WEST

Technical Documentation

PPC-125-U-PDP

Universal axis control module with Profibus and SSI interface

Electronics
Hydraulics meets
meets Hydraulics
Electronics

CONTENTS

1 General information

1.1 *Order number*

PPC-125-U-PDP	- with programmable output (±10 V differential output or 4… 20 mA) and analogue or SSI sensor interface

Extended (alternative) versions

UHC-126-U-PFN	- with extended position and pressure control, programmable output, SSI or analogue sensor interface and Profibus interface.
UHC-126-U-PFN	- with extended position and pressure control, programmable output, SSI or analogue sensor interface and Profinet interface.
UHC-126-U-ETC	- with extended position and pressure control, programmable output, SSI or analogue sensor interface and Ethercat interface.

1.2 *Scope of supply*

The scope of supply includes the module plus the terminal blocks which are part of the housing.
The Profibus plug, interface cables and further parts which may be required should be ordered separately.
This documentation can be downloaded as a PDF file from www.w-e-st.de.

1.3 *Accessories*

WPC-300 - Start-Up-Tool (downloadable from our homepage – products/software)

Any standard cable with USB-A and USB-B connector can be used as the programming cable.

1.4 Symbols used

General information

Safety-related information

1.5 Legal notice

W.E.St. Elektronik GmbH

Gewerbering 31
D-41372 Niederkrüchten

Tel.: +49 (0)2163 577355-0
Fax.: +49 (0)2163 577355-11

Home page: www.w-e-st.de
EMAIL: contact@w-e-st.de

Datum: 08.01.2025

The data and characteristics described herein serve only to describe the product. The user is required to evaluate this data and to check suitability for the particular application. General suitability cannot be inferred from this document. We reserve the right to make technical modifications due to further development of the product described in this manual. The technical information and dimensions are non-binding. No claims may be made based on them.

1.6 Safety instructions

Please read this document and the safety instructions carefully. This document will help to define the product area of application and to put it into operation. Additional documents (WPC-300 for the start-up software) and knowledge of the application should be taken into account or be available.
General regulations and laws (depending on the country: e. g. accident prevention and environmental protection) must be complied with.

These modules are designed for hydraulic applications in open or closed-loop control circuits. Uncontrolled movements can be caused by device defects (in the hydraulic module or the components), application errors and electrical faults. Work on the drive or the electronics must only be carried out whilst the equipment is switched off and not under pressure.

This handbook describes the functions and the electrical connections for this electronic assembly. All technical documents which pertain to the system must be complied with when commissioning.

This device may only be connected and put into operation by trained specialist staff. The instruction manual must be read with care. The installation instructions and the commissioning instructions must be followed. Guarantee and liability claims are invalid if the instructions are not complied with and/or in case of incorrect installation or inappropriate use.

CAUTION!
All electronic modules are manufactured to a high quality. Malfunctions due to the failure of components cannot, however, be excluded. Despite extensive testing the same also applies for the software. If these devices are deployed in safety-relevant applications, suitable external measures must be taken to guarantee the necessary safety. The same applies for faults which affect safety. No liability can be assumed for possible damage.

Further instructions

- The module may only be operated in compliance with the national EMC regulations. It is the user's responsibility to adhere to these regulations.
- The device is only intended for use in the commercial sector.
- When not in use the module must be protected from the effects of the weather, contamination and mechanical damage.
- The module may not be used in an explosive environment.
- To ensure adequate cooling the ventilation slots must not be covered.
- The device must be disposed of in accordance with national statutory provisions.

2 Characteristics

This electronic module is developed to control the position and/or pressure of a hydraulic axis. The hydraulic axis can be driven as positioning control with digital stroke measuring (SSI interface) or analogue sensors. Proportional valves with integrated electronics (typically control valves) can be driven by the analogue output.
Additionally, an integrated pressure limitation control function for one or two pressure sensors (differential pressure) is implemented.
Command signals and actual values are transmitted by a Profibus communication interface. Feedback are status information and actual values.

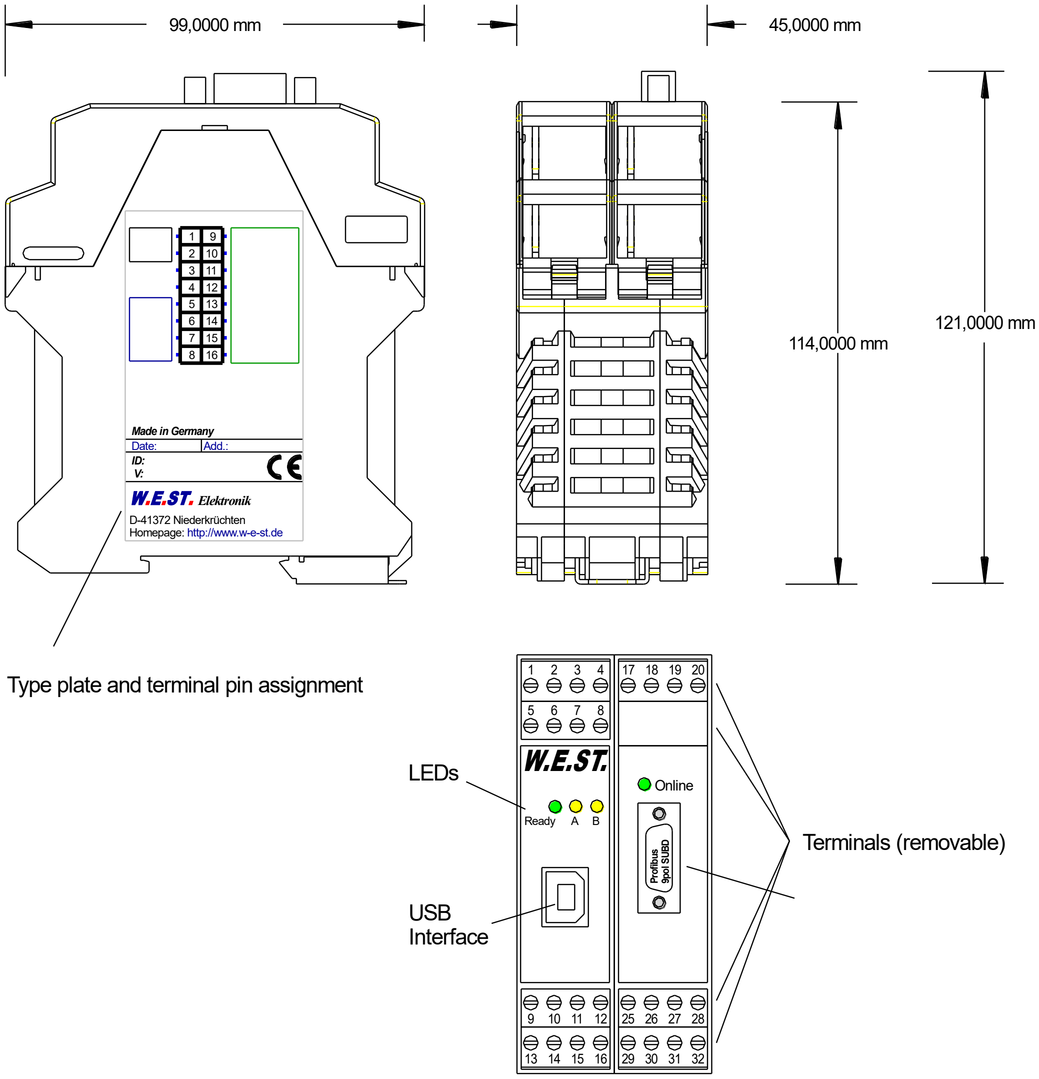
Setting up this module is simple and easy to handle with our WPC-300 start-up software.

Typical applications: general positioning drives, fast transport drives, handling systems, speed-controlled axes and presses with positioning and pressure control.

Features

- **Profibus interface for command values, sensor values, control word and status word**
- **SSI- or analogue feedback sensors (0… 10 V or 4… 20 mA)**
- **Simple and intuitive scaling of the sensor**
- **Resolution of the position 1 µm**
- **Speed resolution 0,005 mm/s**
- **Speed profiles (rapid creep speed)**
- **PQ-control function with pressure limitation**
- **Principle of stroke-dependent deceleration for fast and robust positioning**
- **NC profile generator for constant speed, motion command values in mm, mm/s and mm/s²**
- **Highest positioning accuracy by using the drift compensation**
- **Extended control technology with PT1 controller**
- **Usable with overlapped proportional valves and with zero lapped control valves**
- **Fault diagnosis and extended function checking**
- **Simplified parameterization with WPC-300 software**

2.1 Device description



3 Use and application

3.1 Installation instructions

- This module is designed for installation in a shielded EMC housing (control cabinet). All cables which lead outside must be screened; complete screening is required. It is also necessary to avoid strong electro-magnetic interference sources being installed nearby when using our open and closed loop control modules.

- **Typical installation location:** 24 V control signal area (close to PLC)
  The devices must be arranged in the control cabinet so that the power section and the signal section are separate from each other.
  Experience shows that the installation place close to the PLC (24 V area) is most suitable. All digital and analogue inputs and outputs are fitted with filters and surge absorbers in the device.

- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star-shaped ground wiring scheme is recommended. The following points must be observed when wiring:
    - The signal cables must be laid separately from power cables.
    - Analogue signal cables **must be screened**.
    - All other cables must be screened if there are powerful interference sources (frequency converters, power contactors) and cable lengths > 3 m. Inexpensive SMD ferrites can be used with high-frequency radiation.
    - The screening should be connected to PE (PE terminal) as close to the module as possible. The local requirements for screening must be taken into account in all cases. The screening should be connected to at both ends. Equipotential bonding must be provided where there are differences between the connected electrical components.
    - If having longer lengths of cable (> 10 m), the diameters and screening measures should be checked by specialists (e. g. for possible interference, noise sources and voltage drop). Special care is required if using cables of over 40 m in length, and if necessary the manufacturer should be consulted if necessary.

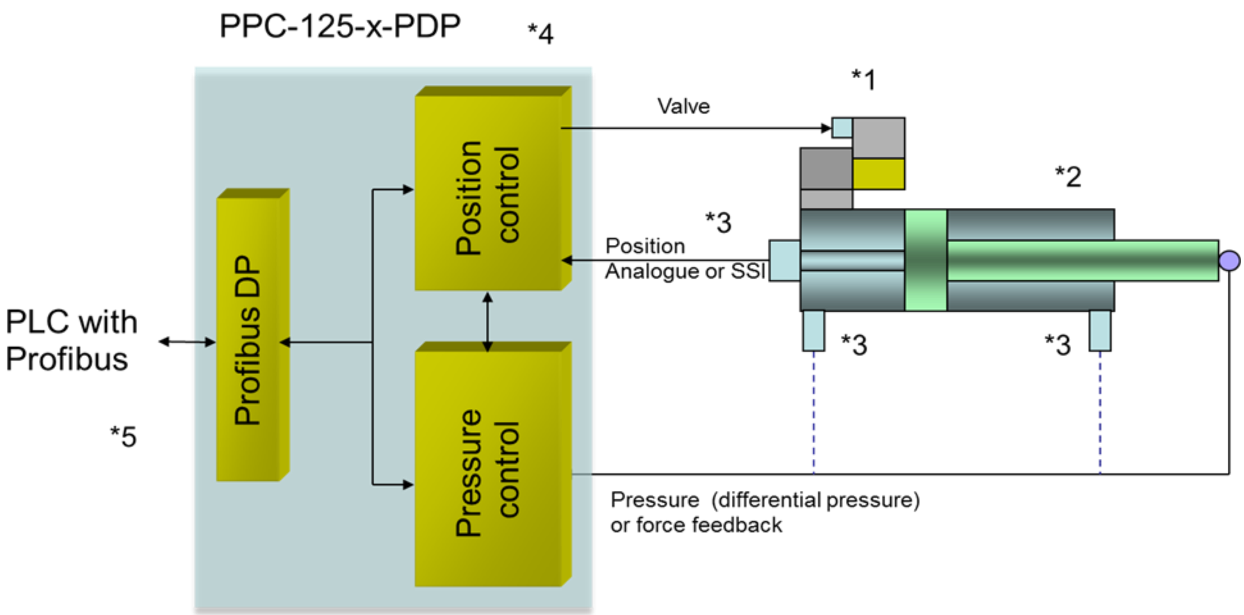
- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.

- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. Switched inductances (relays and valve coils) which are connected to the same power supply must <u>always</u> be provided with appropriate overvoltage protection directly at the coil.

3.2 *Typical system structure*

This minimal system consists of the following components:

(*1) Proportional valve with integrated electronics
(*2) Drive (e.g. hydraulic cylinder)
(*3) Sensors for position (SSI or analogue) and pressure
(*4) PPC-125-PDP control module
(*5) Interface to PLC



3.3 *Method of operation*

Positioning control plus pressure control

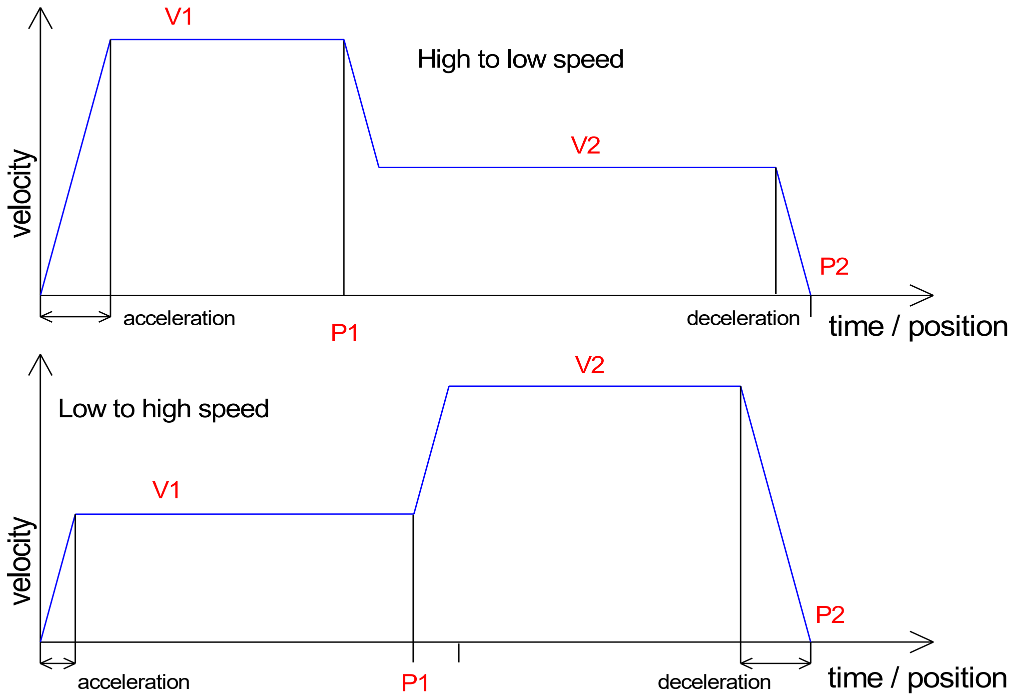
This module is a combined system of the POS-123 (position control) and the PQ-132 (pressure control).

The standard communication via Profibus DP simplifies the wiring. The PPC-125-U-PDP can be used as a universal axis controller for hydraulic drives. Because of a second position and a second velocity, it is optionally possible to drive to target position with the corresponding speed (rapid traverse and creeping speed respectively creeping speed and rapid traverse)

Positioning: Similar to the POS-123, the axis can be used as point to point controller (stroke depended deceleration) as well as in NC mode. With only a few parameters the controller can be optimized, the movement profile is preset via Profibus (position and velocity).

Because of the input of a second position and speed, the axis can be driven to this position with the second velocity. This mode is only activated when the velocity command value 2 is not equal to zero. The following features have to be noticed:

- The position command value (P2) is the end position that is approached with the velocity (V2).
- The position setpoint (P1) is the switching position, which is approached with the speed (V1) and then switched over to the speed (V2).
- The speed is switched via the speed ramp (in NC mode via the acceleration).
- If the position setpoint (P2) is between the feedback value and the position setpoint (P1) (P1 and P2 are reversed), the position (P2) is started at speed (V1).



Influences on positioning accuracy:

The positioning accuracy is determined by the hydraulic and mechanical conditions. The right choice of valve is therefore a decisive factor. In addition, two mutually contradictory requirements (short position time and high accuracy) must be taken into account when designing the system.
The electronic limitations lie mainly in the resolution of the analogue signals, although a resolution of < 0,01 % only needs to be considered for our modules with long positions. In addition, the linearity of the individual signal points (PLC, sensor and control module) must be taken into account.

It is generally recommended to calculate the static and dynamic behavior of the hydraulic axis. For supporting this, following technical basic data are required:

- minimum natural frequency of the cylinder,
- maximum theoretical speed for extending and retracting,
- valve characteristics (natural frequency, overlapped or zero lapped, hysteresis and the flow gain (flow and pressure drop),
- system pressure, maximum pump flow, and a description of the general system requirements.

3.4 *Commissioning*

Step	Task
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly and that the signals are well shielded. The device must be installed in a protective housing (control cabinet or similar).
Switching on for the first time	Ensure that no unwanted movement is possible in the drive (e. g. switch off the hydraulics). Connect an ammeter and check the current consumed by the device. If it is higher than specified, there is an error in the wiring. Switch the device off immediately and check the wiring.
Setting up communication	Once the power input is correct, the PC (notebook) should be connected to the serial interface. Please see the WPC-300 program documentation for how to set up communication. Further commissioning and diagnosis are supported by the operating software.
Pre-parameterization	Now set up the following parameters (with reference to the system design and circuit diagrams): The SYS_RANGE, SENSOR SETTING, POLARITY, ACCELERATION and DECELERATION. Pre-parameterization is necessary to minimize the risk of uncontrolled movements. Parameterize specific settings for the control element (MIN for dead-zone compensation and MAX for maximum velocity). Reduce the speed limitation (VELO command) to a value which is uncritical for the application.
Control signal	Check the control signal with a voltmeter. The control signal (PIN 15 to PIN16) lies in the range of ± 10 V. In the current state it should be 0 V. Alternatively, if current signals are used, approx. 0 mA should flow.
Switching on the hydraulics	The hydraulics can now be switched on. Since the module is not yet generating a signal, the drive should be at a standstill or drift slightly (leave its position at a slow speed).
Activating ENABLE	**CAUTION!** The drive can now leave its position and move to an end position at full speed. Take safety measures to prevent personal injury and damage. The drive stays in the current position (with ENABLE the actual position is accepted as the required position). If the drive moves to an end position, the polarity is probably wrong.
Speed demand	The speed can be limited by means of the VELO parameter or the external speed demand (VS = EXT).
Manual (HAND) operation	If START is disabled, the axis can be moved manually with HAND+ or HAND-. After disabling the HAND signal, the axis stops in a controlled manner at the current position. **CAUTION!** Please check the manual operation in conjunction with the EOUT command. If the EOUT is active do not use the manual operation.
Activating START	With the start signal the demand value of the analogue demand value input is accepted and the axis moves to the predefined target position. If START is disabled, the axis stops in the preset deceleration distance D:S.
Optimize controller	Now optimize the control parameters according to your application and your requirements.

