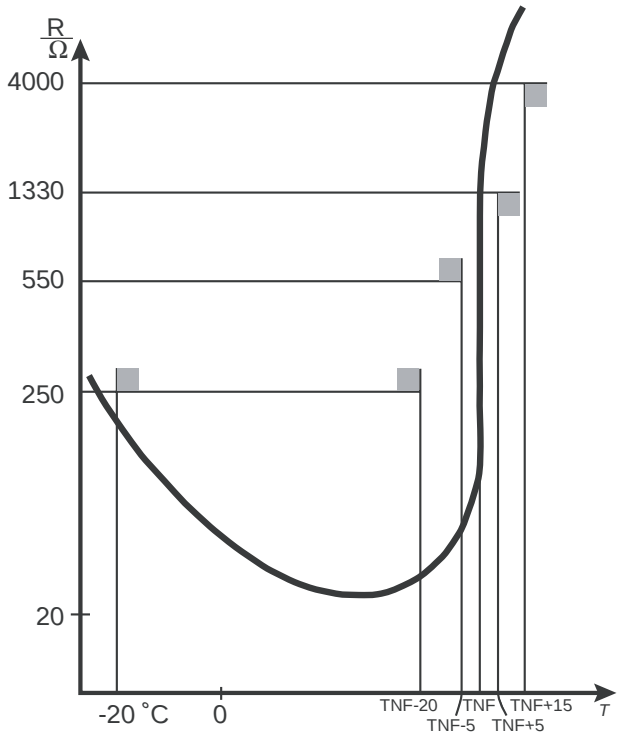


Image 6.18 Resistance diagram as function of temperature of a DIN PTC

Note: The resistance of the DIN PTC is always defined relative to its nominal response temperature (TNF, formerly termed T_{NAT}).
The measurable resistance is dependent on the fitting variant (PTC in-line configuration).

PTC evaluation dependent on the temperature curve of an IEC standard motor

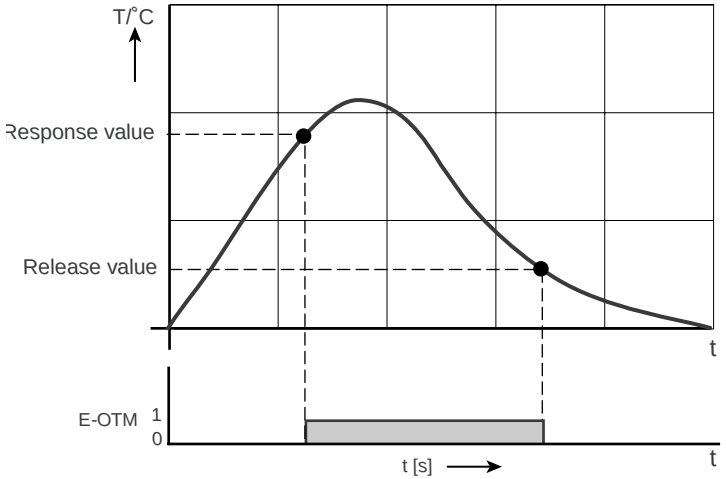


Image 6.19 PTC evaluation operation diagram

Ixt monitoring

Ixt monitoring protects the motor against overheating over its entire speed range. This is especially important for internally cooled motors, since in lengthy service at low speed the cooling provided by the fan and the housing is insufficient. When set correctly, this function replaces a motor circuit-breaker. The characteristic can be adapted to the operating conditions by way of interpolation points.

For parameters see above.

Settings for 335-MOPCN

Inverter module	Recommended 4-pole IEC standard motor [kW]	Rated motor current for motor protection, MOPCN [A]
P6000C0007TBC1	0.375	2.0
P6000C0007SAC1	0.75	3.4
P6000C0011SBC1	1.1	5.1
P6000C0015SBC1	1.5	6.5
P6000C0015TBC1	1.5	3.8
P6000C0022TBW1	2.2	5.6

Table 6.13 Rated motor current in factory setting in inverter module

Inverter module	Recommended 4-pole IEC standard motor [kW]	Rated motor current for motor protection, MOPCN [A]
P6000C0030TCW1	3.0	7.5
P6000C0040TCW1	4.0	9.1
P6000C0055TDW1	5.5	11.6
P6000C0075TDW1	7.5	16.3
P6000C0110TEW1	11	23.1
P6000C0150TEW1	15	31.1
P6000C0220TFW1	22	44.1
P6000C0300TFW1	30	57.1
P6000C0370TFW1	37	70.1
P6000C0450TGW1	45	85.1
P6000C0550TGW1	55	98.1
P6000C0750THW1	75	140.1
P6000C0900THW1	90	168.1

Table 6.13 Rated motor current in factory setting in inverter module

Explanatory notes

- Ixt monitoring protects the motor against overheating over its entire speed range when the motor protection characteristic is adjusted. This is important for internally cooled motors, because in lengthy service at low speeds the cooling by the housing and the fan may not be adequate.
- To protect the motor, as a rule of thumb the motor protection characteristic and operation of the IEC standard motor should conform to the following limit values.
  Observe the motor manufacturers' specifications.

Frequency (Hz)	Rated motor current (%)
0	30
25	80
50	100

6.4.5 Motor holding brake

The following software functions are used in both the open-loop and the closed-loop control modes.

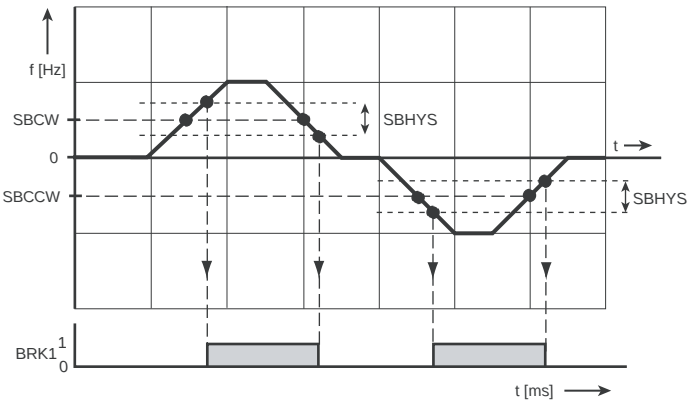
Function	Effect
• An electromechanical holding brake can be actuated depending on a limit value • Optionally, release and engaging of the holding brake can be timed.	• The holding brake engages when a minimum speed limit is infringed.

The motor holding brake has two modes BRK1 and BRK2.

M 3~ BRK1

Motor holding brake BRK1

The diagram below represents the function of the motor holding brake within the programmable speed range. The brake can be released by a digital output set by the function selector dependent on a reference.

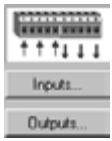


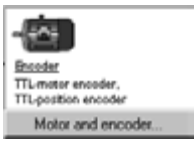
BRK1 Digital output

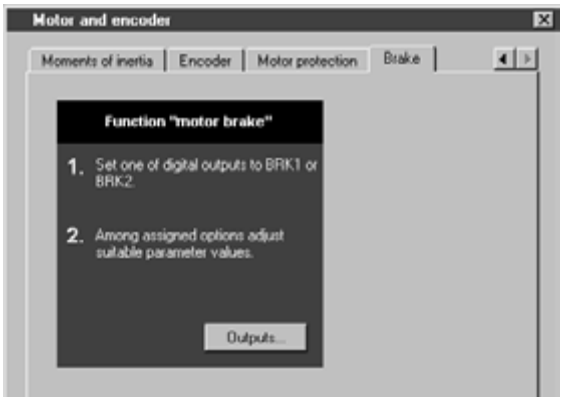
Image 6.20 Speed ranges of the holding brake in setting BRK1

The parameter settings for the motor holding brake are made via the "Outputs" buttons.

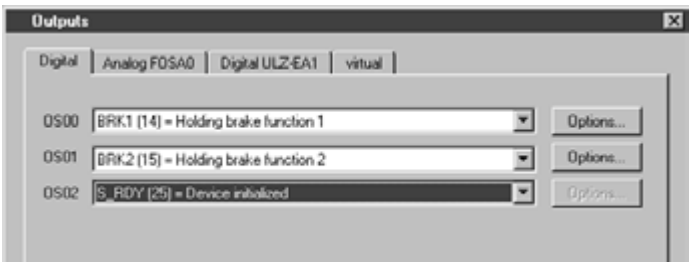
1.







2.



3.

Parameters for motor holding brake BRK1

ProfiTool	Function	Value range	FS	Unit	Parameter
Clockwise	BRK1: Speed limit for motor brake (clockwise)	0 ... 32764	0	rpm	310-SBCW (_FEPROM)
Anti-clockwise	BRK1: Speed limit for motor brake (anti-clockwise)	-32764 ... 0	0	rpm	311-SBCCW (_FEPROM)
Hysteresis	BRK1: Switch-on hysteresis of motor brake	-32764 ... 32764	1	rpm	312-SBHYS (_FEPROM)

Table 6.14 Parameters for motor holding brake BRK1

Settings of digital outputs for motor holding brake BRK1

Setting	Function	F0S00	F0S01	F0S02	F0E0x
BRK1	Output is set when the control reference has exceeded the value in parameter SBCxx (clockwise: SBCW; anti-clockwise: SBCCW).	✔	✔	✔	✔

Table 6.15 Settings for FOxxx of digital outputs for motor holding brake BRK1

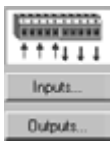
Explanatory notes

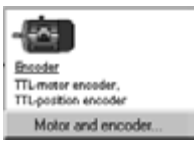
- The speed limit for engagement/release of the holding brake can be set independently for clockwise and anti-clockwise running. Pay attention to the switching hysteresis.
- The switching points for the motor holding brake BRK1 are linked to the reference value.

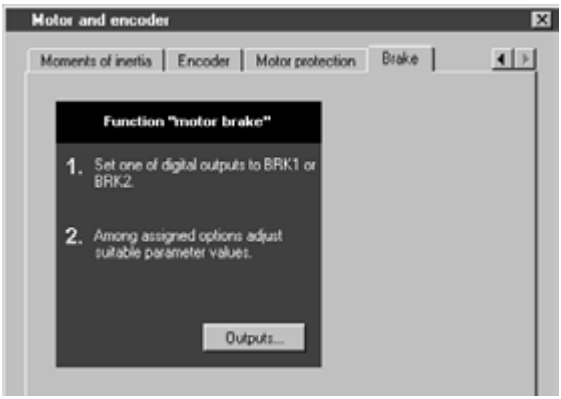
Motor holding brake BRK2

When the brake functionality BRK2 is selected via a digital output, the functionality is automatically adjusted. Allowance can be made for the time for release or engagement of the motor holding brake by means of separate timer elements. The precondition for release is that torque can be built up.

1.







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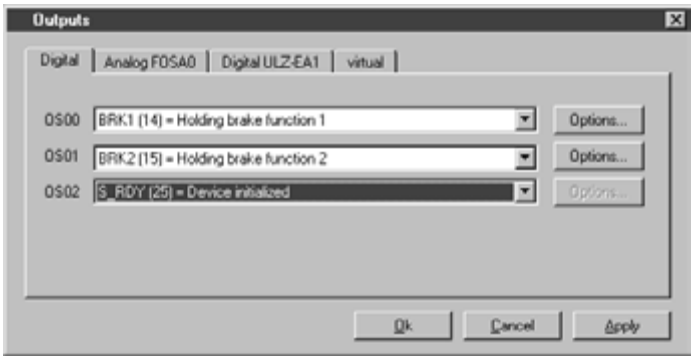

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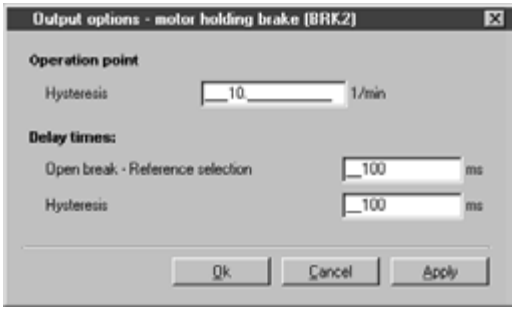


Parameters for motor holding brake BRK2

ProfiTool	Function	Value range	FS	Unit	Parameter
Hysteresis	BRK2: Speed hysteresis for motor brake	1 ... 32764	10	rpm	315-SSHYS (_FEPROM)
Open brake - reference input	BRK2: Delay in reference input with motor brake (brake pick-up time)	0 ... 65535	100	ms	316-TREF (_FEPROM)
Close brake - loop control off	BRK2: Delay in deactivation of loop control with motor brake (brake release)	0 ... 65535	100	ms	317-TCTRL (_FEPROM)

Table 6.16 Parameters for motor holding brake BRK2

Setting of digital outputs for motor holding brake BRK2

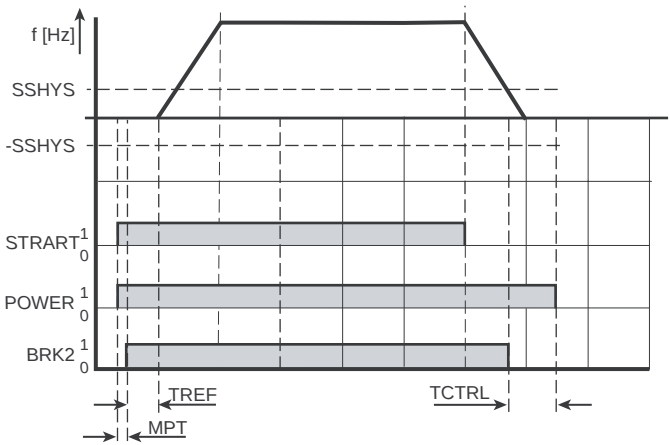
Setting	Function	F0S01	F0S02	F0S03	F0E0x
BRK2	Output is set.	✔	✔	✔	✔

Table 6.17 Settings for FOxxx of digital outputs for motor holding brake BRK2

Explanatory notes

- It is not possible to reconfigure a digital output from or to setting BRK2 online. To set the parameters the power stage must be inactive.
- In conjunction with brake actuation BRK2 with the motor protection control ENMO, the timer element 247-TENMO "Time between motor contactor and active control" is run before and after brake actuation.

Time diagram of motor holding brake BRK2



POWER Inverter power stage
BRK2 Digital output
MPT Motor flux build-up phase (generated automatic via loop control)

Image 6.21 Time diagram of motor holding brake BRK2

Explanatory notes

- Reference ≠ 0 rpm
- In the start phase the motor holding brake is switched depending on the reference value. If the current reference value is ≠ 0 rpm, the magnetization phase to build up flux in the motor is run for the time MPT. Then the digital output = BRK2 is activated and the timer element 316-TREF is activated. The 316-TREF time parameters should be set to the pick-up time of the brake. At the end of the time 316-TREF the brake should be released and the drive accelerates to the preset reference value. At the end of the time 316-TREF the functionality of the motor holding brake BRK2, the "reference reached" message and the standstill recognition are determined by the actual value of the rotor.
- Reference = 0 rpm
- If at reference = 0 rpm the actual value is in the configured "reference-reached window" of parameter 230-REF_R, motor standstill is detected. Simultaneously with reference input = 0 rpm, when the actual value of the speed limit 315-SSHYS is reached the timer element 317-TCTRL is started. The 317-TCTRL time parameters should be set to the release time of the brake. At the end of the time 317-TCTRL the brake should have safely engaged and hold the load. Finally the power stage is disabled.
- In the event of an error all outputs are set to LOW and the motor holding brake closes.

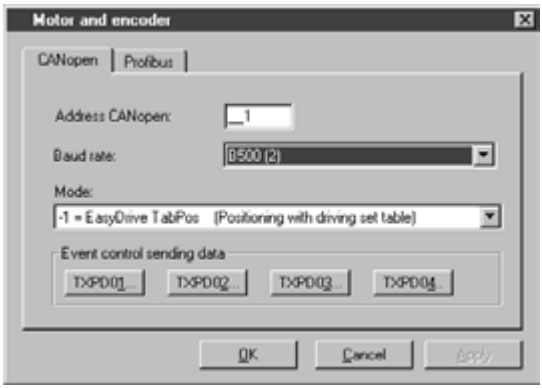
6.5 Bus systems

All configuration options are to be found in the "CAN_{open}" and "Profibus" User Manuals.

6.5.1 CAN$_{open}$

1.

2.



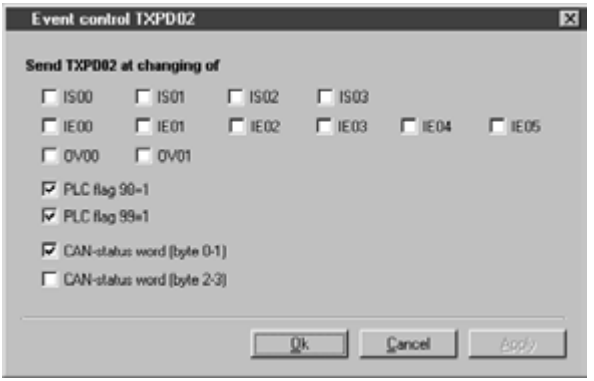
ProfiTool	Function	Value range	FS	Unit	Parameter
Address CAN$_{open}$	Setting device address	0 ... 127	1		580_COADR (_CAN)
Baud rate		B_1M ... B10	B500		581_COBDR (_CAN)
Operation mode		-128 ... 127	-1		638_H6060 (_CAN)

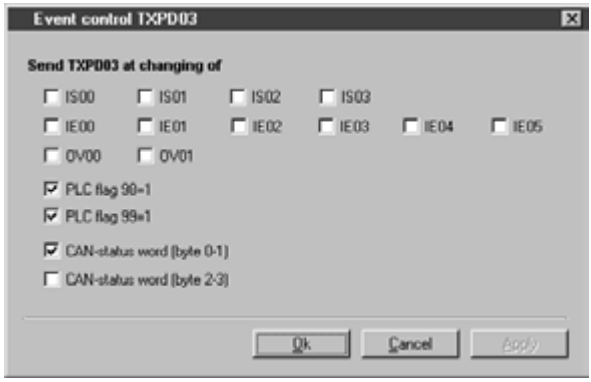
BUS	Setting	Effect
0	B_1M	1 MBaud
1	B800	800 kBaud
2	B500	800 kBaud
3	B250	250 kBaud
4	B125	800 kBaud
5	B50	50 kBaud
6	B20	20 kBaud
7	B10	10 kBaud

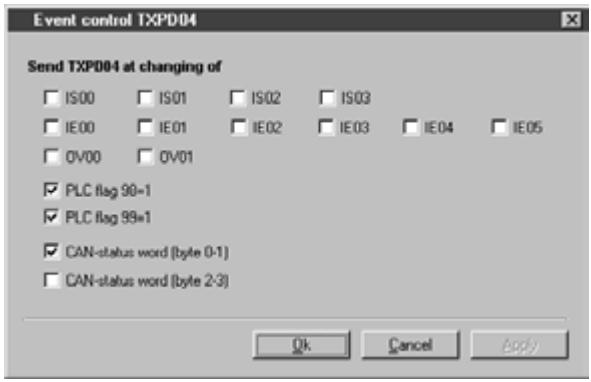
3.


Event control sending data
TXPD01...
TXPD02...
TXPD03...
TXPD04...


Event control TXPD01
Send TXPD01 at changing of
IS00
IS01
IS02
IS03
IE00
IE01
IE02
IE03
IE04
IE05
OV00
OV01
PLC flag 90=1
PLC flag 99=1
CAN-status word (byte 0-1)
CAN-status word (byte 2-3)
Ok
Cancel
Apply


Event control TXPD02
Send TXPD02 at changing of
IS00
IS01
IS02
IS03
IE00
IE01
IE02
IE03
IE04
IE05
OV00
OV01
PLC flag 90=1
PLC flag 99=1
CAN-status word (byte 0-1)
CAN-status word (byte 2-3)
Ok
Cancel
Apply

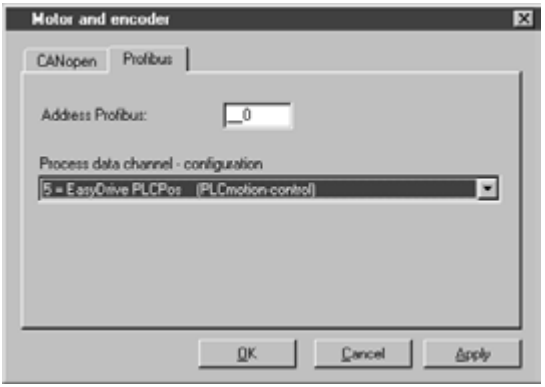




6.5.2 Profibus

1.

2.

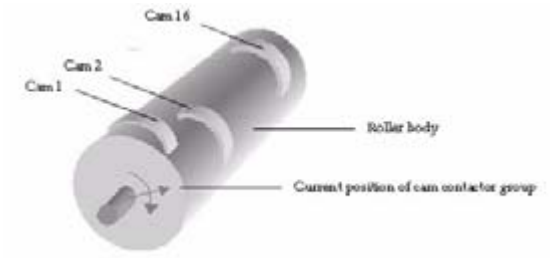


ProfiTool	Function	Value range	FS	Unit	Parameter
Address Profibus	Setting device address	0 ... 127	0		582_PPADR (_OPT)
Process data channel configuration		0 ... 255	0		589_OPCFG (_OPT)

6.6 Cam contactor group

Software cam contactor groups today offer the possibility of almost entirely replacing expensive mechanical cam contactor groups, and at low cost. This enables simple parameter setting and provides for clear functionality with short commissioning times.

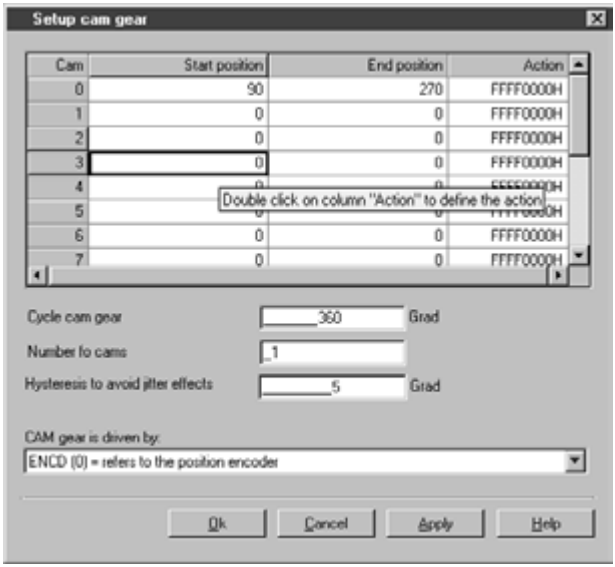
The cam contactor group implemented in the position controller can best be described as a roller with radially ridging (cams) along the roller axle. On the roller,16 cams with start and end position referred to the roller diameter (cycle) can be arranged in any way desired. Each cam is assigned an action register, which triggers the corresponding actions when the cam is reached. For example, this state can be signalled to a higher-level control by setting a flag CMx. The flag status CMx can be transmitted via outputs or over the field bus. The cam status can also be used by writing to a PLC flag Mxxx in the "PLCMotion" sequencer.



The cam contactor group is started and processed when the number of cams is specified as not equal to zero.

1.

2.



Double-clicking in the Action column opens up the following window:

3.

Press F1 in the "Define Action" window to open the latest online help.

The relevant contactor group configurations are made with the following parameters:

ProfiTool	Meaning	Value range	FS	Parameter
Start position	The cam positions can be set in any order, but logically must always be within the cycle. No check is made of this condition!	0 ... 2147483647	0	743_CSTAP (_CAM)
End position		0 ... 2147483647	0	744_CENDP (_CAM)
Action		00000000H ... FFFFFFFFH	FFFF0000H	745_CACTN (_CAM)
Cam contactor group cycle	At the end of the defined cycle a new cycle begins. The cycle is specified in user-specific units (positioning). If no unit is specified, the calculation is made in increments (speed-controlled), with 65536 increments corresponding to one revolution of the motor shaft.	0 ... 2147483647	0	741_CCCYC (_IN)
Number of cams	Only the defined number of cams is evaluated. If the defined number of cams is zero, the cam contactor group is not processed.	0 ... 15	0	742_CCNUM (_IN)
Hysteresis to prevent jitter	Logically, the cam length should be chosen greater than the hysteresis.	0 ... 2147483647	0	747_CCHYS (_IN)
Reference position	Here the position source feeding the cam contactor group is set. The following settings are possible: "ENCD [0] = Cam contactor group cycle referred to position encoder" := The cycle of the cam contactor group is determined by the current position of the position controller. "EGEAR [1] = Cam contactor group cycle referred to master encoder" := The cycle of the cam contactor group is determined by the external master encoder.	ENCD ... EGEAR	ENCD	740_CCENC (_CAM)
Direction=dependent switching		NEG ... OFF	OFF	750.x_CCDIR (_CAM)

Master encoder for cam contactor group

BUS	Setting
0	ENCD
1	EGEAR

The cam length should be chosen greater than the hysteresis.

CACTN = Action registers of the individual cams

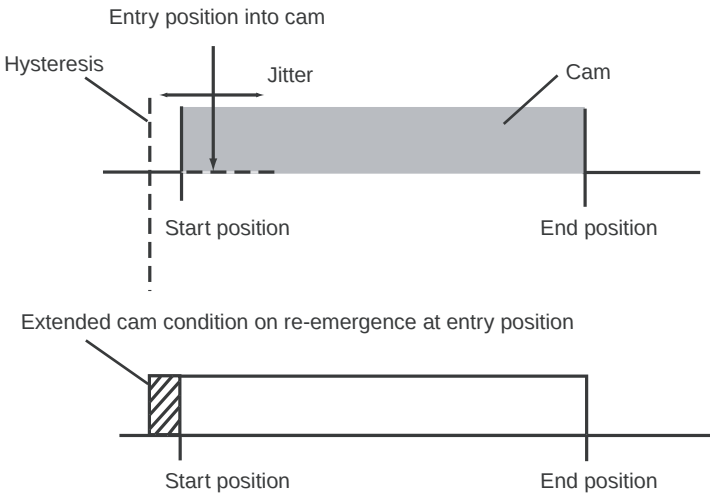
For each cam the following actions are possible (including in multiple combinations):

Bit	Action
0	Reserved for overrule (currently inoperative), possibilities include emergency stop, error,...
1	Reserved for overrule (currently inoperative)
2	Reserved for overrule (currently inoperative)
3	Reserved for overrule (currently inoperative)
4	Set output OS00 (FOS00 = CCOUT)
5	Set output OS01 (FOS01 = CCOUT)
6	Set output OS02 (FOS02 = CCOUT)
7	Set output OS03 (FOS03 = CCOUT)
8	Set output OE00 (FOE00 = CCOUT)
9	Set output OE01 (FOE01 = CCOUT)
10	Set output OE02 (FOE02 = CCOUT)
11	Set output OE03 (FOE03 = CCOUT)
12	Set output OV00 (FOV00 = CCOUT)
13	Set output OV01 (FOV01 = CCOUT)
14	Not used
15	Not used
16 ... 23	Number of iMotion flag (00h - 63h) or >63h for OFF
24 ...31	Number of iMotion flag (00h - 63h) or >63h for OFF

6.6.1 Hysteresis

To prevent jitter, a hysteresis can be specified. The first time the cam is reached the entry position is stored. If the cam is quit at the same position, for example, the cam state is only deactivated when the hysteresis (747-CCHYS) is also quit. For unique identification of the cam, the cam length should be adapted to the maximum velocity of the drive (detection in 1ms cycle).

Logically, the cam length should be chosen greater than the hysteresis.



6.6.2 Synchronization

Synchronization of the cam contactor group to the current position via PLCMotion:

By a positive edge of flag M75 the cam contactor group is synchronized to the current position.

Synchronization of the cam contactor group to the current position via terminal:

With a positive edge at the input programmed for start of "CAMRS (34) = reset cycle of cam contactor group" the cam contactor group is synchronized to the current position.