4 Technical description

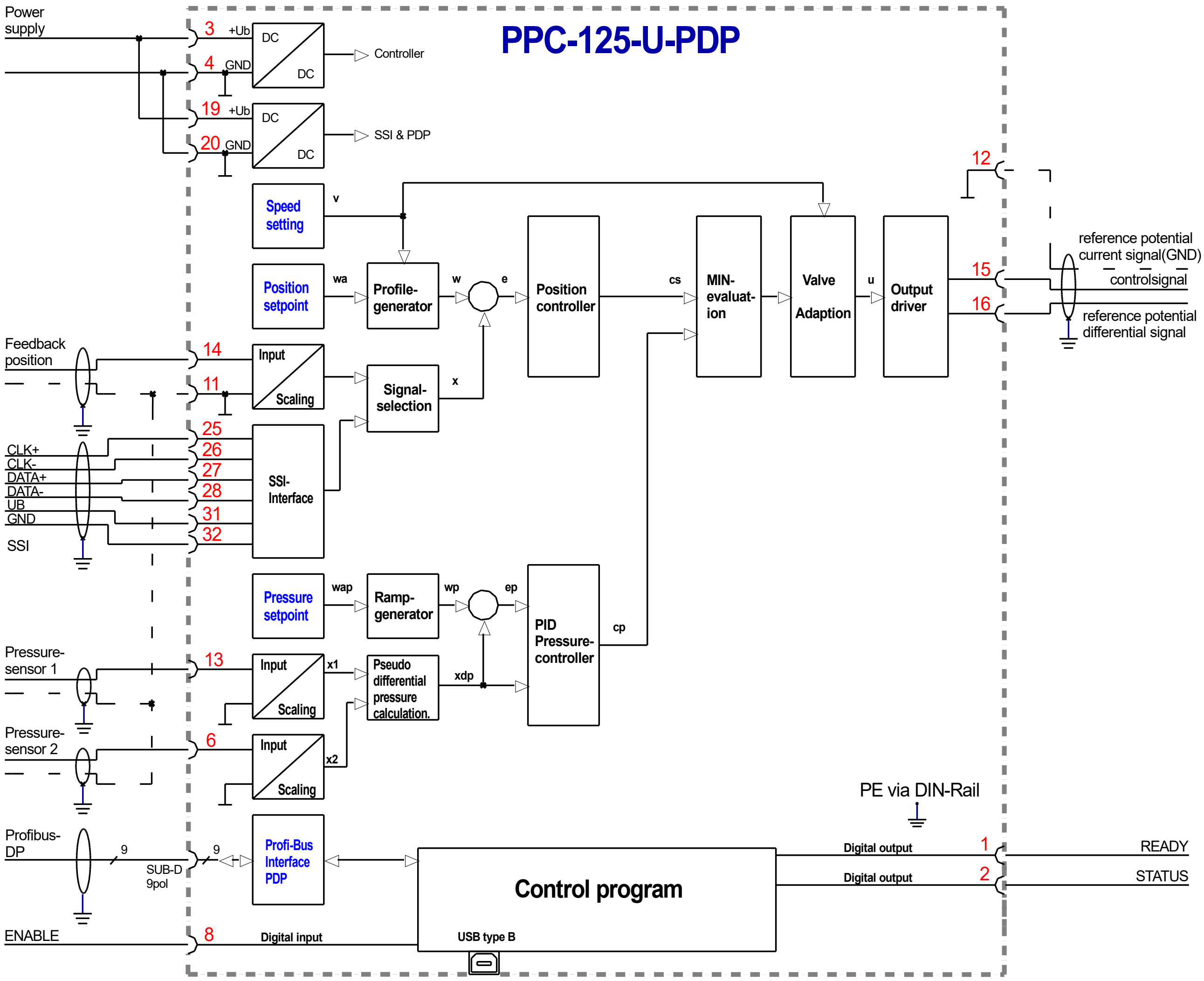
4.1 Input and output signals

Connection	Supply
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) connection.
PIN 19	Power supply Profibus and SSI-interface (see technical data)
PIN 20	0 V (GND)
Connection	**Analogue signals**
PIN 6	Actual pressure (XP2), range 0… 100% corresponds to 0… 10V or 4… 20 mA
PIN 11	GND
PIN 12	GND
PIN 13	Actual pressure (XP1), range 0… 100% corresponds to 0… 10V or 4… 20 mA
PIN 14	Analogue position actual value (XL), range 0… 100% corresponds to 0… 10V or 4… 20 mA
PIN 15 / 16 PIN 15 / 12	Valve control signal. Type of signal and polarity can be selected by the parameter SIGNAL:U.
Connection	**Digital inputs and outputs**
PIN 8	**Enable input:** This digital input signal initializes the application and error messages are deleted. The controller and the READY signal are activated. The output signal to the control element is enabled.
PIN 25	**SSI-interface:** CLK+ output
PIN 26	**SSI-interface:** CLK- output
PIN 27	**SSI-interface:** DATA+ input
PIN 28	**SSI-interface:** DATA- input
PIN 31	**SSI-interface:** 24 V
PIN 32	**SSI-interface:** 0 V
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernible errors. **OFF:** Enable (PIN 8 or Profibus bit) is disabled or an error has been detected.
PIN 2	**STATUS output:** **ON:** The axis is within the preset monitoring range (POSWIN). **OFF:** The axis is outside the preset monitoring range (POSWIN).

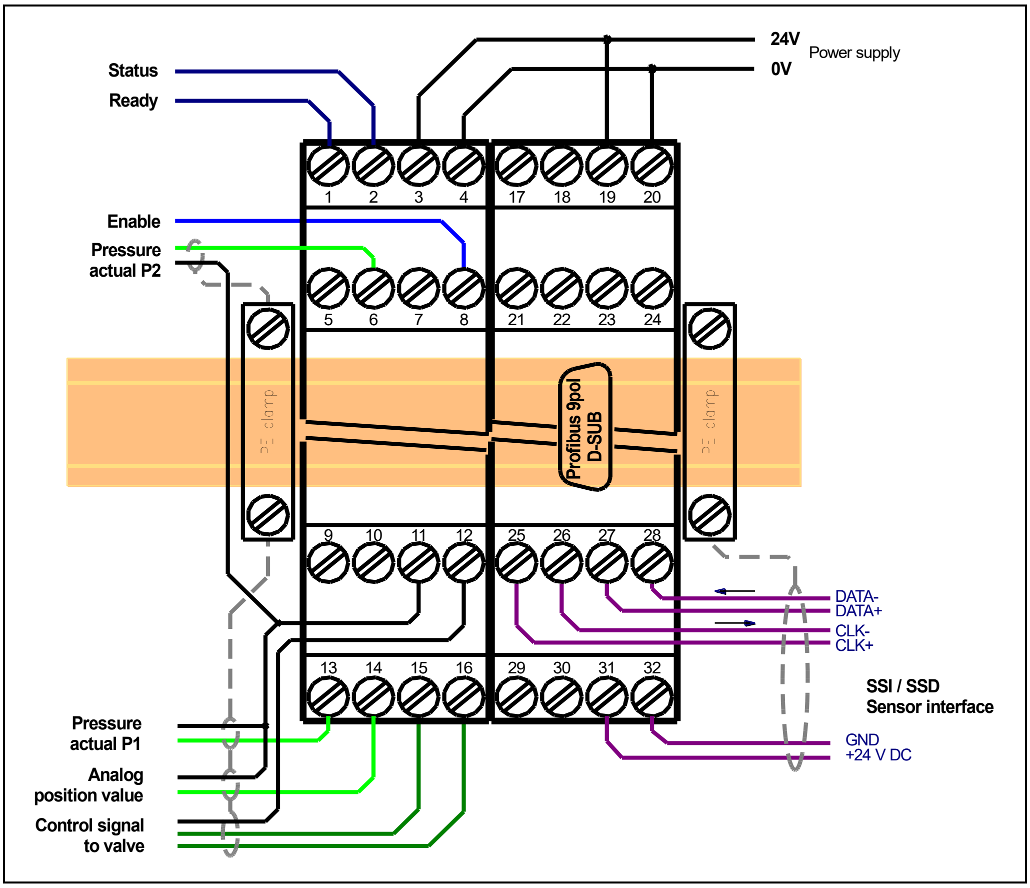
4.2 LED definitions

LEDs	Description of the LED function
GREEN	Identical to the READY output. **OFF:** No power supply or ENABLE is not activated **ON:** System is ready for operation **Flashing:** Error discovered Only active when SENS = ON
YELLOW A	Identical to the STATUS output. **OFF:** The axis is outside the POSWIN window. **ON:** The axis is within the POSWIN window.
YELLOW B	Optional pressure STATUS LED. **OFF:** The axis is outside the PRESSWIN window. **ON:** The axis is within the PRESSWIN window.
GREEN + YELLOW A+B	1. **Chasing light (over all LEDs):** The bootloader is active. No normal functions are possible. 2. **All LEDs flash shortly every 6 s:** An internal data error was detected and corrected automatically! The module still works regularly. To acknowledge the error the module has to be cycle powered.
YELLOW A + YELLOW B	**Both yellow LEDs flash alternately every 1 s:** The nonvolatile stored parameters are in-consistent! To acknowledge the error, the data have to be saved with the SAVE command or the corresponding button in the WPC.

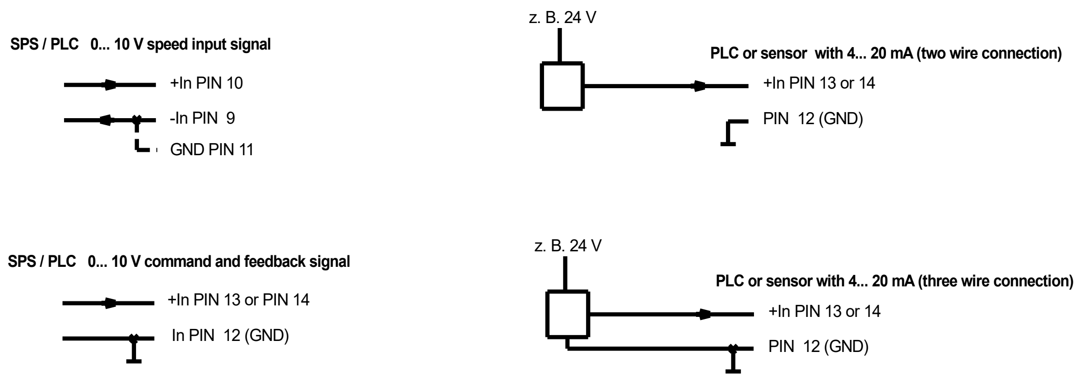
4.3 *Block diagram*



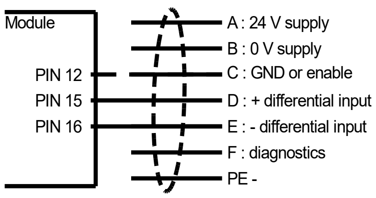
4.4 Typical wiring



4.5 Connection examples



Valve (6 + PE plug) with OBE electronics



4.6 Technical data

Supply voltage (U_b) Power consumption External protection	**[VDC]** **[W]** **[A]**	24 (±10 %) max. 2.5 without sensor supply 1 medium time lag
Digital inputs OFF ON Input resistance	 **[V]** **[V]** **[kOhm]**	 < 2 > 10 25
Digital outputs OFF ON Maximum output current	 **[V]** **[V]** **[mA]**	 < 2 max. U_b 50
Analogue inputs Voltage Input resistance Signal resolution Current Load Signal resolution	 **[V]** **[kOhm]** **[%]** **[mA]** **[Ohm]** **[%]**	Unipolar 0… 10 min. 25 0.003 incl. Oversampling 4… 20 240 Ohm 0.006 incl. Oversampling
Analogue outputs Voltage Maximum load Current Maximum load Signal resolution	 **[V]** **[mA]** **[mA]** **[Ohm]** **[%]**	 0… 10, +/- 10 differential 10 4… 20 390 0.007
Profibus DP interface Data rate ID-number	 **[kbit/s]** 	 9.6,19.2, 93.75, 187.5, 500, 1500, 3000, 6000, 12000 1810h
SSI-interface Specification Data rate	 **-** **[kbit/s]**	 RS-422 120
Serial Interface Data rate	**-** **[kBaud]**	USB - virtuel COM Port 9.6… 115.2
Controller sample time	**[ms]**	1
Housing Material Flammability	 **-** **[class]**	Snap-on module to EN 50022 PA 6.6 polyamide V0 (UL94)
Weight	**[kg]**	0.27

Protection class Temperature range Storage temperature Humidity	**[IP]** **[°C]** **[°C]** **[%]**	20 -20… 60 -20… 70 < 95 (non-condensing)
Connections Communication Plug connectors PE Profibus	**-**	 USB type B 7 x 4-pole terminal blocks via the DIN mounting rail D-Sub 9 pol.
EMC	**-**	EN61000-6-4: 2007 +A1:2011 EN61000-6-2: 2005

5 Parameters

5.1 Parameter overview

Group	Command	Default	Unit	Description
Basic parameter				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	SENS	ON	-	Malfunction monitor
	PDPADR	126	-	Profibus device address
	FUNCTION	POS	-	Function set of the control mode (POS, POS_PQ, PQ)
	HAND:A **HAND:B**	3330 -3330	0,01 % 0,01 %	Output signal in manual mode (limitable by the speed input)
	POSWIN:S **POSWIN:D**	200 5000	µm µm	Ranges of the position monitoring
	PRESSWIN	2000	mbar	Pressure within the programmed window
	EOUT	0	0,01 %	Output signal if not ready
Signal adaptation position control				
	SYS_RANGE	100	mm	Axis working stroke
	SELECT:X	SSI	-	Sensor section
Analogue sensor scaling				
	SIGNAL:X	U0-10		Type of input
	N_RANGE:X	100	mm	Nominal range
	OFFSET:X	0	µm	Offset value
SSI Interface				
	SSI:RANGE	100	mm	Length of the sensor
	SSI:OFFSET	0	µm	Position offset
	SSI:POL	+	-	Polarity
	SSI:RES	100	10 nm	Resolution of the sensor
	SSI:BITS	24	-	Number of data bits
	SSI:CODE	GRAY	-	Code
	SSI:ERRBIT	0	-	Position of the error bit
Profile generator				
	VMODE	SDD	-	Method of positioning
	VRAMP	100	ms	Ramp time for the external command speed
	ACCEL	250	mm/s²	Acceleration in NC mode
	VMAX	50	mm/s	Maximum speed in NC mode
Closed loop control parameter				
	A:A **A:B**	100 100	ms ms	Acceleration (ramp times) in SDD mode
	D:A **D:B** **D:S**	25 25 10	mm mm mm	Deceleration stroke in SDD mode

Group	Command	Default	Unit	Description
	V0:A **V0:B** **V0:RES**	10 10 1	1/s 1/s -	Closed loop gain in NC mode Can be used to change the resolution.
	PT1	1	ms	PT1 time constant
	CTRL	SQRT1	-	Control characteristics
Signal adaptation pressure control				
	PS_RANGE	100	bar	System pressure
	ARATIO	1000	-	Ratio of the cylinder
	F_OFFSET	0	mbar	Offset compensation
Sensor scaling X1				
	SIGNAL:X1	U0-10	-	Type
	N_RANGE:X1	100	bar	Nominal pressure of the sensor
Sensor scaling X2				
	SIGNAL:X2	OFF	-	Type
	N_RANGE:X2	100	bar	Nominal pressure of the sensor
Ramps and PID compensator				
	RA:UP **RA:DOWN**	100 100	ms ms	Ramp times
Parameter set 1				
	C1:P **C1:I** **C1:D** **C1:D_T1** **C1:I_ACT**	50 4000 0 1 5000	0,01 0,1 ms 0,1 ms 0,1 ms 0,01 %	P Gain I Gain, reset time D Gain, derivative D filter Integrator activation
Parameter set 2				
	C2:P **C2:I** **C2:D** **C2:D_T1** **C2:I_ACT**	50 4000 0 1 5000	0,01 0,1 ms 0,1 ms 0,1 ms 0,01 %	P Gain I Gain, reset time D Gain, derivative D filter Integrator activation
Output signal adaptation				
	MIN:A **MIN:B**	0 0	0,01 % 0,01 %	Deadband compensation or flow characteristic linearization
	MAX:A **MAX:B**	10000 10000	0,01 % 0,01 %	Output scaling
	TRIGGER	200	0,01 %	Trigger point of MIN parameter
	OFFSET	0	0,01 %	Output offset value
	SIGNAL:U	U+-10	-	Type of output signal and polarity

Group	Command	Default	Unit	Description
Special commands				
Drift compensator				
	DC:AV **DC:DV** **DC:I** **DC:CR**	0 0 2000 500	0,01 % 0,01 % ms 0,01 %	Control parameter of the drift compensator DC:AV = point of activation DC:DV = point of deactivation DC:I = reset time of the integrator DC:CR = output limit
AINMODE				
	AINMODE	EASY	-	Input scaling mode
	AIN:X **AIN:X1** **AIN:X2**	A: 1000 B: 1000 C: 0 X: V	- - 0,01 % -	Free scaling of the analogue inputs (MATH)

5.2 *Configuration*

5.2.1 LG (Changing the language)

Command	Parameters	Unit	Group
LG x	x= DE|EN	-	STD

Either German or English can be selected for the help texts.

CAUTION: After changing the language settings, the ID button (SPEED BUTTON) in the menu bar (WPC-300) must be pressed (module identification).

5.2.2 MODE (Switching between parameter groups)

Command	Parameters	Unit	Group
MODE x	x= STD|EXP	-	STD

This command changes the operating mode. Various commands (defined via STD/EXP) are blanked out in Standard Mode. The commands in Expert Mode have a more significant influence on system behavior and should accordingly be changed with care.

5.2.3 SENS (monitoring of the module functions)

Command	Parameters	Unit	Group
SENS x	x= ON|OFF|AUTO	-	STD

This command is used to activate/deactivate the monitoring functions (4… 20 mA sensors, output current, signal range and internal failures) of the module.

ON: All monitoring functions are active. Detected failures can be reset by deactivating the ENABLE input.

OFF: No monitoring function is active.

AUTO: Auto reset mode. All monitoring functions are active. If the failure doesn't exist anymore, the module automatically resumes to work.

Normally the monitoring functions are always active because otherwise no errors are detectable via the READY output. Deactivating is possible mainly for troubleshooting.

5.2.4 PDPADR (Profibus address)

Command	Parameters	Unit	Group
PDPADR x	x= 1… 126	-	STD

This command is used to change the address of the module.

The PDPADR must be 126 if an external address change (over the Profibus) should be supported.

5.2.5 FUNCTION (function mode of the module)

Command	Parameters	Unit	Group
FUNCTION x	x= POS|POS_PQ|PQ	-	STD

This command is used to define the general behavior[1].
POS: Standard positioning mode (comparable with the older POS-123-PDP-1115)
POS_PQ: Axis control mode, position and pressure control (comparable with the older PPC-125-PDP-1115)
PQ: Pressure control mode (comparable with the older PQ-132-PDP-1115)

5.2.6 HAND (Manual speed)

Command	Parameters	Unit	Group
HAND:i x	i= A|B x= -10000… 10000	0,01%	STD

The manual speeds are set with these parameters. The drive moves in a controlled manner in the defined direction when the manual signal is active. The direction is defined by the sign of the parameters. After the manual signal has been disabled, the drive remains under control in the current position.

In case of a fault (position sensor fault), the drive can still be moved with this manual function. The output will be switched off when hand signals are turned off.

The manual speed is also limited by the speed demand (MIN evaluation).

Caution! Do not use the manual mode in conjunction with the EOUT command. After the deactivation of the HAND input the output is set to the EOUT value.

[1] Attention: Some of the internal functions are standardized. Please check the parameterization carefully.

5.2.7 POSWIN:S (Static position monitoring range)

5.2.8 POSWIN:D (Dynamic following error monitoring range)

Command	Parameters	Unit	Group
POSWIN:S x POSWIN:D x	x= 2… 200000 x= 2… 200000	µm µm	STD

This parameter is entered in µm.
The POSWIN command defines a range for which the STATUS message on the bus and digital output is generated. This function monitors the control deviation between the command and actual position. The positioning process is not influenced by this function, the controller remains active. START has to be activated for it.

POSWIN:S This parameter defines the allowed control deviation for creating the status message when reaching the target position. It is active in SDD mode.

POSWIN:D This parameter defines the allowed control deviation for creating the status message during the positioning process. It is active in NC mode.

In NC mode the POSWIN:S target position monitoring additionally can be used, too via the ON_TARGET bit in the status word.

5.2.9 PRESSWIN (Pressure window)

Command	Parameters	Unit	Group
PRESSWIN x	x= 100… 50000	mbar	STD

This parameter is entered in mbar.
The PRESSWIN command defines a range for which the signal is generated. This function monitors the failure between the command and actual value.

5.2.10 EOUT (Output signal: READY = OFF)

Command	Parameters	Unit	Group
EOUT x	x= -10000… 10000	0,01 %	EXP

Output value in case of a detected error or a deactivated ENABLE input. This function can be used if the drive has to be moved to one of the two end positions (with defined speed).

|EOUT| = 0 The output is switched off in the event of an error. This is normal behavior.

CAUTION! If the output signal is 4… 20 mA, the output is switched off when **|EOUT| = 0**. If a null value = 12 mA is to be output in the event of an error, EOUT must be set to 1[2].

The output value defined here is stored permanently (independent from the parameter set). The effects should be analyzed by the user for each application from the point of view of safety.

Do not use the manual mode in conjunction with the EOUT command. After the deactivation of the HAND input the output is set to the EOUT value.

5.3 Signal adaptation

5.3.1 SYS_RANGE (Working stroke)

Command	Parameters	Unit	Group
SYS_RANGE x	x= 10… 10000	mm	STD

This command defines the full stroke, which corresponds to 100 % of the input signal. If the demand is set incorrectly, this leads to incorrect system settings, and the dependent parameters such as speed and gain cannot be calculated correctly.

[2] This is necessary if using valves without error detection for signals lower than 4 mA. If the valve has an internal error detection, it moves into a defined position after switching off the output.

5.3.2 SELECT:X (Position sensor type)

Command	Parameters	Unit	Group
`SELECT:X   x`	`x= ANA|SSI`		STD

The appropriate sensor type can be activated with this command.

ANA: The analogue sensor interface (0… 10 V or 4… 20 mA) is active. This sensor is scaled with the **AIN:X command.**

SSI: The SSI sensor interface is active. The SSI sensor is matched to the sensor with the SSI commands. The relevant sensor data must be available.

5.3.3 Analogue inputs

5.3.3.1 SIGNAL (Type of input signal)

Command	Parameter	Unit	Group

`SIGNAL:i   x`	`i=  X|X1|X2`
	`x=  OFF`
	`U0-10`
	`U10-0`
	`I4-20`
	`I20-4`
		-	EASY

This command can be used to change the type of input signal (voltages or current) and to define the direction of the signal. This command is available for all analogue inputs.

5.3.3.2 N_RANGE (Nominal range of the sensor)

Command	Parameter	Unit	Group

`N_RANGE:X  x`
`N_RANGE:X1 x`
`N_Range:X2 x`
	`x= 10… 10000`
	`x= 10…   700`
	`x= 10…   700`
		mm
		bar
		bar
			EASY

N_RANGE (nominal range or nominal stroke) is used to define the length of the sensor. This value should always be equal or higher than SYS_RANGE / PS_RANGE. The control parameter cannot be calculated correctly in case of wrong values.

5.3.3.3 OFFSET (Sensor offset)

Command	Parameter	Unit	Group
OFFSET:X x	x= -100000… 100000	µm	EASY

Adjustment of the zero point of the sensor.

5.3.4 SSI Sensor

5.3.4.1 SSI:RANGE (Nominal length)

Command	Parameter	Unit	Group
SSI:RANGE X	x= 10… 10000	mm	SSI

This parameter is used to define the length of the sensor.
The relevant data are described in the technical data of the sensor.

5.3.4.2 SSI:OFFSET (Sensor offset)

Command	Parameters	Unit	Group
SSI:OFFSET x	x= -200000… 200000	µm	SSI

A sensor offset is entered with this parameter.

5.3.4.3 SSI:POL (Signal direction)

Command	Parameters	Unit	Group
SSI:POL x	x= +|-	-	SSI

To reverse the sensor working direction.

5.3.4.4 SSI:RES (Signal resolution)

Command	Parameters	Unit	Group
`SSI:RES x`	`x= 100… 10000`	`0,01 µm`	SSI

The sensor signal resolution[3] is defined with this parameter. Data is entered with the resolution of 10 nm (nanometer or 0,01 µm). This means that a value of 100 defines a sensor with 1 µm resolution. This also makes it possible to scale rotational sensors.
The appropriate data can be found in the sensor data sheet.

5.3.4.5 SSI:BITS (Number of data bits)

Command	Parameters	Unit	Group
`SSI:BITS x`	`x= 8… 31`	`bit`	SSI

The number of data bits is entered with this parameter.
The appropriate data can be found in the sensor data sheet.

5.3.4.6 SSI:CODE (Signal coding)

Command	Parameters	Unit	Group
`SSI:CODE x`	`x= GRAY|BIN`	-	SSI

The data coding is entered with this parameter.
The appropriate data can be found in the sensor data sheet.

5.3.4.7 SSI:ERRBIT (Position of the “out of range” bit)

Command	Parameter	Unit	Group
`SSI:ERRBIT X`	`x= 8… 31`	`bits`	SSI

The position of the error bit will be defined by this parameter.
The appropriate data can be found in the sensor data sheet.
In case of no error bit, the default value is 0.

[3] The internal resolution of the module is 1 µm. This is also the lowest resolution of the sensor.