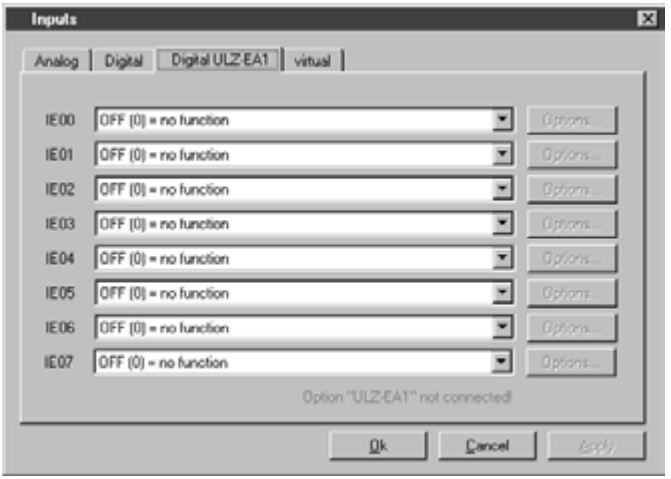
6.6.3 Stop

Stopping cam contactor group via PLCMotion or field bus:

If the number of cams (parameter "742-CCNUM-Number of cams") is set as zero, the cam contactor group is stopped.

Stopping cam contactor group via terminal:

If the input in the "Inputs/Digital" or "Inputs/Digital ULZ-EA1" user screen is programmed for cam contactor group, but not set, the cam contactor group is not processed.



6.7 KEYPAD KP10

Function	Effect
• Definition of the permanent displays • Composition of the user-defined parameter subject area _11UA	• Selection of key actual values for permanent display • Selection of key settings for the application

User-defined parameter subject area _11UA

- The user definable subject area _11UA is only visible in the PARA menu on the KEYPAD KP10 control unit.
- Parameter 13-UAPSP conceals a data box in which a maximum of 14 parameter numbers for viewing in subject area _11UA can be entered.
- No actual value parameters can be displayed in the parameter subject area.
- All parameters displayed in this subject area are editable at user level 1.

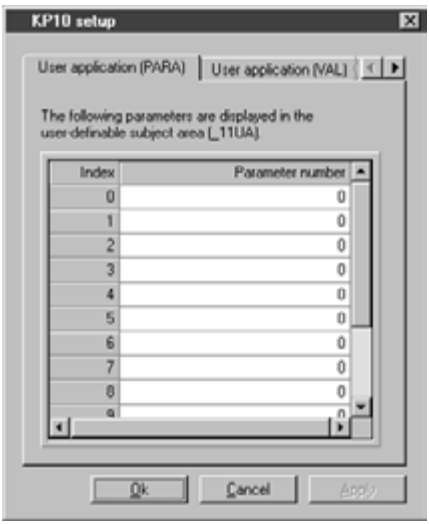


Image 6.22 Configuration of the user-definable parameter subject area

User-definable actual values

- The user-definable actual values are only visible in the VAL menu on the KEYPAD KP10 control unit.
- Parameter 12-UAVAL conceals a data box in which a maximum of 14 parameter numbers for viewing in the VAL menu can be entered.
- Editable parameters can also be displayed.
- All parameters entered here are visible at user level 1.

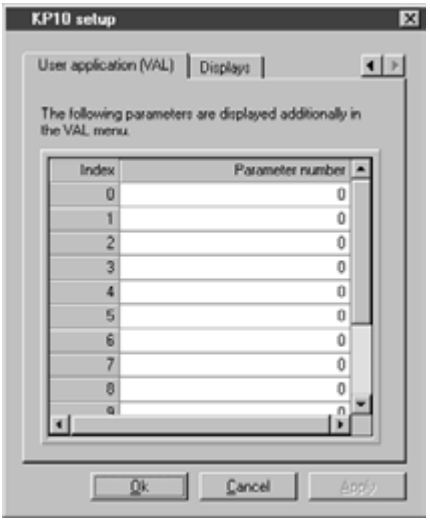


Image 6.23 Configuration of user-definable actual values in the VAL menu

Display for continuous actual value display and bar graph

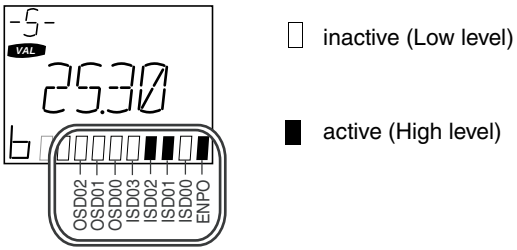


Image 6.24 Display for continuous actual value display and bar graph

The continuous actual value display and bar graph can be used separately to display actual values. The bar graph is used for status display of system values or to view trends of individual actual values.

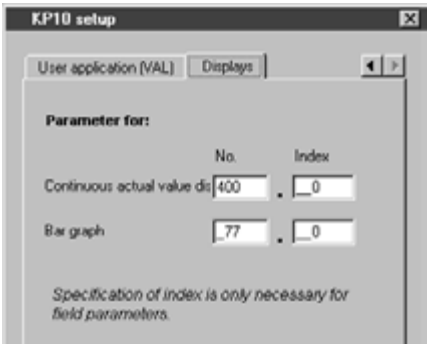


Image 6.25 Configuration of the continuous actual value and bar graph display

ProfiTool	Value range	FS	Parameter
Parameter number	0 ... 999	0	13_UAPSP (_KPAD)
Parameter number	0 ... 999	0	12_UAVAL (_KPAD)

ProfiTool	Value range	FS	Parameter
Continuous actual value display No. / Index	1 ... 999 / 0 ... 255	400 / 0	360_DISP / 375_DPIDX (_KPAD)
Bar graph No. / Index	1 ... 999 / 0 ... 255	170 /	361_BARG / 374_BGIDX (_KPAD)

Settings for 360-DISP and 361-BARG

Function	Parameter		KP10 user level	DISP	BARG
	PT	KP10			
Actual torque	14	ACTT	2	✔	✔
Actual speed	77	SPEED	2	✔	✔
DC-link voltage	405	DCV	2	✔	✔
Control actual value	400	ACTV	2	✔	
Current control reference	406	REFV	2	✔	✔
Effective value of apparent current	408	APCUR	2	✔	✔
System time after power-up	86	TSYS	3	✔	
Position controller operating hours	87	TOP	3	✔	
Power stage operating hours	413	ACTOP	2	✔	
States of digital inputs and outputs	419	IOSTA	2	✔	✔
Filtered input voltage ISA00	416	ISA0	4	✔	
Filtered input voltage ISA01	417	ISA1	4	✔	
Filtered input current ISA00	418	IISA0	4	✔	
Motor temperature with KTY84 evaluation	407	MTEMP	2	✔	
Interior temperature	425	DTEMP	2	✔	✔
Heat sink temperature	427	KTEMP	2	✔	✔
Faulty parameter in self-test	423	ERPAR	4	✔	
Filtered output voltage	420	OSA00	4	✔	

Table 6.18 Settings for continuous actual value display and bar graph

Scaling of parameters

Parameter	Function	Effect/Notes	Reference value
SPEED	Current actual speed	Clockwise only (positive values only)	Max. speed
APCUR	Current apparent current		$2*I_N$
ISA0	Voltage or current at analog input ISA00		10 V / 20 mA
ISA1	Voltage at analog input ISA01		10 V
MTEMP	Current motor temperature	Motor temperature only with linear evaluation (PTC)	200 °C
KTEMP	Current heat sink temperature	≤ 15 kW: Temperatures > 100 °C in the power stage module correspond to temperatures > 85 °C on the heat sink and result in a shut-off ≥ 15 kW: Temperatures >85 °C result in a shut-off, because the temperature sensor is mounted directly on the heat sink.	200 °C
DTEMP	Current interior temperature	Interior temperatures > 85 °C result in a shut-off	200 °C
DCV	DC-link voltage	Referenced values dependent on device version P6000xxxxS 500 V P6000xxxxT 1000 V	500 V / 1000 V
ACTT	Current actual torque		Max. torque

Table 6.19 Scaling of parameter actuals

6.8 Actual values

6.8.1 Temperature monitoring

Function	Effect
• Visualization of device and motor temperatures	

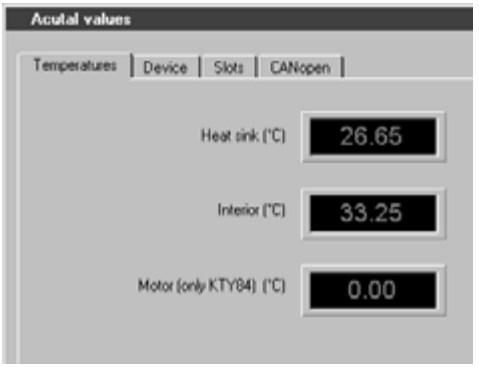


Image 6.26 Temperature actual values display

Parameters for temperatures

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Heat sink	Inverter heat sink temperature	*			427-KTEMP (_VAL)
Interior	Inverter interior temperature	*			425-DTEMP (_VAL)
the motor	Motor temperature. Only displayed if the motor is fitted with a linear temperature sensor KTY84-130	*			407-MTEMP (_VAL)

Table 6.20 Temperatures

Explanatory notes

- Parameter values which are produced from current calculations and so are not editable have an asterisk (*) in the "Value range" column.

6.8.2 Device data

Function	Effect
• Delivery of all data of the position controller	• Unique identification of the position controller and the device software

The device data contain information on the hardware and software which should be kept to hand and quoted when calling on telephone support.

The device data can in part also be read from the rating plates.

Image 6.27 Device data tab

Parameters for device data

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Software version	Software revision	*			92-REV (_STAT)
Software version suffix -xx	Revision index as suffix to revision number	*			106-CRIDX (_STAT)
CS:	Checksum XOR	*			115-CSXOR (_STAT)
Serial number	Serial number of device	*			127-S_NR (_STAT)
Data set name	Data set name	0-28 characters	-		89-NAMDS (_CONF)

Table 6.21 Device data

ProfiTool	Meaning	Value range	FS	Unit	Parameter
DC-link voltage	Current DC link voltage		-		405-DCV (_VAL)
Operating hours		*	124		87-TOP (_VAL)
Time after power-on		1 ... 65535	0	A	86-TSYS (_VAL)

Table 6.21 Device data

Explanatory notes

- Parameter values which are produced from current calculations and so are not editable have an asterisk (*) in the "Value range" column.

6.8.3 Option

Function	Effect
• Delivery of all data of the option module	• Unique identification of the connected option module

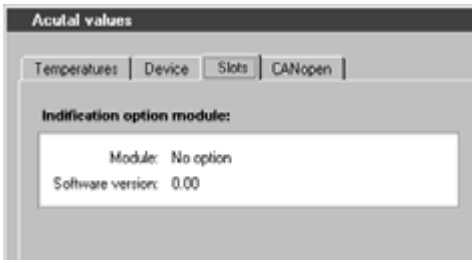


Image 6.28 Option module status display

Use of the following modules is possible:

- Profibus field bus module ULZ-DPV1
- I/O expansion modules ULZ_EA1

The actual value display is dependent on the module concerned

For more information on the option modules refer to the relevant User Manual (e.g. Profibus User Manual).

6.8.4 CAN_{open} field bus status

Function	Effect
• Delivery of status of CAN_{open} communication	• Unique identification of correct data transfer

Image 6.29 Status of CAN_{open} communication

Parameters for temperatures

ProfiTool	Meaning	Value range	FS	Unit	Parameter
Active operation mode	Active CAN_{open} operation mode as per DS402	*			653-H6061 (_CAN)
Control word (byte 3-0)	Control word of field bus communication	*			573-H6040 574-H223E (_CAN)
Status word (byte 3-0)	Status word of field bus communication	*			572-H6041 575-H223F (_CAN)
Network status	Current status of network				588-NMT (_CAN)

Table 6.22 Temperatures

Explanatory notes

- Parameter values which are produced from current calculations and so are not editable have an asterisk (*) in the "Value range" column.
- Detailed diagnosis of the bus system is only possible with standard commercially available bus analyzers. Here it is only possible to check the control and status information.

For more information on CAN communication refer to the CAN_{open} User Manual.

6.9 Warnings/ Errors

1.

2.

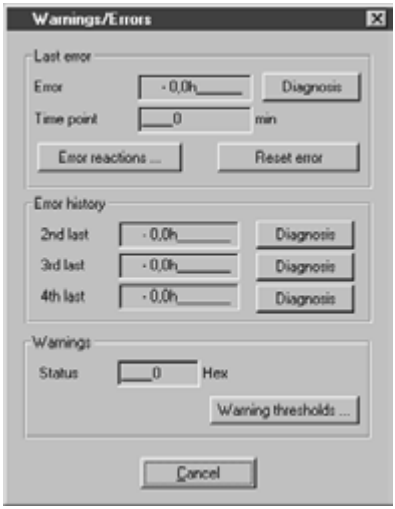


Image 6.30 "Warnings/Errors" tab

6.9.1 Warning messages

Function	Effect
• When programmable limit values are exceeded for various actual values of the inverter module or of the motor a warning is delivered.	• An impending fault in the drive system is signalled in good time to the system control.

Warning messages are automatically reset as soon as the cause of the warning no longer exists. The warning message is sent via the digital outputs, and at the same time the actual value to be monitored for the warning is also defined.

3.

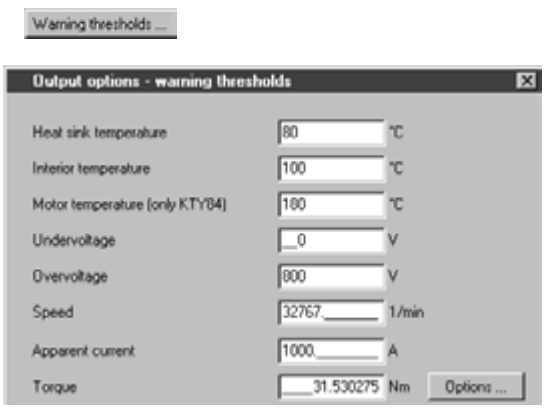


Image 6.31 Warning thresholds

Warning messages

ProfiTool	Value range	FS	Parameter
Heat sink temperature	5 ... 100	100	500_WLTI (_WARN)
Interior temperature	5 ... 80	80	501_WLTD (_WARN)
Motor temperature (only KTY84-130)	5 ... 250	180	502_WLTM (_WARN)
Undervoltage	0 ... 800	0	503_WLUV (_WARN)
Voltage overload	0 ... 800	800	504_WLOV (_WARN)
Output frequency	0 ... 32767	32767	505_WLS (_WARN)
Apparent current	0 ... 1000	1000	506_WLIS (_WARN)
Torque	-10000 ... 10000	10000	507_WLTQ (_WARN)

Options ...