5.3.5 Using of the commands SYS_RANGE, N_RANGE:X and OFFSET:X

The application scaling will be done by these three commands. In this example the system is defined by a length of 120 mm of the sensor, a working stroke of 100 mm of the cylinder and an offset of 5 mm. These parameters have to be typed in and the axis is driving between 5 mm and 105 mm of the sensor stroke and between 0 mm and 100 mm of the cylinder stroke.

Correct scaling:
SYS_RANGE = 100 (mm)
N_RANGE:X = 120 (mm)
OFFSET:X = -5000 (µm)

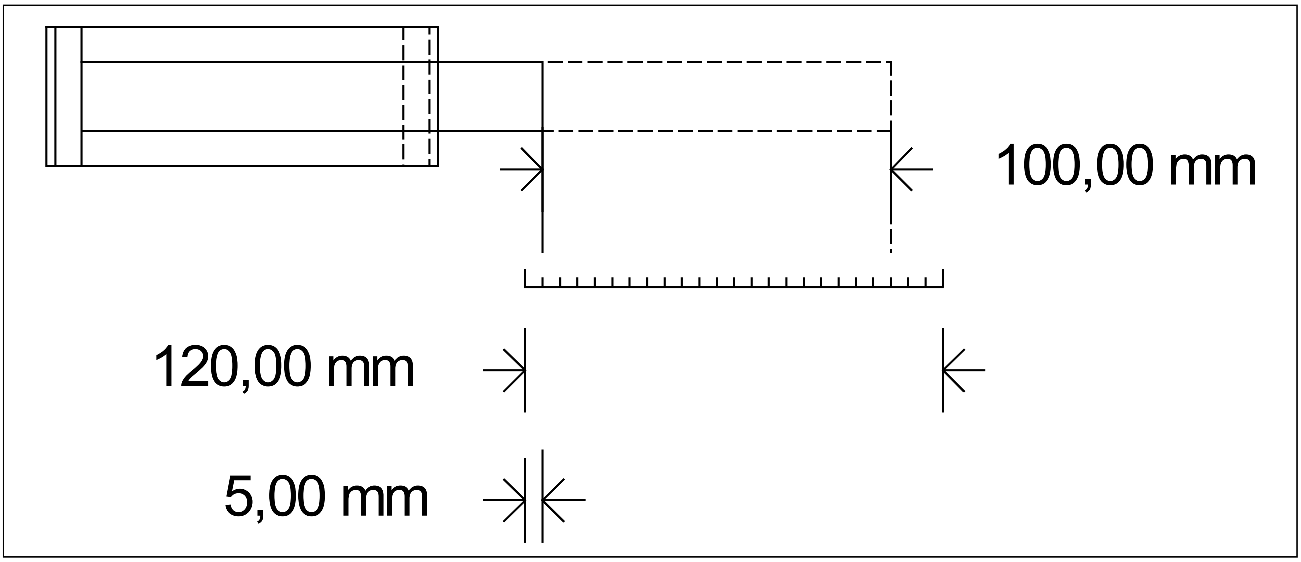


Figure 1 (Input scaling of the sensor)

5.4 Speed commands

5.4.1 VRAMP (Ramp time for external speed demand)

Command	Parameters	Unit	Group
VRAMP x	x= 10… 5000	ms	EXP

The rate of change of speed demand can be limited by this ramp time. In case of NC mode, this parameter should be set to 10 ms.

5.5 *Profile generator*

5.5.1 VMODE (Method of positioning)

Command	Parameters	Unit	Group
VMODE x	x= SDD|NC		EXP

The fundamental control structure can be changed with this parameter.

SDD: **S**troke-**D**ependent **D**eceleration. In this mode, stroke-dependent deceleration is activated. This mode is the default mode and is suitable for most applications. With stroke-dependent deceleration the drive comes to a controlled stop at the target position. From the deceleration setpoint the drive then switches to closed loop control mode and moves accurately to the desired position. This control structure is very robust and reacts insensitively to external influences such as fluctuating pressures. One disadvantage is that the speed varies with the fluctuating pressure as the system runs under open-loop control.

NC: **N**umerically **C**ontrolled. In this mode a position profile is generated internally. The system always works under control and uses the following error to follow the position profile. The magnitude of the following error is determined by the dynamics and the closed loop gain. The advantage is that the speed is constant (regardless of external influences) due to the profile demand. Because of continuous control, it is necessary not to run at 100 % speed, as otherwise the errors cannot be corrected. 70… 80 % of the maximum speed is typical although especially the system behavior and the load pressure should be taken into account when specifying the speed.

5.5.2 ACCEL (Acceleration in NC mode)

Command	Parameters	Unit	Group
ACCEL x	x= 1… 20000	mm/s²	VMODE=NC

This command is used to define the acceleration in NC mode. The command is active if the VMODE has been parameterized to NC.

5.5.3 VMAX (Maximum speed in NC mode)

Command	Parameters	Unit	Group
VMAX x	x= 1… 2000	mm/s	VMODE=NC

Specification of the maximum speed in NC mode. This value is defined by the drive system and should be specified as precisely as possible (not too high under any circumstances). The speed is scaled by means of the VELO value or via the external speed demand. The command is only active if the VMODE has been parameterized to NC. The lower speed between extending and retracting have to be used for this parameter.

5.6 *Position control parameter*

5.6.1 A (Acceleration (ramp) time)

Command	Parameters	Unit	Group
`A:i x`	`i= A|B` `x= 1… 5000`	`ms`	VMODE=SDD

Ramp function for the 1st and 3rd quadrant.

The acceleration time for positioning is dependent on the direction. "A" corresponds to connection 15 and "B" corresponds to connection 16 (if POL = +).
Normally A = flow P-A, B-T and B = flow P-B, A-T.

For the quadrants 2 and 4, parameters D:A and D:B are used as the deceleration distance demand.

5.6.2 D (Deceleration / braking distance)

Command	Parameters	Unit	Group
`D:i x`	`i= A|B|S` `x= 1… 10000`	`mm`	VMODE = SDD

This parameter is specified in mm[4].
The deceleration stroke is set for each direction of movement (A or B). The control gain is calculated internally depending on the deceleration distance. The shorter the deceleration distance, the higher the gain. A longer deceleration distance should be specified in the event of instability.

Parameter D:S is used as the stopping ramp when disabling the START signal. After disabling, a new target position (current position plus D:S) is calculated in relation to the speed and is specified as a command value.

$$G_{Intern} = \frac{STROKE}{D_i}$$ Calculation of control gain

CAUTION: If the maximum stroke (SYS_RANGE command) is changed, the deceleration distance must also be adjusted. Otherwise this can result in instability and uncontrolled movements.

[4] **CAUTION!** In older modules this parameter was specified in % of the maximum stroke. Since data specification for this module has now been converted to mm, the relationship between the stroke (SYS_RANGE command) and these parameters must be taken into account.

5.6.3 V_0 (Loop gain setting)

Command	Parameters	Unit	Group
`V0:i x`	`i= A|B` `x= 1… 400`	s^{-1}	**VMODE = NC**

This parameter is specified in s^{-1} (1/s).
In NC Mode normally the loop gain is specified rather than the deceleration stroke[5].
The internal gain is calculated from this gain value together with the parameters VMAX and SYS_RANGE.

$$D_i = \frac{v_{max}}{V_0}$$

$$G_{Intern} = \frac{STROKE}{D_i}$$

Calculation of the internal control gain

In NC Mode the following error at maximum speed is calculated by means of the loop gain. This following error corresponds to the deceleration stroke with stroke-dependent deceleration. The conversion and therefore also the correct data demands related to the closed loop control system are relatively simple if the relationship described here is taken into account.

5.6.4 V0:RES (Scaling of the loop gain)

Command	Parameters	Unit	Group
`V0:RES x`	`x= 1|100`	-	**VMODE = NC**

V0:RES = 1 loop gain in s^{-1} (1/s) units.
V0:RES = 100 loop gain in 0,01 s^{-1} units[6].

⚠ The increased resolution should be used in case of $V_0 < 4$.

[5] The loop gain is alternatively defined as a KV factor with the unit (m/min)/mm or as V_0 in 1/s. The conversion is KV = V_0/16,67.

[6] In case of very low loop gains (1 s^{-1} to 3 s^{-1}) the better resolution of the adjustment should be selected.

5.6.5 T1 (Timing of the controller)

Command	Parameter	Unit	Group
PT1 x	x= 0… 300	ms	EXP

This parameter can be used to change the internal timing of the control function.
Hydraulic drives are often critically to control, especially in case of very fast valves. The PT_1 filter can be used to improve the damping rate and allows therefore higher loop gains.

Requirements for the use are: The natural frequency of the valve should be equal or higher than the natural frequency of the drive.

5.6.6 CTRL (Deceleration characteristics)

Command	Parameters	Unit	Group
CTRL x	x= LIN|SQRT1|SQRT2	-	STD

The deceleration characteristic is set with this parameter. In case of positively overlapped proportional valves the SQRT function should be used. The non-linear flow function of these valves is linearized by the SQRT[7] function.

In case of zero lapped valves (control valves and servo valves) the LIN or SQRT1 function should be used depending from the application. The progressive characteristic of the SQRT1 function has a better positioning accuracy but can also lead to longer positioning times in individual cases.

LIN: Linear deceleration characteristic (gain is increased by a factor of 1).

SQRT1: Root function for braking curve calculation. The gain is increased by a factor of 3 (in the target position). This is the default setting.

SQRT2: Root function for braking curve calculation. The gain is increased by a factor of 5 (in the target position). This setting should only be used with a significantly progressive flow through the valve.

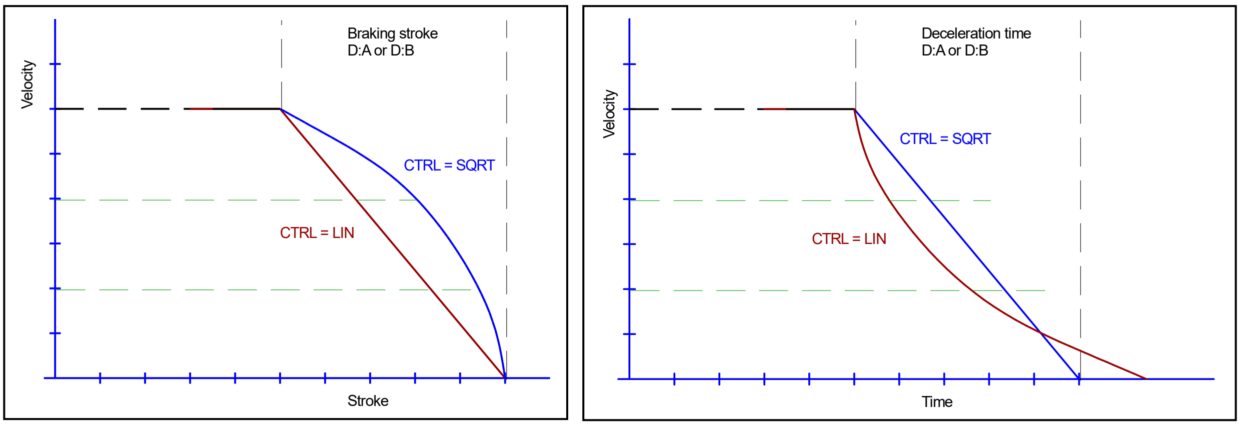


Figure 2 (Braking function with respect to stroke and time)

[7] The SQRT function generates constant deceleration and thus reaches the target position faster. This is achieved by increasing the gain during the deceleration process.

5.7 *Pressure control parameter*

5.7.1 PS_RANGE (System pressure)

Command	Parameters	Unit	Group
PS_RANGE X	x= 10… 1000	bar	**STD**

This command defines the pressure which corresponds to 100 % of the input signal. If the demand is set incorrectly, this leads to incorrect system settings, and the dependent parameters cannot be calculated correctly.

5.7.2 ARATIO (Cylinder area ratio)

Command	Parameters	Unit	Group
ARATIO X	x= 200… 5000	-	**EXP**

In order to limit the output force in either direction correctly, the parameter ARATIO provides the ratio of the two areas of the cylinder (bore side / piston side).
Accordingly, a corresponding value of 1000 defines a ratio of 1.

For example:	Area ratio = 2.08:	ARATIO has to be set to 2080
	Area ratio = 0,5:	ARATIO has to be set to 500
	Area ratio = 1:	ARATIO has to be set to 1000

5.7.3 F_OFFSET (Feedback offset)

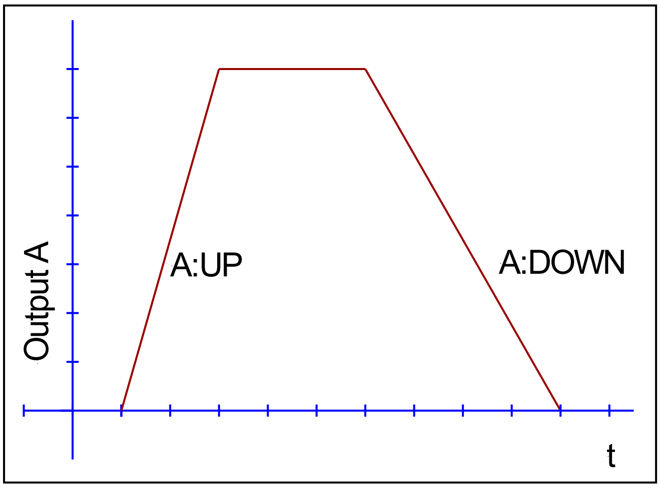
Command	Parameters	Unit	Group
F_OFFSET X	x= -500000… 500000	mbar	**EXP**

This parameter is entered in mbar.
This parameter adds an offset value to the resulting feedback signal. For example, to compensate external force differences (suspended loads, spring forces etc.).

5.7.4 RA (Command signal ramp time)

Command	Parameters	Unit	Group
`RA:i x`	`i= UP|DOWN` `x= 1… 600000`	**ms**	**STD**

The ramp times for the pressure command value are defined here in ms. Two separate time values are entered for increasing and decreasing pressure.



5.7.5 C (PID control parameters)

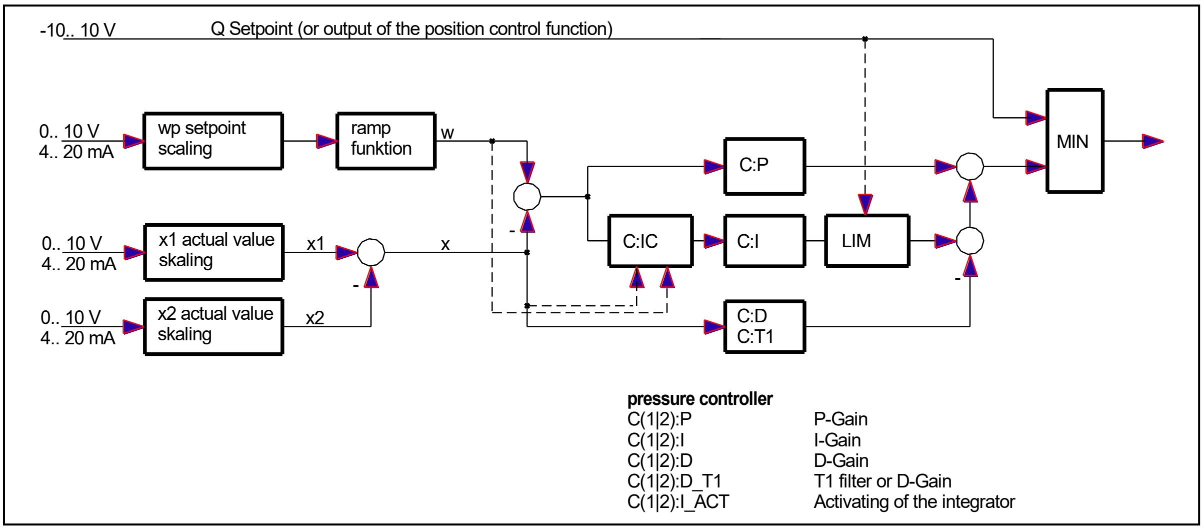
Command	Parameter	Unit	Group
Cp:i x	p= 1|2(parameter set) i= P|I|D|D_T1|I_ACT :P x= 1… 10000 :I x= 0… 30000 :D x= 0… 1200 :D_T1 x= 5… 1000 :I_ACT x= 0… 10000	 0,01 0,1 ms 0,1 ms 0,1 ms 0,01 %	**STD**

The control function will be parameterized via this command.

The P, I and D gain are similar to a standard PID controller. The T1 factor is used for the D-gain in order to suppress high-frequency noise.

I_ACT controls the integrator function. To reduce pressure overshoots, an activation point for the integrator can be programmed via the I_ACT value. The integrator is activated if the actual pressure is higher than the programmed threshold.

The integrator function of the controller can be disabled in special cases by setting C:I to zero.



5.8 *Output signal adaptation*

5.8.1 MIN (Deadband compensation)

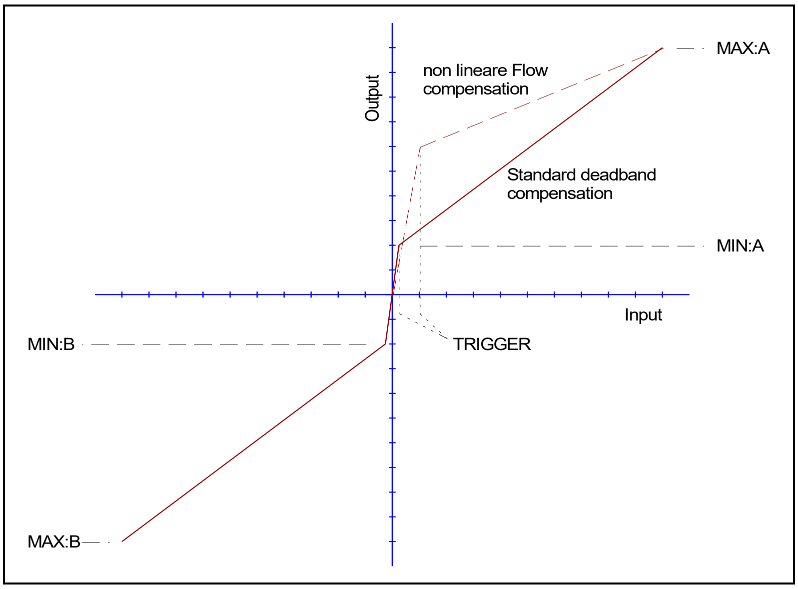
5.8.2 MAX (Output scaling)

5.8.3 TRIGGER (Response threshold for the MIN parameter)

Command	Parameters	Unit	Group
	i= A|B	-	**STD**
MIN:i x	x= 0… 6000	0,01 %	
MAX:i x	x= 3000… 10000	0,01 %	
TRIGGER x	x= 0… 4000	0,01 %	

The output signal to the valve is adjusted by means of these commands. A kinked volume flow characteristic is used instead of the typical overlap step for the position controls. The advantage is a better and more stable positioning behavior. At the same time, kinked volume flow characteristics can also be adjusted with this compensation[8].

CAUTION: If there should also be adjustment options for deadband compensation on the valve or valve amplifier, it must be ensured that the adjustment is performed either at the power amplifier or in the module.
If the MIN value is set too high, this has an effect on the minimum speed, which can then no longer be adjusted. In extreme cases this leads to oscillation around the controlled position.



[8] Various manufacturers have valves with a defined nonlinear curve: e.g. a kink at 40 or 60 % (corresponding to 10 % input signal) of the nominal volume flow. In this case the TRIGGER value should be set to 1000 and the MIN value to 4000 (6000).

If zero lapped or slightly underlapped valves are used, the volume flow gain in the zero range (within the underlap) is twice as high as in the normal working range. This can lead to vibrations and jittery behavior. To compensate this, the TRIGGER value should be set to approximately 200 and the MIN value to 100. The gain in the zero point is thus halved and an overall higher gain can often be set.

5.8.4 OFFSET (Valve zero correction)

Command	Parameters	Unit	Group
`OFFSET x`	`x= -4000… 4000`	`0,01 %`	**STD**

This parameter is entered in 0,01 % units.
The offset value is added to the output value. Valve zero offsets can be compensated with this parameter.

5.8.5 SIGNAL:U (Type and polarity of the output signal)

Command	Parameter	Unit	Group

`SIGNAL:U x`	`x= U+-10`
	`I4-12-20`
	`U-+10`
	`I20-12-4`
		-	**EXP**

This command is used to define the output signal (voltage or current) and to change the polarity[9].

Differential output ± 100 % corresponds with ± 10 V (0… 10 V at PIN 15 and PIN 16).
Current output ± 100 % corresponds with 4… 20 mA (PIN 15 to PIN 12). 12 mA (0 %) = center point of the valve.

Current output: An output current of << 4 mA indicates an error and the module is disabled. The current input of the proportional valves should be monitored by the valve. The valve has to be deactivated in case of < 4 mA input signal. Otherwise the EOUT command can be used to get a defined output signal.

[9] The older POL command is removed.

5.9 *Special commands*

5.9.1 Drift compensation / high accurate positioning

The high accurate positioning or the drift compensation can be used in case of external influence which is limiting the positioning accuracy. This function could be critical if limit cycling[10] by wrong parameterization or the system behavior was not taken into account.

Which positioning errors can be compensated[11]?

1. Zero point adjustment of the valve. By this kind of failure a constant offset between command and feedback signal remains. This failure is more or less constant.
2. Zero point failure depending on the temperature. The same behavior as point 1, but the failure is increasing slowly (over the temperature).
3. Position failure caused by an external force. All control and servo valves have a typical pressure gain characteristic. In case of external forces an output signal of 2…3 % has to be generated for the compensation of this force. And this signal is proportional to the positioning error. In opposite to point one and two the positioning failure generated by the force signal can vary cycle to cycle.

How does it work?

The position errors should be compensated when the axis is near by the target position. The output signal is going lower and lower but a system specific position error remains. At the activation point this function – a slowly working integrator – is active. This integrator signal is added to the output signal and will compensate offsets and other failure. To prevent instabilities, the integrator value will be frozen when the output value is lower than the deactivation point.

Drift compensation (to compensate failure of the zero point adjustment)

To compensate position errors of point one and two.

High accurate positioning (used at external forces or general drift compensation)

To compensate positions errors of point three. Alternatively of point one, two and three.

Positioning modules without fieldbus:

Only one function is implemented to compensate the positioning error of point one, two and three. The activation is controlled by the parameterization of DC:AV parameter.