ProfiTool	Value range	FS	Parameter
Switch-on delay	0 ... 10	0	508_TWLTQ (_WARN)

Explanatory notes

- Any warning can be delivered at any digital output.
- The motor temperature warning (WLTM) indicates a motor overload.
- The device temperature warning (WLTI) takes the temperature value from the sensor on the heat sink on the power stage transistors or, in the case of small inverter modules, directly from the power stage module.
- Owing to high breakaway and startup torques, it may be necessary to activate the torque warning threshold only after the threshold value has been exceeded for a period of time. This can be done with parameter 508-TWLTQ "Switch-on delay for torque warning threshold".
- Inadequate or excessive DC-link voltage triggers the undervoltage (WLUV) or voltage overload (WLOV) warning as appropriate.
- The status word 120-WRN is formed from the current warning messages. It is displayed in the Error/Warning window.

Note: The warning messages are displayed in the PROFITOOL on a separate status bar. They can also be evaluated in hexadecimal coding in parameter 120-WRN.

A listing of the error and warning messages displayed in the PROFITOOL is given in the Appendix.

Warning messages are assigned a hysteresis:

Physical variable	Hysteresis
Voltages	Undervoltage - 0V / + 10 V Voltage overload - 10 V / + 10 V
Temperature	- 0 °C / + 5 °C
Frequency	+ 0 Hz / - 1 Hz

Table 6.23 Hysteresis of warning messages

Status word 122-WRN

Warning	Function	Hex value	Bit
WOTI	Warning message when heat sink temperature has exceeded value in parameter 500-WLTI	0001H	0
WOTD	Warning message when interior temperature has exceeded value in parameter 501-WLTD	0002H	1
WOTM	Warning message when motor temperature has exceeded value in parameter 502-WLTM	0004H	2
WOV	Warning message when DC-link voltage has exceeded value in parameter 504-WLOV	0008H	3
WUV	Warning message when DC-link voltage has fallen below value in parameter 503-WLUV	0010H	4
WLS	Warning message when output speed has exceeded value in parameter 505-WLS	0020H	5
WIS	Warning message when apparent current has exceeded value in parameter 506-WLIS	0040H	6
WIIT	Warning message when I^2*t integrator of device is active	0080H	7
-	Reserved	0100H	8
WIT	Warning message when Ixt integrator of motor is active	0200H	9
WLTQ	Warning message when torque has exceeded value in parameter 507-WLTQ	0400H	10

Table 6.24 Hexadecimal representation of warning messages

6.9.2 Error messages

Function	Effect
• Display of faults in the drive system	• Quick location of the cause of the error and definition of the response of the drive to an error

Error messages can be detected and evaluated by way of the status LEDs of the inverter module. If the red LED H1 is flashing an error has occurred.

The response to an error can be parameterized according to the cause of the error.

Flash code of red LED (H1)	Display KEYPAD	Error cause
1x	E-CPU	Collective error message
2x	E-OFF	Undervoltage shut-off
3x	E-OC	Current overload shut-off
4x	E-OV	Voltage overload shut-off
5x	E-OLM	Motor overloaded
6x	E-OLI	Device overloaded
7x	E-OTM	Motor temperature too high
8x	E-OTI	Heat sink/device temperature too high

Table 6.25 Error message signalling

Note: For more error numbers and possible causes refer to the Appendix.

Acknowledgment and resetting of errors

Errors can be acknowledged and reset in various ways:

- Rising edge at digital input ENPO
- Rising edge at a programmable digital input with setting of the function selector to RSERR
- Write value 1 to parameter 74-ERES via bus system or via corresponding bit in control word
- In the ProfiTool, on the Error//Warning tab, by clicking the "Reset error" button

Errors and their responses

Error reactions ...

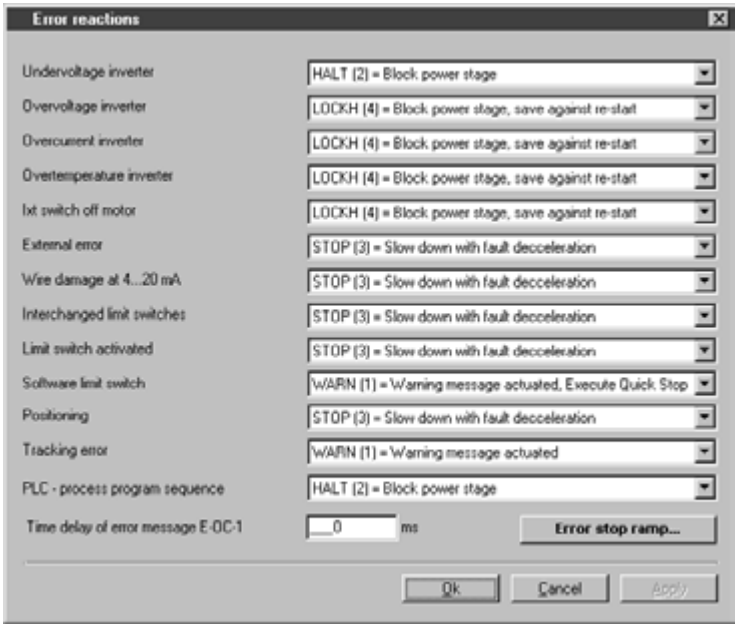


Image 6.32 Setting of error responses

Error parameters

ProfiTool	Value range	FS	Parameter
Inverter undervoltage	STOP ... RESET	STOP	512_R-OFF (_ERR)
Inverter voltage overload	STOP ... RESET	LOCKH	514_R-OV (_ERR)
Inverter current overload	STOP ... RESET	LOCKH	513_R-OC (_ERR)
Motor overheating	STOP ... RESET	LOCKH	516_R-OTM (_ERR)
Motor Ixt shut-off	STOP ... RESET	LOCKH	519_R-OLM (_ERR)
External error message	WARN ... RESET	STOP	524_R-EXT (_ERR)
Wire break at 4 .. 20 mA	WARN ... RESET	STOP	529_R-WBK (_ERR)
Interchanged limit switches	STOP ... RESET	STOP	535_R-LSX (_ERR)
Limit switch approached	STOP ... RESET	STOP	534_R-LS (_ERR)
Software limit switch	NOERR ... LOCKS	WARN	543_R-SWL (_ERR)
Positioning	STOP ... RESET	STOP	536_R-POS (_ERR)
Tracking error	WARN ... RESET	WARN	542_R-FLW (_ERR)
PLC sequence program	WARN ... RESET	STOP	541_R-PLC (_ERR)
Time delay, error message E-OC-1	0 ... 1000	0 ms	545_TEOC (_ERR)

Table 6.26 Error messages

Explanatory notes

- The error stop ramp parameters can be set on a separate tab. See Section 6.2.3

Meanings of the various error responses

BUS	KP/PT	Function
0	NOERR	No response
1	WARN	Trigger warning (message), no further response relating to drive
2	STOP	Disable power stage. If the error is no longer present, the device can be restarted after confirming the error message. If auto-start is programmed (7-AUTO=ON), the device starts automatically following the reset.
3	STOP	Brake drive with error stop ramp down to 0 rpm, then disable power stage. If the error is no longer present, the device can be restarted after confirming the error message. If auto-start is programmed (7-AUTO=ON), the device starts automatically following the reset.
4	LOCKH	Disable power stage and secure against restarting. If the error is no longer present, the device can be restarted after confirming the error message. If auto-start is programmed (7-AUTO=ON), automatic starting of the device is prevented.
5	LOCKS	Brake drive with error stop ramp down to 0 rpm, then disable power stage. Secure against restarting. If the error is no longer present, the device can be restarted after confirming the error message. If auto-start is programmed (7-AUTO=ON), automatic starting of the device is prevented.
6	RESET	Disable power stages and wait for error reset by power down/up. **NOTE:** This error can **only** be reset by powering down and back up! After a reset the device runs through an initialization and self-test phase. During this time it cuts bus links and detects no signal changes at the inputs. Additionally, the outputs return to their hardware home positions. Conclusion of an initialization and self-test phase can be indicated by way of a digital output with "Device ready". If the error is no longer present, the device indicates "ready" following the reset and can be restarted. If auto-start is programmed (7-AUTO=ON), the device starts automatically.

Table 6.27 Response to error

Presentation of error history

Parameters 95-ERR1 to 98-ERR4 store the error with its location and number and the time of error referred to the operating hours meter.

After each error the error memory scrolls on and error parameter 95-ERR1 displays the last error.

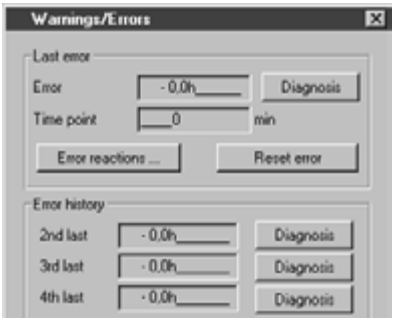
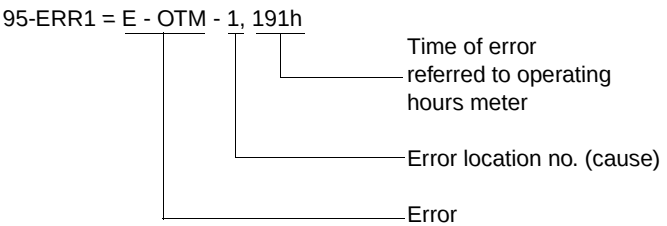


Image 6.33 Display of error history in PROFITOOL

Example of viewing on PROFITOOL:

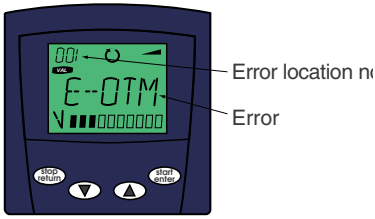


ProfiTool	Meaning	Value range	FS	Unit	Parameter
Last error - Error	Last error occurring	0 ... 65535	0	h	95-ERR1 (_ERR)
Last error - Time point	System time on occurrence of last error	0 ... 65535	0	min	94-TERR (_ERR)
Error history - 2nd last	Second-last error	0 ... 65535	0	h	96-ERR2 (_ERR)
Error history - 2nd last	Third-last error	0 ... 65535	0	h	97-ERR3 (_ERR)
Error history - 2nd last	Fourth-last error	0 ... 65535	0	h	98-ERR4 (_ERR)

Table 6.28 Parameters from subject area _51ER Error messages

Note: A listing of the error and warning messages displayed in the PROFITOOL is given in the appendix.

Example of viewing via KEYPAD KP10:



E-OC time limited error checkback

When switching in the motor cable at the motor output of the position controller, if the power stage is active or the motor is still excited high voltages and currents will occur for a short period of time. Although they cannot destroy the frequency inverter power stage, they do produce error message E-OC-1. The power stage is disabled as soon as the current overload is detected with message E-OC-1. The programmable time delay delays the error message, and at the end of the delay time a check is made whether the hardware enable ENPO is still set. If it is, the error message is signalled.

7 User programming

7.1 PLC functionality

The firmware includes a routine for sequential processing of a user-programmable sequence program.

Number of programs in device memory:	1
Number of command lines per program:	254
Edit time per command line:	1 ms

The sequence program permits:

- Starting motor control
- Reference input for motor control (torques, speeds, position)
- Setting/reading analog and digital inputs/outputs
- Reading/writing parameters
- Mathematical operations (+,-,*, :, ≠, ≤,, ≥, modulo, abs, round)
- Logic operations (AND, OR, Exclusive OR)
- Time or numerator functions
- Single-axis positioning control

An installed PROFITOOL is required for use of the PLC functionality and the PLC Editor, as it is an integral component of it.

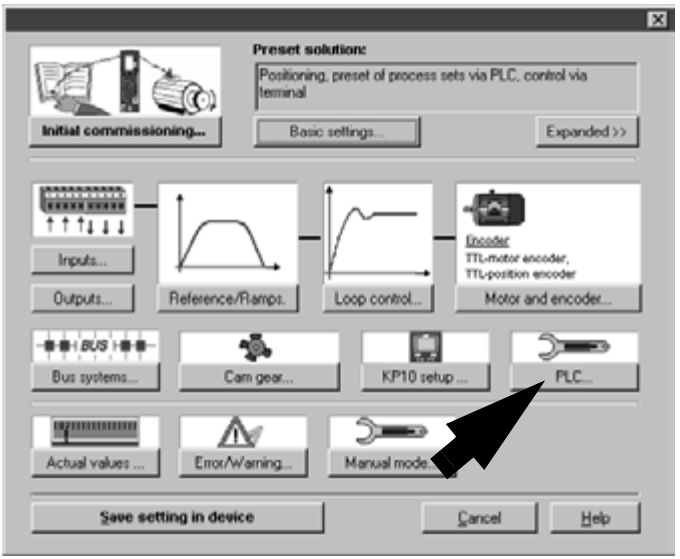
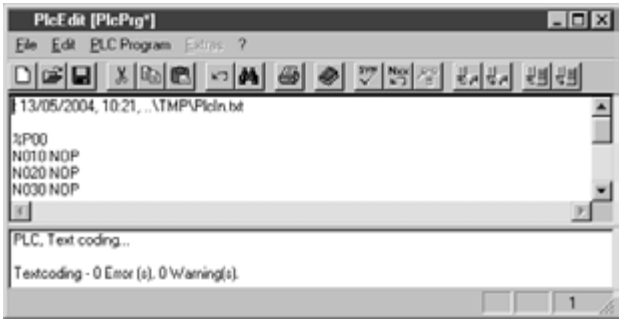


Image 7.1 PROFITOOL main window

7.2 PLC program

7.2.1 PLC Editor

The PLC Editor is a component of the PROFITOOL and accordingly can only be used by way of the PROFITOOL.



The PLC Editor is only required for project design and initial commissioning. In-production commissioning of the drive controller is then effected by way of the PROFITOOL data set or the DATACARD.

The PLC Program Editor offers the following functions:

- Program writing
  - Program writing editor
  - Generation of a text declaration file <projectname>.txt for the variables for display of application-specific texts in the PROFITOOL
  - Syntax checking of the command code
  - Renumbering of the line numbers
- Program handling
  - Loading/saving/printing/writing new programs
  - Loading/saving of a program from/to the connected drive controller
    Loading/saving a program from/to a PROFITOOL data set
- Online help on the PLC Editor and on the command syntax, with examples

All PLC functions can be selected via function buttons.