Positioning modules with fieldbus:

Two functions are implemented to compensate offset/temperature dependent and/or force dependent positioning errors[12]. The activation is controlled by the parameterization of DC:AV parameter and the following fieldbus control bits:

DC_ACTIVE: General activation of the drift compensation and high accurate positioning.

DC_FEEZE: Freezing of the static drift compensation value.

F_POS: Activation of the high accurate positioning (dynamic drift compensation).

[10] The „limit cycling“ is a small and permanent oscillation around the target position. The main reason are static frictions and the hysteresis of the valve. By proper parameter setting, this can be avoided under the boundary condition that the desired accuracy is not achieved. In this case, the hydraulic system is the limiting factor in the accuracy.

[11] This is relevant for zero lapped control valves and servo valves.

[12] To prevent / minimize position overshoots the static drift compensation have to be done first.

Typical setup

Valve pressure gain: 2,5 %; the activation point has to be set to 3… 5 % (DC:AV 300… 500).
Valve hysteresis: 0,5 %; the deactivation point has to be set to 0,7… 1,0 % (DC:DV 70… 100). The lower the value the better the accuracy.

DC:CR should be equal to DC:AV.

The optimum integrator time has to be determined experimentally. Starting with higher values is recommended.

5.9.1.1 DC:AV (Activation value)

5.9.1.2 DC:DV (Deactivation value)

5.9.1.3 DC:I (Integrator time)

5.9.1.4 DC:CR (Integrator limitation)

Command	Parameter	Unit	Group
`DC:AV x`	`x= 0… 2000`	`0,01 %`	**EXP**
`DC:DV x`	`x= 0… 1000`	`0,01 %`	
`DC:I x`	`x= 0… 2000`	`ms`	
`DC:CR x`	`x= 0… 500`	`0,01 %`	

DC:AV This parameter is used to define the activation point (activation value). The DC function is completely deactivated in case of DC:AV = 0.

DC:DV This parameter is used to define the deactivation point (DV = deactivation value) Within the deactivation window no compensation value will be calculated (frozen state).
DC:AV = 0 should be used for best positioning, but „limit cycling“ can occur. This value should be set to 50 % of an acceptable error.

DC:I This parameter is used to define the integrator time. The lower this value the faster the compensation. Low values will result in „limit cycling“.

DC:CR The output range of the DC function will be limited (CR = control range) by this parameter.

5.9.2 AINMODE

The AINMODE is used to define the kind of parameterizing of the analogue inputs. The EASY mode (DEFAULT) supports a simple and application oriented input scaling.

The MATH mode supports the free input scaling by a linear equation. This mode is compatible to our older modules.

Attention: This command can only be executed in the terminal window. In case of switching back, DEFAULT data should be reloaded.

5.9.2.1 AINMODE (Input scaling mode)

Command	Parameter	Unit	Group
AINMODE x	x= EASY|MATH	-	Terminal

This command is used to switch over the kind of input scaling.

5.9.2.2 AIN (Analogue input scaling)

Command	Parameters	Unit	Group
AIN:i	i= X|X1|X2		MATH
A	a= -10000… 10000	-	
B	b= -10000… 10000	-	
C	c= -10000… 10000	0,01 %	
X	x= V|C	-	

This command can be used to scale the individual inputs. The following linear equation is used for scaling.

$$Output = \frac{a}{b}(Input - c)$$

The "C" value is the offset (e.g. to compensate the 4 mA at a 4... 20 mA input signal). This value is given in percent. The variables A and B define the gain factor with which the signal range is scaled to 100 % (e.g. 1.25 for 4... 20 mA input signal, parameterized by default by A=1250 and B=1000). These two values have no units. X switches from voltage to current signal and activates the internal measuring resistor.

The gain factor is calculated by comparing the usable range (A) with the actually used range (B). 0... 20 mA can be used, which results in a value of 20 for (A). Used are 4... 20 mA, which gives (B) a value of 16 (20-4). 0... 4 mA are not used, which corresponds to an offset of 20 % for the 20 mA range and thus to a value of 2000 for (C). Last (X) switch to C.

The command would therefore look as follows: AIN:I 20 16 2000 C or AIN:I 1250 1000 2000 C.

Typical settings:

Command	Input	Description
`AIN:X 1000 1000 0 V`	0… 10 V	Range: 0… 100 %
`AIN:X 10 8 1000 V` OR `AIN:X 1000 800 1000 V`	1… 9 V	Range: 0… 100 %; 1 V = 1000 used for the offset and gained by 10 / 8 (10 V divided by 8 V (9 V -1 V))
`AIN:X 10 4 500 V` OR `AIN:X 1000 400 500 V`	0,5… 4,5 V	Range: 0… 100 %; 0,5 V = 500 used for the offset and gained by 10 / 4 (10 V divided by 4 V (4,5 V -0,5 V))
`AIN:X 20 16 2000 C` OR `AIN:X 2000 1600 2000 C` OR `AIN:X 1250 1000 2000 C`	4… 20mA	Range: 0… 100 % The offset will be compensated on 20 % (4 mA) and the signal (16 mA = 20 mA – 4 mA) will be gained to 100 % (20 mA). Each of this parameterization for 4… 20 mA is setting the range to 0… 100 %.

5.9.3 ST (Status report)

Putting in this command in the terminal window displays the state of digital in and outputs. Means the bus communication and enable input can be checked here. The displayed message looks e.g. like the following:

```
>ST
control word:         1000 0000 / 0000 0000
status word:          0000 0000 / 0001 1011
position setpoint 1:  0
speed setpoint 1:     0
position setpoint 2:  1770
speed setpoint 2:     2070
pressure setpoint:    0
Enable:               enabled
```

In parameterization mode it can vary like this:

```
>ST
control word:         1100 0000 / 1000 0000
status word:          1000 0000 / 0101 1111
position setpoint 1:  570
speed setpoint 1:     2000
parameter value:      1770
parameter address:    2070
pressure setpoint:    0
Enable:               enabled
```

5.9.4 PROCESS DATA (Monitoring)

Command	Description	Unit
WA	Demand value (input signal)	mm
W	Demand value (according to the profile generator)	mm
V	Speed input	%
X	Actual position value	mm
E	Error value	mm
CS	Output of the position controller	%
WAP	Command pressure	%
WP	Command pressure (after ramp)	bar
X1	Actual pressure value 1	bar
X2	Actual pressure value 2	bar
XP	Differential pressure (conditioned)	bar
EP	Error value	bar
CP	Output signal of the pressure control function	%
U	Output signal of the module	%

The process data are the variables which can be observed continuously on the monitor or on the oscilloscope.

6 Appendix

6.1 *Failure monitoring*

Following possible error sources are monitored continuously when SENS = ON/AUTO:

Source	Fault	Characteristic
Feedback signal pressure PIN 13 / PIN 6 - 4... 20 mA	Out of range or broken wire	The output will be switched off.
Feedback signal position PIN 14 - 4… 20 mA	Out of range or broken wire	The output will be switched off.
SSI-VERSION Sensor value	Out of range or broken wire	The output will be switched off.
EEPROM (when switching on)	Data error	The output is deactivated. The module can only be activated by saving the parameters again!

CAUTION: Take care of the EOUT command. Changes will influence the behavior.

6.2 *Troubleshooting*

It is assumed that the device is in an operable state and there is communication between the module and the WPC-300. Furthermore, the valve control parameterization has been set with the assistance of the valve data sheets.

The RC in monitor mode can be used to analyze faults.

CAUTION: All safety aspects must be thoroughly checked when working with the RC (Remote Control) mode. In this mode the module is controlled directly and the machine control cannot influence the module.

FAULT	CAUSE / SOLUTION
ENABLE is active, the module does not respond and the READY LED is off.	There is presumably no power supply or the ENABLE signal (PIN 8) is not present. If there is no power supply, there is also no communication via our operating program. If a connection has been made to the WPC-300, then a power supply is also available. If the power supply exists, an attempt should be made to see whether the system can be moved by means of the HAND+ and HAND- inputs (measuring the output signal to the valve helps).

FAULT	CAUSE / SOLUTION
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault has been detected by the module. The fault could be: • A broken cable or no signal at the input (PIN 13 or PIN 14), if 4… 20 mA signals are parameterized. • No SSI sensor • Internal data error: press the command/SAVE button to delete the data error. The system reloads the DEFAULT data. With the WPC-300 operating program the fault can be localized directly via the monitor.
ENABLE is active; the READY LED is on, the system moves to an end position.	The control circuit polarity is incorrect. The polarity can be changed with the POL command or by reversing the connections to PIN 15 and PIN 16.
ENABLE is active, the READY LED is on, and the STATUS LED is not on, the system moves to the target position but doesn't reach it (positioning error).	Serious positioning errors can result from incorrect parameterization or incorrect system design. • Is the cylinder position specified correctly? • Are the deceleration strokes correct (to start the system the deceleration distances should be set to approx. 20… 25 % of the cylinder position[13])? • Is the valve a zero lapped control valve or a standard proportional valve? In case of a proportional valve, the valve overlap which may be present should be compensated for with the MIN parameters. Typical values can be found in the valve data sheet.
ENABLE is active, the READY LED is on, and the system oscillates on the target.	The system is working and also actuating the valve. Various potential problems could be: • The parameterization is not yet adjusted to the system (gain too high). • There is severe interference on the power supply. • Very long sensor cables (> 40 m) and sensor signal interference. • The MIN setting to compensate the valve overlap is too high. As a basic principle, the parameterization of the sensor data and the controller settings must be carried out first (before switching on). An incorrect demand is equivalent to incorrect system design which then leads to incorrect operation. If the system oscillates, the gain should first be reduced (longer deceleration distances for D:A and D:B) and in case of overlapped valves the MIN parameter should also be reduced.

Speed too low	The drive may be able to move to position but the speed is too low.
	• Check the control signal to the valve
	  ◦ via the integrated oscilloscope (U variable)
	  ◦ measure the signal to the valve with an external oscilloscope/voltmeter.
	• If the control is within the range of ± 100 % (± 10 V), the fault must be sought in the hydraulics.
	• If the control signal is relatively low, the following points should be checked:
	  ◦ Is the internal/external speed signal limiting the speed?
	  ◦ Which setting has been specified for the deceleration distance in relation to the POSITION?

Speed too high	The drive should move to position. The drive moves in and out too fast leading to uncontrolled behavior. Reducing the speed (MAX or VELO parameter) has very little or no effect. • The hydraulic system is over-sized. The entire parameterization of the movement cycle cannot be reproduced (overlap and deceleration distance settings)

[13] The stability criterion of the hydraulic axis must be taken into account.

7 Profibus interface

7.1 Profibus function

The Profibus module supports all baud rates from 9,6 kbit/s up to 12000 kbit/s with auto detection of the baud rate. The functionality is defined in IEC 61158. The Profibus address can be programmed by a terminal program, WPC-300 or online via the Profibus. A diagnostic LED indicates the online status.

7.2 Installation

A typical screened Profibus plug (D-Sub 9pol with switchable termination) is mandatory. Every Profibus segment must be provided with an active bus termination at the beginning and at the end. The termination is already integrated in all common Profibus plugs and can be activated by DIL switches. The bus determination needs a 5 Volt power supply for the correct function, which is supplied at PIN 6 of the D-sub-socket. The Profibus cable has to be screened at the determined contact clips in the Profibus plug.

7.3 Device data file (GSD)

The Profibus-DP features are documented in a device-data-file. Structure, content and code of this file (GSD) are standardized. They allow the projecting of any DP-slaves with projecting devices of several producers.