New program
Open program as file
Save program as *.plc file
Cut text
Copy text
Paste text
Undo
Find/Replace
Print program
Online Help
Program syntax check / Rump program with new file
Renumbering of the line numbers
Load program from data set
Save program to data set
Load program from device
Save program in device

7.2.2 Writing a new program

For a **quick start** or to **write a new** sequence program the syntax check is called up with an empty text box. The PLC Editor now offers the facility to write a rump program.

7.2.3 PLC program structure

The PLC Program Editor supports the PLC Editor program writing, program handling and online help functions. The functions can be selected by way of buttons - see section 4.2.1 "PLC Editor".

A program is divided into two parts:

1. Text declaration for variables, flags, numerators and timers used
2. Sequence program

The **text declaration** identifies the variables, flags, numerators and timers used in the sequence program with the application-specific function. From the text declaration, a text file is generated which is evaluated in the PROFITOOL and which displays the variables with the application-specific texts.

The text declaration begins with the identifier, containing the project name of the text declaration file (for details see "PLC program files").

```
%TEXT (projectname)              ; Begin text declaration
```

Assignment of the parameter texts follows:

```
DEF M000 = Reference point_OK
DEF H000 = Reference position_1
DEF H001 = Reference position_2
DEF H002 = Actual position
DEF H003 = Zero correction
```

The end of the text declaration is always marked by the line:

```
END
```

The text declaration is optional. Non-declared PLC parameters are not displayed in the text file and displayed in the PROFITOOL with their number.

Bild 7.2 Display of PLC variables with application-specific texts

The **sequence program** follows on from the text declaration. It contains a program header, the actual program part and the program end.

The program header comprises a line containing the program number (here at the moment only %P00 possible):

```
%P00
```

The lines of the actual program part are designated command lines. The maximum number of sets that can be stored in the P6000 is limited to 254 (N001 ... N254). Each command line is composed of the line number, the command and the operand. Separated by a semicolon, a comment can also be inserted.

```
N030 SET M000 = 0     ;           Reference point not defined
```

At the end of the program the following line (without line number) always comes:

```
END
```

You will find sample programs in the installed PROFITOOL directory "..\userdata\samples\PLC".

7.2.4 Program checking and editing

The **syntax check** checks the current program for errors in the command code. It is automatically run when the program is saved to the drive controller, or can be executed manually by clicking the relevant button. The result of the check is displayed on the status bar. If error messages occur, a double-click on the message leads directly to the program line containing the error.

The **renumbering** of the line facilitates the insertion of program sets. On renumbering, the first line is assigned the number N010, and all further numbers are incremented in stepwidths of 10 (N020, N030, ...). If a program cannot be displayed in such a way within the specified line range (001-254) the stepwidth is automatically reduced.

7.2.5 PLC program files

The **program content** is stored in two files:

1. **Program file** *.plc
   This file contains the sequence program and the text declaration, and so holds the complete program information. This means when forwarding the PLC program all that is needed is to copy this file.
2. **Text declaration file** <projectname>.txt
   The file is used by the PROFITOOL to display the application-specific parameter names.
   It is automatically generated from the text declaration of the program file after the program was been successfully loaded into the drive controller or into a data set. The <projectname>.txt file is copied to the PROFITOOL directory
   "WATTDRIVE\ ProfiTool\firmdata\<projectname>.txt". This file is only available on the PC with which the program was written and the source code was loaded into the drive controller. It can be copied to other PCs, however.

The entire sequence program is stored as machine code in two parameters. These parameters are contained in the device data set, and can be loaded and saved accordingly via the PROFITOOL or for in-production commissioning via the DATACARD.

To reproduce all program information and data each program must be saved as a *.plc file.
The comment lines in the sequence program and the text declarations are not stored in the controller or in the device data set, so they cannot be read back.

7.2.6 Program handling

Open / Edit

An existing PLC program can be opened in different ways:

1. Double-click on the *.plc file. The PROFITOOL opens, and in turn launches the PLC Editor and the program.
2. Open from the PROFITOOL menu by choosing "File/Open/PLC sequence program ...".

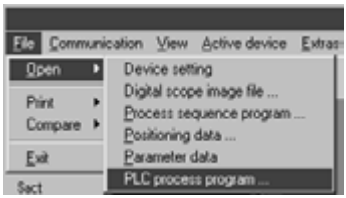


Bild 7.3 Open a PLC program via the ProfiTool

3. Open via the running PLC Editor. 
4. Open a program from a device data set. 

Save after creating/editing

An existing PLC program can be saved by the PLC Editor in different ways.

1. Save a program to a file 

   By way of this button a *.plc is created on your PC containing the PLC program and the text declaration. As well as the *.plc file the text declaration file is also created - see section 4.2.5 "PLC program files".

2. Save a program to a device 

   By way of this button the PLC program is stored in the controller. It is saved as machine code in two parameters 0- see section 4.2.5 "PLC program files".

3. Save a program to a data set 

   Where a device data set exists, this button can be used to save a PLC program to it.

Achtung: It is not possible to create a new data set containing only the PLC program.

7.3 PLC command syntax

Operand	Comments
Cxx, Cyy	Numerator index 00-10
Hxxx, Hyyy	Variable index 000-127
Fxxx, Fyyy	Variable index 000-127
Zxx, Zyy	Timer index 00-10
Ny	Line number 001-254
PARA[n, i]	Parameter number n 000-999 Parameter index i 000-255
Mxxx, Myyy	Flag index 000-255
Ippi	Inputs ppi = A00, A01 S00-S03, E00-E07
Oppi	Outputs ppi = S00-S02, E00-E03

Operand	Comments
b	Value 1-32
d	Status of a numerator 0 ... 65535 (16 bit)
t	Status of a timer 0 ... 4,294,967,295 (32 bit)
f	Floating-point numeric value (32 bits)
z	Integer numeric value ±2147483648 (32 bit)

Operand	Comments
&	AND
|	OR
^	Exclusive OR
!=	≠
<=	≤
>=	≥
%	Modulo
ABS	absolute value

Operand	Comments
+	addition
-	subtraction
*	multiplication
:	division
%	modulo
ABS	absolute value
ROUND	rounding

7.3.1 Overview

Command	Operand		Comments
Jump commands			
JMP		Ny/END	Unconditional jump
	(ACTVAL = < > Hxxx,Fyyy)	Ny/END	Actual
	(ACTVAL <= >= Hxxx,Fyyy)	Ny/END	
	(ACTVAL != Hxxx,Fyyy)	Ny/END	
	(ACTVAL = != 0)	Ny/END	
	(REFVAL = < > Hxxx,Fyyy)	Ny/END	Reference
	(REFVAL <= >= Hxxx,Fyyy)	Ny/END	
	(REFVAL != Hxxx,Fyyy)	Ny/END	
	(REFVAL = != 0)	Ny/END	
	(REF = 0/1, =Mxxx)	Ny/END	Axle status
	(ROT_0 = 0/1, =Mxxx)	Ny/END	
	(Ippi = 0/1)	Ny/END	Status of an input
	(Oppi = 0/1)	Ny/END	Status of an output
	(Mxxx = 0/1, = != Myyy)	Ny/END	Status of a flag
	(Mxxx & | ^ Ippi)	Ny/END	Log. gate, flag input
	(Mxxx & | ^ Oppi)	Ny/END	Log. gate, flag output
	(Hxxx = != 0)	Ny/END	
	(Hxxx = != < <= > >= Hyyy) Ny/END		Quantity of integer variable
	(Fxxx = != 0.0)	Ny/END	
	(Fxxx= != < <= > >= Fyyy) Ny/END		Quantity of floating-point variable
	(Cxx = != d)	Ny/END	Numerator status
	(Zxx = != 0)	Ny/END	Timer status
	END		Jump to end of program
Subroutine call			
CALL	Ny		Subroutine call after line Ny Maximum nesting depth: 250
RET			Return to line of subroutine call
BRKPT	SET BRKPT=1		Sets a break point in the program line.
	SET BRKPT=0		No function

Command	Operand	Comments
Set commands		
SET	Oppi = 0/1, Mxxx	Set output directly or with flag
	OUTPUT = Hxxx	Set output map
	Mxxx = 0/1, Ippi, Oppi, Myyy, M[Cxx]	Set flag
	Mxxx = Hxxx	Set flag (LSB of Hxxx)
	M[Cxx] = 0/1	
	M[Cxx] = Myyy	Set flag (indexed*)
	Mxxx & | ^ Myyy	Logically link flag
	Mxxx = STA_ERR	Read error status (1 -> error)
	Mxxx = STA_WRN	Read warning status (1 -> warning)
	Mxxx = STA_ERR_WRN	Read error/warning status (1 -> error/warning)
	Mxxx = STA_ACTIV	Loop control active
	Mxxx = STA_ROT_R	Motor running clockwise
	Mxxx = STA_ROT_L	Motor running anti-clockwise
	Mxxx = STA_ROT_0	Motor standstill
	Mxxx = STA_LIMIT	Limitation
	Mxxx = STA_REF	Reference reached
	Mxxx = STA_BRAKE	Brakes status, 1 -> brake active
	Mxxx = STA_OFF	Power off status
	Mxxx = STA_C_RDY	Control ready status
	Mxxx = STA_WUV	Undervoltage warning
	Mxxx = STA_WOV	Voltage overload warning
	Mxxx = STA_ WIIT	Warning I^2*t
	Mxxx = STA_WOTM	Motor overheating warning
	Mxxx = STA_WOTI	Heat sink temperature warning
	Mxxx = STA_WOTD	Interior temperature warning
	Mxxx = STA_WIS	
	Mxxx = STA_WFOUT	
	Mxxx = STA_WFDIG	
	Mxxx = STA_ WIT	I*t warning
	Mxxx = STA_ WTQ	Torque warning
	Mxxx = STA_INPOS	Position reference reached
	ENCTRL = 0/1, Mxxx	Control off/on
	INV = 0/1, Mxxx	Invert reference
	ERR = 0/1, Mxxx	Trigger external error
	BRKPT = 0/1, Mxxx	Break points off / on
	BRAKE=0/1,Mxxx	brake active

Command	Operand	Comments
SET	PCTRL = 0/1, Mxxx	
	EGEARPOS = Hxxx	Reference master encoder increments
	Hxxx = EGEARPOS, EGEARSPEED	Evaluate master encoder increments, master encoder speed
	F[CXX], H[Cxx], M[Cxx] = Value	Indexed assignment
	Hxxx = z, Hyyy, H[Cyy], Fxxx, Mxxx, Cyy, Zxx	Set variable
	H[Cxx] = z, Hyyy	Set integer variable (indexed)
	Hxxx + - * : % z, Hyyy	Calculate variable
	Hxxx << >> z, Hyyy	Shift variable
	Hxxx = ABS Hyyy	Variable amount formation
	Hxxx = PARA[n], PARA[n, i], ACTPOS	Set variable
	Hxxx = REFPOS	
	Hxxx, Fxxx = ACTFRQ	Assign actual frequency [Hz]
	Hxxx, Fxxx = ACTSPEED	Assign actual speed [rpm]
	Hxxx, Fxxx = ACTTORQUE	Assign actual torque [Nm]
	Hxxx, Fxxx = ACTCURRENT	Assign actual current (effective) [A]
	Hxxx = OSA0	Analog output value
	Hxxx = ISA0	Assign analog input 0
	Hxxx = ISA1	Assign analog input 1
	Hxxx = OUTPUT, INPUT	Read variable with output/input map
	OSA0 = Hxxx	Assign analog value
	REFVAL = Hxxx, Fxxx	Assign reference frequency
	INPOSTIME = HXXX	Reference reached time,
	Fxxx = f, Hxxx, F[Cxx], Fyyy	Set floating-point variable
	F[Cxx] = Fyyy	Set floating-point variable (indexed)
	Fxxx + - * : f, Fyyy	Calculate floating-point variable
	Fxxx = ROUND Fyyy	Round floating-point variable
	Fxxx = ABS Fyyy	Floating-point variable amount formation
	Fxxx = PARA[n, i], PARA[n], PARA[Hyyy,Hzzz], PARA[Hyyy]	Set parameter
	Fxxx = ACTPOS, REFPOS	Assign position actual/reference value
	Cxx = d, Cyy, Hyyy	Set numerator
	Cxx + - d, Hyyy	Calculate numerator
	Zxx = t, Hyyy	Set timer
	PARA[n] = Hxxx, Fxxx	Parameter number direct

Command	Operand	Comments
	PARA[Hxxx] = Hyyy, Fxxx	Parameter number via integer variable
	PARA[n,i] = Hxxx, Fxxx	Parameter number input, direct
SET	PARA[Hxxx, Hyyy] = Hzzz, Fxxx	Parameter number input via integer variable
	OV = 1/0	Activate/deactivate override
	ACCR = Hxxx	Change acceleration
	DECR = Hxxx	
	ACCR = 0 ...150%	Scaling
	DECR = 0 ...150%	Scaling
Wait commands		
WAIT	d, Hxxx	Waiting time in ms (0 ... 4,294,967,295 ms)
	ROT_0	Reference position = destination position
	REF	Actual position in position window
	PAR	Wait until parameter is written.
Positioning commands (only in position control)		
GO	W A Hxxx	Move **absolutely** by value of Hxxx and wait before continuing program until target position is reached
	W R Hxxx	Move **relatively** by value of Hxxx and wait before continuing program until target position has been reached
	A Hxxx	Move **absolutely** by value of Hxxx (program continues)
	R Hxxx	Move **relatively** by value of Hxxx (program continues)
	0	Execute selected reference run
	0+Hxxx	Execute selected reference run and set reference position=Hxxx
	A Hxxx V Hyyy	
	R Hxxx V Hyyy	
	T[Hxxx]	Position via table
	W T[Hxxx]	Move via table entry Hxxx, wait
	W T[Cxx]	Move via table entry Cxx, wait
	T[xxx]	Move via table entry xxx
	W T[xxx]	Move via table entry xxx, wait until position reached

Command	Operand	Comments
	V Hxxx	Infinite moving via variable
	W A Hxxx V Hyyy	
	W R Hxxx V Hyyy	
	SYN 1 / SYN 0	Activate/deactivate synchronous running
Other commands		
NOP		Instruction without function
INV	Oppi, Mxxx, Hxxx	Inversion
END		Terminates program, all subsequent lines are ignored. Enter no line number.

7.3.2 Detailed explanatory notes

Jump commands and subroutine calls (JMP)

- Unconditional jump commands are always executed (unconditionally).
- Conditional jump commands are only executed when the specified condition is met. The condition for execution of the command is given in brackets (...).
- The specified jump destination is a line number or the end of the program.

Unconditional jump commands

These commands are not linked to any preconditions (axle position, status of internal program variables) and consequently are executed immediately and unconditionally.

```
JMP  Ny       Jump to set with number y
JMP  END      Jump to end of program
```

Conditional jump commands

Conditional jump commands/subroutine calls are linked to a specific condition, given in brackets. If the condition is met, the jump is executed to the specified set number, to the end of the program. If the condition is not met, the program is resumed with the following set.

Hinweis: The execution of a conditional jump can be linked to one of the following conditions.

Actual

Reach:

```
JMP (ACTVAL    =    Hyyy,Fyyy)     Ny/END
```

Exceed:

```
JMP (ACTVAL    >    Hxxx,Fyyy)     Ny/END
JMP (ACTVAL    >=   Hxxx,Fyyy)     Ny/END
```

Fall short:

```
JMP (ACTVAL    <    Hxxx,Fyyy)     Ny/END
JMP (ACTVAL    <=   Hxxx,Fyyy)     Ny/END
```

Compare:

```
JMP (ACTVAL    !=   Hxxx,Fyyy)     Ny/END
JMP (ACTVAL    =    0)             Ny/END
JMP (ACTVAL    !=   0)             Ny/END
```

Hinweis: The `REFVAL` command is relevant to speed control.
In positioning the `REF` command is used, as it relates to "reference reached".

Reference

Reach:

```
JMP (REFVAL   =       Hxxx,Fyyy)  Ny/END
```

Exceed:

```
JMP (REFVAL   >       Hxxx,Fyyy)  Ny/END
JMP (REFVAL   >=      Hxxx,Fyyy)  Ny/END
```

Fall short:

```
JMP (REFVAL   <       Hxxx,Fyyy)  Ny/END
JMP (REFVAL   <=      Hxxx,Fyyy)  Ny/END
```

Compare:

```
JMP (REFVAL   !=      Hxxx,Fyyy)  Ny/END
JMP (REFVAL   =       0)          Ny/END
JMP (REFVAL   !=      0)          Ny/END
```

Axle status

REF reached:

```
JMP (REF = 1)         Ny/END    Actual value in reference window
```

REF not reached:

```
JMP (REF = 0)         Ny/END    Actual value not in reference win-
dow
```

Dependent on a flag:

```
JMP (REF = Mxxx)      Ny/END    Flag: Mxxx=1; Mxxx=0
```

Axle stationary:

```
JMP (ROT_0 = 1)       Ny/END
```

Axle moving:

```
JMP (ROT_0  = 0)      Ny/END
```

Dependent on a flag:

```
JMP (ROT_0 = Mxxx)    Ny/END
```

Status of a digital input

Status = 0:

```
JMP (Ippi = 0)        Ny/END
```

Status = 1:

```
JMP (Ippi = 1)        Ny/END
```

Status of a digital output

Status = 0:

```
JMP (Oppi = 0)        Ny/END
```

Status = 1:

```
JMP (Oppi = 1)        Ny/END
```

Status of a logical flag

```
JMP (Mxxx = Myyy)      Ny / END
JMP (Mxxx != Myyy)     Ny / END
JMP (Mxxx = 0)         Ny / END
JMP (Mxxx = 1)         Ny / END
JMP (Mxxx & Ippi)      Ny / END
JMP (Mxxx | Ippi)      Ny / END
JMP (Mxxx ^ Ippi)      Ny / END
JMP (Mxxx & Oppi)      Ny / END
JMP (Mxxx | Oppi)      Ny / END
JMP (Mxxx ^ Oppi)      Ny / END
```

Quantity of an integer variable (direct comparison)

Compare:

```
JMP (Hxxx = 0)         Ny / END
JMP (Hxxx != 0)        Ny / END
```

Quantity of an integer variable (comparison with second variable)

Compare:

```
JMP (Hxxx = Hyyy)      Ny / END
JMP (Hxxx != Hyyy)     Ny / END
```

Exceed:

```
JMP (Hxxx >= Hyyy)     Ny / END
JMP (Hxxx > Hyyy)      Ny / END
```

Fall short:

```
JMP (Hxxx <= Hyyy)     Ny / END
JMP (Hxxx < Hyyy)      Ny / END
```

Quantity of a floating-point variable (direct comparison)

Compare:

```
JMP (Fxxx = 0.0)       Ny / END
JMP (Fxxx != 0.0)      Ny / END
```

Quantity of a floating-point variable (comparison with second variable)

Compare:

```
JMP (Fxxx = Fyyy)      Ny / END
JMP (Fxxx != Fyyy)     Ny / END
```

Exceed:

```
JMP (Fxxx >= Fyyy)     Ny / END
JMP (Fxxx > Fyyy)      Ny / END
```

Fall short:

```
JMP (Fxxx <= Fyyy)     Ny / END
JMP (Fxxx < Fyyy)      Ny / END
```

Status of a numerator

```
JMP (Cxx = d)          Ny/END      Jump when value reached
JMP (Cxx != d)         Ny/END      Jump when value not reached
```

Status of a timer

```
JMP (Zxx = 0)          Ny/END      Timer elapsed?
JMP (Zxx != 0)         Ny/END      Timer not yet elapsed?
```

Hinweis: It is only possible to scan for equal time when the timer has elapsed (i.e. "= 0"), as there is no guarantee that a specific interim state ("=t") is reached at the point of scanning.

Subroutines (CALL, RET)

A subroutine is a component part of the main program. No separate program header, e.g. P01, is generated. The call is not implemented by a JMP, but by way of a CALL.

```
CALL Ny  Call a subroutine
(or jump to the first line of the subroutine)

RET      Return to subroutine
```

Possible program structure
(the line numbers are merely examples)

```
N010 ... ; Start main program
...
N050 CALL N110; Call subroutine
...
N100 JMP ...; End of main program


N110 ... ; Start subroutine
...
N200 RET ; End of subroutine
```

When the subroutine has been run through the program is resumed with the set which follows the call. The maximum nesting depth for subroutines is 250 If this number is exceeded, an error message is delivered and the current program is aborted.

Set break point (BRKPT)

With this command it is possible to interrupt the sequence program at any line.

Procedure for use of break points in a sequence program:

Activate/deactivate break points in the sequence program

```
Ny SET BRKPT = 1 / 0
```

Set break points in the sequence program in line

```
Ny BRKPT
```

When break points are activated the program is interrupted in line Ny (parameter 450 PLCST = BRKPT).

The Start command (parameter 450 PLCST = GO) resumes the program with the next command line.

Shutting down the PLC (e.g. by way of parameter 450 PLCST = OFF) terminates the program.

; Sample program

```
%P00
N010     NOP                        ; No instruction
N020     SET BRKPT = 1              ; Activate break points
N030     SET H000 = 0               ; Assign variable
N040     SET H001 = 10              ; Assign variable
N050     BRKPT                      ; Break point
N060     SET H000 + 1               ; Increment  variable
N070     JMP (H000 < H001) N100     ; H000 less than 10 ?
N080     SET BRKPT = 0              ; Deactivate break points
N100     JMP N040                   ; Increment further
END
```

When break points are deactivated the function is as in the case of an empty instruction (NOP).

Empty instruction (NOP)

This is an instruction with no function, i.e. the program processes the line without a response being triggered. The processing takes up computing time (like other commands).

Procedure for use in the sequence program:

```
Ny NOP   Instruction without function
```

Program end (END)

Both the text declaration and the actual sequence program must be terminated with this command. All subsequent lines are ignored. If END is missing an error message is delivered.

Procedure for use in the sequence program

```
END      No line number is specified!
```

Set commands (SET)

Hinweis: The results of arithmetic operations etc. are always saved to the left-hand variable.
F001 = 10; F002 = 15, Set F001 - F002;
in F001 "-5" results

Using the set commands, a wide variety of operations can be performed in the positioning programs:

- Setting of outputs (direct, via flags)
- Setting of flags (direct, indexed, via logic links, ...)
- Set, calculate variables ...
- Set, increment, decrement numerator
- Set and start timer
- Activate and deactivate override
- Change acceleration parameters

Set digital output

direct:

```
SET Oppi = 0
SET Oppi = 1
```

via flag:

```
SET Oppi = Mxxx
```

Output configuration:

```
SET OUTPUT = Hxxx
```

Only the outputs with function selector setting FOppi=PLC are set.

Set logical flag

direct:

```
SET Mxxx = 0
SET Mxxx = 1
```

indexed:

```
SET M[Cxx] = 0
SET M[Cxx] = 1
```

via 2nd flag:

direct:

```
SET Mxxx = Myyy       Assign flag value
```

indexed:

```
SET M[Cxx] = Myyy
```

via logic link:

```
SET      Mxxx & Myyy  Logical AND
SET      Mxxx | Myyy  Logical OR
SET      Mxxx ^ Myyy  Logical EXCLUSIVE OR
```

via integer variable

```
SET Mxxx = HxxxAssignment of LSB of Hxxx
```

via digital inputs and outputs

```
SET Mxxx = Ippi       Assign input status
SET Mxxx = Oppi       Assign output status
```

Set special flags – variables (status variables)

```
SET Mxxx  = STA_ERR      Drive is in error condition
SET Mxxx  = STA_WRN      Drive is in warning condition
SET Mxxx  = STA_ERR_WRN Drive is in error or warning condition
SET Mxxx  = STA_ACTIV    Control active
SET Mxxx  = STA_ROT_R    Motor running clockwise
SET Mxxx  = STA_ROT_L    Motor running anti-clockwise
SET Mxxx  = STA_ROT_0    Motor stopped
SET Mxxx  = STA_LIMIT    Limit reached
SET Mxxx  = STA_REF      Frequency reference reached
SET Mxxx  = STA_BRAKE    Drive is in braking condition
SET Mxxx  = STA_OFF      Drive is in power-off condition
SET Mxxx  = STA_C_RDY    Drive is in controller ready condition
SET Mxxx  = STA_WUV      Undervoltage warning
SET Mxxx  = STA_WOV      Voltage overload warning
SET Mxxx  = STA_WIIT     Warning I^2*t warning
SET Mxxx  = STA_WOTM     Motor overheating warning
SET Mxxx  = STA_WOTI     Heat sink temperature warning
SET Mxxx  = STA_WOTD     Interior temperature warning
SET Mxxx  = STA_WIS      Apparent current limit warning
SET Mxxx  = STA_WFOUT    Output frequency limit warning
SET Mxxx  = STA_WFDIG    Warning: master reference value incorrect
SET Mxxx  = STA_WIT      I*t warning
SET Mxxx  = STA_WTQ      Torque warning
```

```
SET Mxxx = STA_INPOS  Position reference reached
                      (only with position controller switched on)
```

Set special flags – variables (control variables)

```
SET ENCTRL = 0 / 1, Mxxx Control off/on
                         (only with control location PLC)
SET INV = 0 / 1, Mxxx    Invert reference
SET ERR = 0 / 1, Mxxx    Trigger external error
SET BRKPT = 0 / 1, Mxxx  Break points off / on
SET PCTRL = 0 / 1, Mxxx  Position controller off/on
SET ACCR = 0 ... 150%    Scaling of acceleration from 0 to 150 %
SET DECR = 0 ... 150%    Scaling of negative acceleration
                         from 0 to 150 %
SET EGEARPOS = Hxxx      Reference run-in master
                         encoder increments
SET Hxxx = EGEARPOS      Evaluate run-in master
                         encoder increments
```

Indexed assignment of a constant value

```
SET F[Cxxx] = Value
SET H[Cxxx] = Value
SET M[Cxxx] = Value
```

Set integer variable

direct:

```
SET Hxxx = z
```

indexed:

```
SET H[Cxx] = z
```

with 2nd variable:

direct:

```
SET Hxxx = Hyyy
```

indexed:

```
SET H[Cxx] = Hyyy
```

with 2nd indexed variable:

direct:

```
SET Hxxx = H[Cyy]
```

with 2nd floating-point variable:

```
SET Hxxx = Fxxx
```

Assignment of a float variable with limitation to +/- 2147483647 and no rounding

with flag:

```
SET Hxxx = Mxxx
```

with numerator status:

direct:

```
SET Hxxx = Cyy
```

with timer status:

```
SET Hxxx = Zxx
```

via calculation - direct: [2)]

```
SET Hxxx +z           Addition
SET Hxxx -z           Subtraction
SET Hxxx *z           Multiplication
SET Hxxx :z           z ≠ 0 [1)]Division
SET Hxxx % z          Modulo
```

via shift with constant:

to right:

```
SET Hxxx >> z         Division Hxxx by 2^z
```

to left:

```
SET Hxxx<< z          Multiplication Hxxx with 2^z
```

Calculation via second variable - direct: [2)]

```
SET Hxxx + Hyyy       Addition
SET Hxxx - Hyyy       Subtraction
SET Hxxx * Hyyy       Multiplication
SET Hxxx : Hyyy       Hyyy ≠ 0 [1)]Division
SET Hxxx % Hyyy       Modulo
```

Calculation via shift with second variable:

right:

```
SET Hxxx >> Hyyy
```

left:

```
SET Hxxx << Hyyy
```

Calculation via amount formation:

```
SET Hxxx = ABS Hyyy
```

1) z or Hyyy = 0 is not permitted (division by 0)! (triggers error message).

2) In these operations it must be ensured that no overranging occurs.

Set special integer variable

with value of parameter:

direct:

```
SET Hxxx = PARA[n]
```

with value of field parameter:

direct:

```
SET Hxxx = PARA[n,i]
```

with actual position:

direct:

```
SET Hxxx = ACTPOS
```

with reference position:

direct:

```
SET Hxxx = REFPOS
SET Hxxx = ACTFRQ     Assign frequency actual value
SET Hxxx = ACTSPEED   Assign speed actual value
SET Hxxx = ACTTORQUE  Assign torque actual value
SET Hxxx = ACTCURRENT Assign current actual value
SET Hxxx = OSA0       Value of analog output Assign
SET Hxxx = ISA0       Value of analog input 0 Assign
SET Hxxx = ISA1       Value of analog input 1 Assign
SET Hxxx = Input      Assign input map
SET Hxxx = Output     Assign output map
SET OSA0 = Hxxx       Assign analog value (0..1023 = 0V..10V).
                      Only the least significant 10 bits
                      (0..0x3FF) of Hxxx are evaluated,
                      the rest is discarded.
```

Function selector of analog output must be set to PLC.

```
SET REFVAL = Hxxx     Assign reference frequency
                      [Hz]
SET INPOSTIME = Hxxx  Reference-reached time
                                [ms] - assign
                                (Default: 20 ms)
```

Set floating-point variable

direct:

```
SET Fxxx = f
```

with 2nd variable:

direct:

```
SET Fxxx = Fyyy       Assignment of float variables
```

indexed:

```
SET F[Cxx] = Fyyy     Indexed assignment
```

with 2nd indexed variable

```
SET Fxxx = F[Cxx]     Indexed assignment
```

with 2nd integer variable

```
SET Fxxx = Hxxx       Assignment of integer variables
```

via calculation - direct:

```
SET Fxxx + f          Addition of float constants
SET Fxxx – f          Subtraction of float constants
SET Fxxx * f          Multiplication of float constants
SET Fxxx : f          Division of float constants
```

Calculation via 2nd variable - direct:

```
SET Fxxx + Fyyy       Addition of float variables
SET Fxxx – Fyyy       Subtraction of float variables
SET Fxxx * Fyyy       Multiplication of float variables
SET Fxxx : Fyyy       Division of float variables
```

Calculation by rounding:

```
SET Fxxx = ROUND      Fyyy
                      Mathematical rounding-up
                      2.8  ->  3.0     -2.8 -> -3.0
```

Calculation via amount formation:

```
SET Fxxx = ABS Fyyy   Amount formation    -2.8 -> 2.8
```

Set special floating-point variable

```
SET Fxxx = PARA[Hyyy, Hzzz]
                      Assign field parameter value
SET Fxxx = PARA[Hyyy] Assign parameter value
SET Fxxx = PARA[n, i] Assign field parameter value
SET Fxxx = PARA[n]    Assign parameter value
SET Fxxx = ACTFRQ     Actual frequency
SET Fxxx = ACTSPEED   Actual speed
SET Fxxx = ACTTORQUE  Actual torque
SET Fxxx = ACTCURRENT Actual current
SET Fxxx = ACTPOS     Assign actual position value
SET Fxxx = REFPOS     Assign position reference value
SET REFVAL= Fxxx      Assign frequency reference
                      via floating-point variable
```

Set numerator

direct:

```
SET Cxx = d
```

with variable:

```
SET Cxx = Hyyy
```

with numerator:

```
SET Cxx = Cyy
```

Increment/decrement numerator:

```
SET Cxx + d
SET Cxx - d
```

Increment/decrement numerator via variable:

```
SET Cxx + Hyyy
SET Cxx - Hyyy
```

Set and start timer

After assignment of a timer with a value, it is automatically decreased by one every millisecond until ultimately the value 0 is reached. By way of timer Z11 the WAIT commands are executed.

direct:

```
SET Zxx = t
```

with variable:

```
SET Zxx = Hyyy
```

The value of the timer is given in ms.

Set parameter

with integer variable:

```
SET PARA[n] = Hxxx     Parameter number input, direct
SET PARA[Hxxx] = Hyyy  Parameter number input via
                       floating-point variable
```

with floating-point variable

```
SET PARA[n] = Fxxx     Parameter number input, direct
SET PARA[Hxxx] = Fxxx  Parameter number input via integer variable
```

Hinweis: The backing-up of the sequence program, the parameters and positioning data to the Flash-EPROM can also be triggered by the program. (SET PARA [150] =1).

Set field parameter

with integer variable:

```
SET Para [n,i] = Hxxx       Parameter number and index input,
                            direct
SET PARA [Hxxx,Hyyy] = Hzzz Parameter number and index
                            input via integer variables
```

with floating-point variable

```
SET  PARA [n,i] = Fxxx       Parameter number and
                             index input, direct
SET PARA [Hxxx, Hyyy] = Fxxx Parameter number and index
                             input via integer variables
```

Hinweis: When reading/writing a parameter pay attention to the data type. Example: Do not assign floating-point values to a parameter of type Integer.

Parameter data type	PLC variable
USIGN8, USIGN16, USIGN32	Hxxx, Fxxx
FIXPT16	Fxxx
INT8, INT16, INT32	Hxxx, Fxxx
INT32Q16	Fxxx
FLOAT32	Fxxx

Change acceleration

```
SET ACCR = Hxxx
SET DECR = Hxxx
```

Invert (INV)

With the INV command it is possible to logically invert an integer variable, a flag or the status of a digital output. In this way, for example, an output with a Low level is assigned a High level, enabling it to be used in the program as a status indicator.

Procedure for use in the sequence program:

```
Ny INV Hxxx          Logically invert integer variable
Ny INV Mxxx          Logically invert flag
Ny INV Oppi          Logically invert digital output
```

Positioning commands (GO)

With these commands you can move the driven positioning axle. These commands should only be used in positioning mode. There are three basic methods of moving the axle:

- **Absolute positioning**: Move to a specific position **(GO A ..)**
- **Relative positioning**: Move a specific distance **(GO R ...)**
- **Synchronism**: Electronic gearing (**GOSYN**)

Positioning with or without program resumption

- With program resumption (GO ...)

  If such a command is given in a program, when the axle starts up the program is immediately resumed with the following set. In this way multiple commands can be processed in parallel.

If the command is passed during an ongoing positioning operation, the axle moves at the changed speed to the new destination position. The new command is immediately executed; that is, the position from the original command is no longer approached!

- Without program resumption (GO W ...)

  In these commands the following set is only processed when the actual position has reached the position window. As long as the axle is not in the position window - e.g. because of a tracking error - the program is not resumed.

  The "W" is an abbreviation for "Wait", GOW = "Go and Wait".

  GO W A HxxxMove absolutely by value of Hxxx and wait before continuing program until target position has been reached

- GO W R Hxxx Move relatively by value of Hxxx and wait before continuing program until target position has been reached
- GO A Hxxx Move absolutely by value of Hxxx (program continues)
- GO R Hxxx Move relatively by value of Hxxx (program continues)
- GO 0 Reference to zero (reference position = actual position = 0)
- GO 0 + HxxxReference to value of Hxxx (reference position = actual position = Hxxx)

Positioning with resumption

Position or travel via variable / velocity via variable

absolute:

```
GO A Hxxx V Hyyy
```

relative:

```
GO R Hxxx V Hyyy
```

Position via variable / velocity via parameter

```
GO A Hxxx      Move absolutely by value of Hxxx
               (program continues)
GO R Hxxx      Move relatively by value of Hxxx
               (program continues)
```

Position or travel via table

```
GO T[Hxxx]
```

Positioning without resumption

Position or travel via variable / velocity via variable

absolute:

```
GOW A Hxxx V Hyyy
```

relative:

```
GOW R Hxxx V Hyyy
```

Position via variable / velocity via parameter

```
GO W A Hxxx          Move absolutely by value of Hxxx and wait
                     before continuing program until
                     target position has been reached
GO W R Hxxx          Move relatively by value of Hxxx and wait
                     before continuing program until
                     target position has been reached
```

Position or travel via table

```
GO W T[Hxxx]         Move as per table entry Hxxx,
                     wait until position reached
GO W T[Cxx]          Move as per table entry Cxxx,
                     wait until position reached
GO T[xxx]            Move as per table entry
GO WT[xxx]           Move as per table entry,
                     wait until position reached.
```

Example:

```
SET H000 = 655360 (increments = 10 revs)
GO 0 + H000
```

After referencing the zero position thereby identified is assigned the value 10 revolutions (in the device)

Referencing

The reference run is carried out using the defined reference run type and the associated velocities (727 HOSPD).

If this command is sent in a program, the following set only takes effect when the reference run is completed.

```
GO 0             A reference run is carried out dependent on the
                 method entered in parameter 730 (-4 to 35)
GO 0 + Hxxx      The reference run is carried out, resulting in
                 position 0. Then this zero position is set to
                 the value specified in Hxxx
```

Infinite moving

via variable:

```
GO V Hxxx   Hxx= Index of variable with velocity value
```

The preceding sign of the value in Hxxx determines the direction.

Speed synchronism

Activate synchronism:

```
GOSYN 1
```

Deactivate synchronism:

```
GOSYN 0
```

Angle synchronism (electronic gearing)

In angle synchronism the drive controller converts the incoming square pulses of a master encoder directly into a position reference and moves to that position under position control.

Activate synchronism:

```
GOSYN 1
```

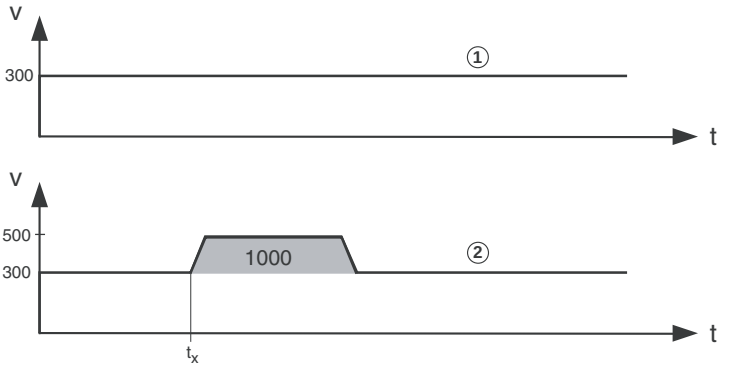
Deactivate synchronism:

```
GOSYN 0
```

After activation of synchronism by the GOSYN 1 command, the sequence program is immediately resumed with the next set.

Hinweis: Synchronism is activated hard, without limiting the dynamic of the axle by ramps. Gentle coupling into a rotating master axle is not possible.

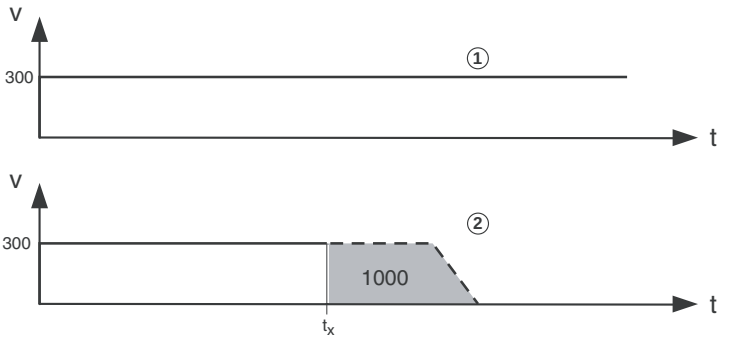
A GOR command (relative positioning) during synchronism results in an overlaid positioning.



(1) Master axle
(2) Slave axle

Bild 7.4 Relative positioning during synchronous running. t_x=Time of command GO R H000 V001 with H000 = 1000 and H001 =200

A GOA command (absolute positioning) during synchronism aborts the synchronism, the axle keeps running at the current synchronous positioning speed and carries out the requested absolute positioning, observing the preset ramps. A velocity preset with this command is ignored.



(1) Master axle
(2) Slave axle

Bild 7.5 Absolute positioning during synchronous running. t_x=Time of command GO A H000 VH001 with H000 = 1000 and H001 =200

Configuration of the master encoder input is described in more detail in section 6.2.4.

Travel optimized positioning of an indexing table

The destination position is specified in absolute terms and the positioning controller moves the axle in the direction in which the travel is shortest.

This mode of positioning requires the indexing table application to have been selected in "Scaling". For the indexing table function the settings in the driving profile are decisive. If the indexing table function, directional optimization and rotation are programmed there, the commands are executed with travel optimization.

Example for a rotation of 360°:

Reference 1: 180°

Reference 2: 510° (=360°+180°)

Without travel optimization the positioning would move 330° in positive direction; with travel optimization is moves 30° in negative direction.

Hinweis: Standard positioning commands such as GO A Hxxx V Hyyy can still be used. They do not operate in the absolute position system of the indexing table, however - no travel optimized response.

Braking

For normal braking with the programmed acceleration:

```
STOP B
```

For fast braking (emergency stop) with maximum acceleration as per the emergency stop configuration (Quickstop):

```
STOP M
```

Braking and shut-off of position control

Fast braking (velocity reference=0) and then shut off control (e.g. for parameter setting):

```
STOP 0
```

Restart position control by:

```
STOP B   or
```

```
STOP M
```

Wait commands

Time

With these commands you can implement a delay by a specific time in milliseconds. At the end of this time the program is resumed with the next set. The WAIT command is executed by way of timer Z11.

direct:

```
WAIT d
```

via variable:

```
WAIT Hxxx
```

Axle status

The program is resumed when the following condition is met.

PW reached:

```
WAIT REF              Actual position in position window 1)
```

Axle stationary:

```
WAIT ROT_O            Reference position = target position 2)
1) Positioning complete, "Axle in position" output is set
2) Positioning arithmetically complete
```

Parameter write access

```
WAIT PAR         Wait for parameter write operations to complete.
```

If the parameter write operations are essential to the further course of the program, a WAIT PAR should be placed after the parameter assignments.

; Sample program

```
%P00
N010     SET H000 = 1  ; Assign variable H000 value 1
N020     SET PARA[460.1] = H000; Write (field) parameter 460.
                         Index 1
N030     SET PARA[460.2] = H000; Write (field) parameter 460.
                         Index 2
N040     SET PARA[270] = H000; Write parameter 270
N050     WAIT PAR      ; Wait before continuing program until
                       ; all parameter write operations
                       ; are completed
END                    ; End of program
```

7.4 PLC control and parameters

Uncomplicated setting of the above parameters is offered by the PLC function screen (expanded main window -> PLC or via "Basic settings/ PLC" with appropriate PLC preselection):

Bild 7.6 PROFITOOL - PLC function screen

7.4.1 PLC control parameters

All PLC control commands are mapped by parameters. The parameters can be edited by way of the PROFITOOL in a PLC function screen (see image 4.4).

PROFITOOL	Meaning	Value range	Change ONLINE	Parameter
Integer variables (32 bits)	Integer variables are whole numbers. When linked to floating-point variables or parameters the portion after the decimal point is ignored. No rounding is carried out either. Access in sequence program H000...H127	2^{-31} to 2^{31}	yes	460-PLC_H
Flag (0/1)	Access in sequence program M000...M255		yes	461-PLC_M
Timer (32 bit)	Time base 1 ms Access in sequence program Z00...Z11 Timers are set to a value and then run down to 0.		yes	462-PLC_Z
Numerator for indexed addressing (8 bit)	Access in sequence program C00...C10		yes	463-PLC_C
Map of the digital outputs (bit-coded)	The map can also be written in the program as a special OUTPUT variable. OSD00-OSD02 Bit 0 - bit 2 OED00-OED03 Bit 4 - bit 6 To set outputs working in the program, the relevant function selector must be set to FOppi = PLC.		yes	464-PLC_O
Floating-point variables	Access in sequence program F000...F127	-3.37×10^{38} to 3.37×10^{38}	yes	465-PLC_F
Map of the digital and analog inputs (bit-coded)	The map can also be read in the program as a special INPUT variable. ISD00-ISD03 Bit 0 - bit 3 IED00-IED07 Bit 4 - bit 11 ISA00 - ISA01 Bit 12 - bit 13		Read only	466-PLC_I
Name of PLC program (project name)	The project name is defined when the sequence program (text declaration) is written. The name directly designates the text declaration file (projectname.txt) (max. 32 characters, no special characters, blanks are ignored)		yes	468- PLCPJ

Table 7.1 Control parameters

7.4.2 PLC program parameters

PROFITOOL	Meaning		Change ONLINE	Parameter
Operating status of sequence control	This parameter enables starting/stopping (dependent on parameter 452-PLCCT=PARA) and displays the current operating status of the sequence program.		yes	450-PLCST
	OFF(0)	Stop PLC program/program stopped		
	GO(1)	Start PLC program/program running		
	BRKPT(2)	PLC program interrupted With GO the program is resumed. Regardless of the control location, it is possible at any time to interrupt (BRKPT) or terminate (OFF) the program by way of the relevant parameter. With GO the program can then be resumed from the point at which it was stopped, provided the control location condition still applies (e.g. terminal still set). If the condition is not met, the parameter is set to OFF.		
Current program line	Displays the current program line being processed. The line number is also visible on the digital oscilloscope.		Read	451-PLCPL
Start conditions for the sequence control	Parameter PLCCT defined the location from which the sequence program is started.		yes	452-PLCCT
	TERM(0)	PLC start via input Function selector of an input must be set to Fixxx = PLCGO. (0 -> Program stopped, 1 -> Program started)		
	PARA(1)	PLC start via parameter Manual change of operating status PLCST		
	AUTO(2)	PLC start automatically on device startup; operating status parameter is set to GO, serving as a status indicator		
	CTRL(3)	PLC start simultaneous with activation of control PLC stop simultaneous with deactivation of control		
Start with program line (0= first program line)	The program starts at the line specified in PLCSN. Useful if there are different independent routines in one program.		yes	454-PLCSN
Program stop in line x (break point)	The program is interrupted in the line specified under PLCBN; parameter 450-PLCST switches to BRKPT. The program is restarted with 450-PLCST=GO(1).		yes	455-PLCBN
Start with program line (0= first program line).	The program starts at the line specified in PLCSN. Useful if there are different independent routines in one program.			456-PLCSN

Tabelle 7.2 Program parameters

7.5 PLC error messages

The sequence control generates various error messages:

Error	Description
E-PLC 210	Error triggered via PLC (SET ERR = 1, Mxxx with Mxxx = 1)
E-PLC211	Error in subroutine calls/return by CALL / RET. Stack underflow: unexpected RET without prior CALL. Stack overflow: max. nesting depth (250 calls) reached
E-PLC212	Error writing parameters (buffer full). The write operation from the interrupt is routed via a buffer with a maximum of 30 entries, with the buffer itself being processed in the main loop. If this message occurs, the buffer limit has been reached, i.e. the main loop could not process all parameter assignments. The WAIT PAR command causes the program to be stopped until all parameters have been written and the buffer is emptied. In the event of large numbers of parameter access operations (more than 30 consecutive parameter assignments) or when safeguarding parameter write access in the further course of the program, an interim WAIT PAR should be inserted.
E-PLC213	Error writing parameters. Parameter does not exist, is not a field parameter, over-/under-ranging, value not writable, etc.
E-PLC214	Error reading parameters. Parameter does not exist or is not a field parameter.
E-PLC215	Internal error: no code, or program instruction not executable.
E-PLC216	Internal error: no code, program instruction not executable or jump to unused address. The error occurs when a sequence program is loaded while one is still running in the controller and the new program contains different line numbers. Unless absolutely essential, shut down the PLC when loading a program.
E-PLC217	A division by zero occurred in a division operation in the program sequence.
E-PLC218	The PLC does not exist in this software version.
E-PLC219	The motor identification does not exist in this software version.
E-PLC220	Error in a floating-point operation in the sequence control. The sequence control is in Wait condition and displays the incorrect program line. Check the abort conditions (value ranges) in floating-point operations. Correct the sequence program/the incorrect program line as necessary. Note: In floating-point calculations over-/under-ranging (0...3.37E+38) may occur. When comparing two floating=point variables it may be that the abort condition cannot be attained. When programming, ensure unique and plausible value ranges.
E-PLC221	The sampling time of the sequence control has been exceeded, i.e. the program is taking more time than is allotted to it.

Tabelle 7.3 Error messages of the PLC sequence control

7.6 PLC sample programs

The examples set out in this section are intended purely as programming exercises. Consequently, neither the tasks nor the proposed solutions have been tested in terms of safety.

The examples are intended to illustrate what solutions are possible with integrated sequence control and how a typical program segment might look. A preset solution accessing PLC must be selected. For example: "PCT_3 (18) Positioning, driving set input via PLC, control via terminal".

The specified values for distance unit, velocity and acceleration are merely examples, and it is essential that they be adapted to specific applications as appropriate. The basis of the examples is a geared motor with a rated speed of 1395 rpm and a transmission ratio of 9.17.

Consequently, Watt Drive Antriebstechnik GmbH can accept no responsibility or liability of any kind in connection with or arising from the use of this program material or any part of it.

The numerical values for travel, velocity and acceleration relate to the programming units defined in the position controller.

7.6.1 Conveyor belt

After startup, the drive unit of a conveyor belt is to be moved 1 metre (corresponding to 10 revolutions of the output shaft) at a velocity of 35 mm/s. On expiry of a waiting time of 5s the process is to be repeated until an input is reset (input used ISD03).

Setting units and scaling in the Scaling Wizard:

Position:	mm
Velocity:	mm/s
Acceleration:	mm/s^2
Feed constant:	1000 mm corresponds to 10 revolutions of the output shaft
Gearing:	Revolutions of motor shaft 917 Revolutions of output shaft 100

Adapting driving profile:

Max. velocity:	250 mm/s
Max. startup acceleration:	$50\ mm/s^2$
Max. braking acceleration:	$50\ mm/s^2$

The sample program can be loaded into the controller once the reference runs as set out in section 5.2.3 have been programmed.

```
%TEXT
DEF H001 = Travel
DEF H002 = Velocity
END

%P00
N001 SET H001 = 1000  ; Distance in mm
N002 SET H002 = 35    ; Velocity in mm/s

N010 GO 0             ; Carry out referencing
N020 JMP (IS03=0) N020; Continue if input = high
N030 GO W R H001 V H002; Move in pos. direction at 35 mm/s
N040 WAIT 5000        ; Wait 5 s
N050 JMP N020         ; Restart cycle
END
```

7.6.2 Absolute positioning

The four positions are to be approached absolutely at velocity v=80 mm/s and the program is then to wait 1 s in each case. For the movement back to the starting position three times the velocity (240mm/s) is to be applied.

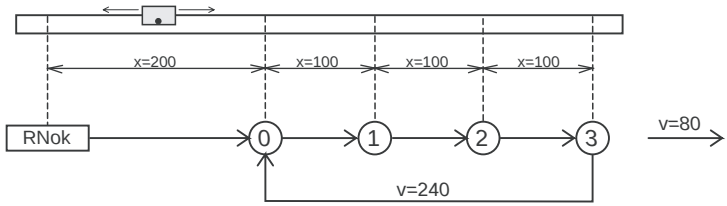


Bild 7.7 Approaching positions

Setting units and scaling in the Scaling Wizard:

Position:	mm
Velocity:	mm/s
Acceleration:	mm/s^2
Feed constant:	100 mm corresponds to 1 revolution of the output shaft
Gearing:	Revolutions of motor shaft 917 Revolutions of output shaft 100

Adapting driving profile:

Max. velocity:	250 mm/s
Max. startup acceleration:	$50 mm/s^2$
Max. braking acceleration:	$50 mm/s^2$

The sample program can be loaded into the controller once the reference runs as set out in section 5.2.3 have been programmed.

Positions and velocities are specified directly as values; the acceleration is set according to the machine parameters.

```
; Scaling in s=mm and v=mm/s
%TEXT
DEF H000 = Position_0
DEF H001 = Position_1
DEF H002 = Position_2
DEF H003 = Position_3
DEF H004 = Velocity_v1
DEF H005 = Velocity_v2
END
```

```
%P00
N001 SET H000 = 200
N002 SET H001 = 300
N003 SET H002 = 400
N004 SET H003 = 500
N005 SET H004 = 80
N006 SET H005 = 240

N020 GO 0             ; Referencing
N030 GO W A H000 V H004; Approach starting position
N040 WAIT ROT_0       ; Wait for axle to stop
N050 WAIT 1000        ; Wait 1 s
N060 GO W A H001 V H004; Approach position 1 and wait until
                        axle stationary
N070 WAIT 1000
N080 GO W A H002 V H004; Position 2
N090 WAIT 1000
N100 GO W A H003 V H004; Position 3
N110 WAIT 1000
N120 GO W A H000 V H005; Back to starting position

N130 JMP N050
END
```

7.6.3 Relative positioning

In the previous example the axle is always advanced by the same distance, so a solution involving relative positioning is appropriate. A numerator contains the latest position at any point. For units and scaling see previous example.

```
%TEXT
DEF H000 = Position_0
DEF H001 = Distance_between_positions
DEF H002 = Velocity_1
DEF H003 = Velocity_2
END

%P00
N001 SET H000 = 200   ; Position 0 in mm
N002 SET H001 = 100   ; Distance between two positions in mm
N005 SET H002 = 80    ; Velocity in mm/s
N006 SET H003 = 240   ; Velocity in mm/s

N010 GO 0             ; Referencing
N020 GO W A H000 V H002;Approach starting position and wait
N030 SET C00 = 0      ; Set numerator = 0
N040 WAIT 1000
N050 GO W R H001 V H002;Approach next position
N060 SET C00+1        ; Run position counter
N070 WAIT 1000
N080 JMP (C00 != 3) N050;Position 3 not yet reached
N090 GO W A H000 V H003; Back to starting position
N100 JMP N030
END
```

The solution is even more simple and elegant if the numerator is omitted and the comparison is made with the reference position (SP)

```
%TEXT
DEF H000 = Position_0
DEF H001 = Distance_between_positions
DEF H002 = Velocity_1
DEF H003 = Velocity_2
END

%P00
N001 SET H000 = 200   ; Position 0 in mm
N002 SET H001 = 100   ; Distance between two positions in mm
N003 SET H002 = 80    ; Velocity in mm/s
N004 SET H003 = 240   ; Velocity in mm/s
N005 SET H004 = 500   ; Target position 3 as comparison

N010 GO 0             ; Referencing
N020 GO W A H000 V H002; Approach starting position and wait
N030 WAIT 1000

N040 GO W R H001 V H002; Approach next position
N050 WAIT 1000
N060 JMP (REFVAL < H004) N040; Position 3 not yet reached

N070 GO W A H000 V H003; Back to starting position

N080 JMP N030
END
```

7.6.4 Sequence program

Here the position controller is used as a fully programmable sequence control for a speed profile.

An endless-loop conveyor belt is operated at two speeds. When a destination position (≥10000) is reached the belt is to be stopped. The cycle is repeated by repeating the enable input. The subroutine technique is used to keep the structure neat and clear. The main program is responsible for initialization, and calls up the subroutines 1 to 3 in an endless loop.

Input (ProfiTool):	IS00	Start(1) = Start control
	IS01	PLC (35) = Input usable in sequence program
	IS02	PLC (35) = Input usable in sequence program
	IS03	/STOP (feed hold, must be set to High)
Input (program):	ISD01	Selection of velocity 0 = v1 / 1 = v2
	ISD02	Enable
Output (program):	OSD00	Target position reached

Setting units and scaling in the Scaling Wizard:

Position:	degrees
Velocity:	degrees/s
Acceleration:	degrees/s^2
Feed constant:	360° corresponds to 1 revolution of the output shaft
Gearing:	Revolutions of motor shaft 917 Revolutions of output shaft 100

Adapting driving profile:

Max. velocity:	900 degrees/s
Max. startup acceleration:	320 degrees/s^2
Max. braking acceleration:	320 degrees/s^2

The sample program can be loaded into the controller once the reference runs as set out in section 5.2.3 have been programmed.

```
%TEXT
DEF H000 = Velocity
DEF H001 = Position
END

%P00     ; Main program

N005 GO 0              ; Carry out referencing
N010 SET M000 = 1      ; Flag = 1: Axle not to start up
N015 SET M001 = 0      ; Flag = 0: Axle is not in motion
N020 SET H001 = 10000; Target position for comparison

N025 CALL N045         ; Subroutine scan inputs
N030 CALL N080         ; Subroutine start axle
N035 CALL N105         ; Subroutine position comparison
N040 JMP N025          ; Repeat
```

; Subroutine 1: Scan inputs

```
N045 JMP (M001 = 1) N075; If drive in motion, jump to RET
N050 JMP (ISO2 = 0) N075; No scan
N055 SET M000 = 0Start initiated, set flag = 0

N060 SET H000 = 300               ;Set velocity 1
N065 JMP (IS01 = 0) N075; Velocity 1 selected
N070 SET H000 = 600; Velocity 2 selected + set
N075 RET
```

; Subroutine 2: Start axle

```
N080 JMP (M000 = 1) N100
N085 GO R H001 V H000             ; Start axle at velocity
                                   H000, target position H001
N090 SET M000 = 1      ; Enable detected, reset flag
N095 SET M001 = 1; Drive in motion
N100 RET
```

; Subroutine 3: Position comparison

```
N105 JMP (REF = 1) N120
N110 SET OS00 = 0
N115 JMP N135
N120 SET M000 = 1
N125 SET M001 = 0Drive stopped
N130 SET OS00 = 1
N135 RET

END
```

Appendix A Index

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

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