The GSD-data are read by a PROFIBUS-Master-configuration software and the correspondent settings are given to the master.

Enclosed is also the identification number of the Profibus knot. It is necessary for a master without significant report overhead to identify the types of the connected devices.

The GSD-file is available at the address: http://www.w-e-st.de/files/software/hms_1810.gsd
File: **hms_1810.gsd**

In the setting of the transfer bytes, 16 bytes (8 words consistent) are necessary as IN/OUT variables.

7.4 *Description of the Profibus interface*

Positioning resolution of 1 µm (independent from the real sensor resolution), max. 0x989680 (10.000.000) is used. The command position is limited by the parameter STROKE.

The command speed is interpreted in percentage of the programmed speed or of the output signal. The value of 0x3fff corresponds with 100 % speed.

The resolution of command and feedback pressures is 0,1 bar.

Parameterization via Fieldbus is explained separately in the following chapter.

The module is controlled with a **control word** consisting of following bits:

- **ENABLE:** General activation of the system.
- **START:** The command position is taken over by a low to high signal change. If **START** is deactivated during the movement, the system will be decelerated by the programmed value of the deceleration ramp.
- **UNITS**: 0 = **compatibility mode**: pressure values in % (0… 0x3fff = 0… 100 %)
  1 = pressure values in 0,1 bar
- **DIRECT:** The command position will be taken over directly. **START** must be active.
- **HAND:A / HAND:B:** Manual mode. **START** must be deactivated.
- **PQ_ACTIVE:** Activation of the pressure limitation control function.
- **PQ_INVERSE:** Changing of the control direction of the PQ control (extending or retracting).
- **PQ_SET**: Selecting of the parameter set one or two.
- **DC_ACTIVE:** Activation of the automatic zero point compensation.
- **DC_FREEZE:** Saving of the value of the zero point compensation.
- **F_POS:** Activation of the automatic position errors compensation by external forces.

Command values:

- **Command position:** activated by the START bit. (Resolution 1 µm).
  Second position for *rapid-creep mode.*
-
- **Speed:** 0x3fff correspond with 100 %. Manual speed is also limited by the speed value.
  Second speed activates the *rapid-creep mode*.
-
- **Command pressure:** resolution 0,1 bar or 0x3fff (100 %).

Feedback of status and actual values:

- **READY:** 1 = no error, system is enabled (PB-Bit).
  0 = disabled or an error has been detected
- **STATUS:** 1 = axis within the active POSWIN window.
  0 = axis out of the active POSWIN window.
- **ON_TARGET:** 1 = axis within the target positon (POSWIN:S in NC mode).
  0 = axis out of the target position (POSWIN:S in NC mode).
- **SEG_2:** 1 = second segment of the profile is active
  0 = second segment of the profile is not active
- **PRESSWIN:** 1 = pressure control within the pressure window
  0 = pressure control out of the pressure window
- **$\overline{\text{DERROR}}$:** 1 = no data error.
  0 = data error has been detected.
- **$\overline{\text{ANAERROR}}$:** 1 = analog position sensor OK.
  0 = error (below 3 mA).
- **$\overline{\text{SSIERROR}}$:** 1 = SSI position sensor OK.
  0 = error (out-of-range or error bit).
- **$\overline{\text{PERROR1}}$:** 1 = pressure sensor X1 OK.
  0 = error.
- **$\overline{\text{PERROR2}}$:** 1 = pressure sensor X2 OK.
  0 = error.
- **PQ_ACT x:** 1 = pressure limitation control is active.
  0 = pressure limitation control is inactive.

Feedback values:

- **Internal command position:** input position (SDD mode) or calculated position of the NC generator.
- **Feedback position**: the actual position of the sensor (resolution 0,001 mm).
- **Differential pressure:** pressure (X1- X2) with considering of the areas of the cylinder.

7.5 *Input from PROFIBUS*

7.5.1 **Command overview**

16 data bytes are sent.

<table>
<tr><th>Nr.</th><th>Byte</th><th colspan="2">Function</th><th>Type</th><th>Range</th><th>Units</th></tr>
<tr><td>1</td><td>0</td><td colspan="2" rowspan="2">Control word Hi
Control word Lo</td><td rowspan="2">int</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>2</td><td>1</td></tr>
<tr><td>3</td><td>2</td><td colspan="2" rowspan="4">Command position 1 (Hi)

Command position 1 (Lo)</td><td rowspan="4">long</td><td rowspan="4">0… 10000000</td><td rowspan="4">0,001 mm</td></tr>
<tr><td>4</td><td>3</td></tr>
<tr><td>5</td><td>4</td></tr>
<tr><td>6</td><td>5</td></tr>
<tr><td>7</td><td>6</td><td colspan="2" rowspan="2">Command speed 1 Hi
Command speed 1 Lo
Alternative in FUNCTION: PQ</td><td rowspan="2">uint

int</td><td rowspan="2">0… 0x3fff

0xc001…0x3fff</td><td rowspan="2">0…100%

+/- 100%</td></tr>
<tr><td>8</td><td>7</td></tr>
<tr><td>9</td><td>8</td><td rowspan="4">Command position 2 (Hi)

Command position 2 (Lo)</td><td rowspan="4">Para value</td><td rowspan="4">long</td><td rowspan="4">0… 10000000</td><td rowspan="4">0,001 mm</td></tr>
<tr><td>10</td><td>9</td></tr>
<tr><td>11</td><td>10</td></tr>
<tr><td>12</td><td>11</td></tr>
<tr><td>13</td><td>12</td><td rowspan="2">Command speed 2 Hi
Command speed 2 Lo</td><td rowspan="2">Para Index</td><td rowspan="2">int</td><td rowspan="2">0… 0x3fff
(0… 100 %)</td><td rowspan="2">-</td></tr>
<tr><td>14</td><td>13</td></tr>
<tr><td>15</td><td>14</td><td colspan="2" rowspan="2">Command pressure Hi
Command pressure Lo</td><td rowspan="2">int</td><td rowspan="2">0… 10000
0… 0x3fff</td><td rowspan="2">0,1 bar
%</td></tr>
<tr><td>16</td><td>15</td></tr>
</table>

7.5.2 Definition Control word 1 - Bits

Byte 0 – control word 1 Hi-Byte			
Nr.	**Bit**	**Function**	
1	0	UNITS	0: units in % (0… 0x3fff) 1: units in 0,1 bar
2	1	DIRECT	1: Positon values are set „on the fly“ 0: Position values are set by a signal change (START bit) from 0 to 1
3	2	PQ_INVERSE	Inverse mode of the pressure limitation control
4	3	PQ_ACTIVE	Activation of the pressure limitation control
5	4	HAND-B	Manual mode, defined by the parameter HAND:B
6	5	HAND-A	Manual mode, defined by the parameter HAND:A
7	6	START	Start input for the position control function
8	7	ENABLE	Enabling of the controller

Byte 1 – control word 1 Lo-Byte			
Nr.	**Bit**	**Function**	
1	0	DC_FREEZE	Value of the automatic zero point adjustment will be frozen
2	1	DC_ACTIVE	Activation of the automatic zero point adjustment
3	2	F_POS	Activation of the accurate (fine) positioning at external forces
4	3	Reserve	
5	4	PQ_SET	Switching over between parameter set 1 and parameter set 2
6	5	Reserve	
7	6	*PARAVALID*	Transferring parameter to module
8	7	*PARAMODE*	Activation of the parametrizing mode

7.6 *DATA to PROFIBUS*

7.6.1 Overview (feedback)

16 Bytes are sent to the Profibus.

7.6.1.1 Table for position control (without pressure control function)

Nr.	Byte	Function	Type	Range	Units
1	0	Status word 1 Hi	int		
2	1	Status word 1 Lo			
3	2	Feedback position Hi	long		0,001 mm
4	3	…			
5	4	…			
6	5	Feedback position Lo			
7	6	Internal command position Hi	long		0,001 mm
8	7	…			
9	8	…			
10	9	Internal command position Lo			
11	10	Control error Hi	long		0,001 mm
12	11	…			
13	12	…			
14	13	Control error Lo			
15	14				
16	15				

7.6.1.2 Table for position control with pressure limitation control

Nr.	Byte	Function	Type	Range	Units
1	0	Status word 1 Hi	int		
2	1	Status word 1 Lo			
3	2	Feedback position Hi	long		0,001 mm
4	3	…			
5	4	…			
6	5	Feedback position Lo			
7	6	Internal command position Hi	long		0,001 mm
8	7	…			
9	8	…			
10	9	Internal command position Lo			
11	10	Differential pressure XP*	int	0… 10000 0xc000… 0x3fff	0,1 bar %
12	11				
13	12	Pressure sensor X1	int	0… 10000 0… 0x3fff	0,1 bar %
14	13				
15	14	Pressure sensor X2	int	0… 10000 0… 0x3fff	0,1 bar %
16	15				

7.6.1.3 Table for pressure control / pressure limitation control without position control

Nr.	Byte	Function	Type	Range	Units
1	0	Status word 1 Hi	Integer		
2	1	Status word 1 Lo			
3	2	Undefined			
4	3				
5	4				
6	5				
7	6	Undefined			
8	7				
9	8				
10	9				
11	10	Differential pressure XP*	int	0… 10000 0xc000… 0x3fff	0,1 bar %
12	11				
13	12	Pressure sensor X1	int	0… 10000 0… 0x3fff	0,1 bar %
14	13				
15	14	Pressure sensor X2	int	0… 10000 0… 0x3fff	0,1 bar %
16	15				

* Pseudo differential pressure (the different cylinder areas have been taken in consideration)

7.6.2 Definition status word

Byte 0 – Status word Hi-Byte			
Nr.	**Bit**	**Function**	
1	0		
2	1		
3	2	PQ_ACT	Pressure limitation control is active
4	3	PRESSWIN	Pressure value is within the allowed window
5	4	SEG_2	2nd segment of profile is active
6	5	ON_TARGET	Target position reached (POSWIN:S in NC mode).
7	6	STATUS	Actual position within the active POSWIN range
8	7	READY	System is enabled and no errors are detected

Byte 1 – status word Lo-Byte			
Nr.	**Bit**	**Function**	
1	0	$\overline{\text{DERROR}}$	EEPROM error
2	1	$\overline{\text{ANAERROR}}$	Analog position sensor
3	2	$\overline{\text{SSIERROR}}$	SSI Position sensor error
4	3	$\overline{\text{PERROR1}}$	Pressure sensor 1 error
5	4	$\overline{\text{PERROR2}}$	Pressure sensor 2 error
6	5		
7	6	*PARAACTIVE*	Parameterization mode is active
8	7	*PARAREADY*	Parameter value transferred successfully

7.7 *Parameterization via Profibus*

7.7.1 How to use this function

Control:
PARAMODE: Activation of the parameterization mode (**only possible if 2. profile segment is not active**)

PARAINDEX: Setting the index/address of the parameter which should be changed.
PARAVALUE: Setting the new value for the parameter to be changed.

PARAVALID: When changing this bit to 1 the data will be transmitted.

Feedback:
PARAACTIVE: Parameterization via Fieldbus is activated (**rapid-creep mode not possible**).
PARAREADY: Parameter value was programmed successfully.

Available parameters with its index can be found at the following table.

7.7.2 Table of parameters

Parameter table			
Nr.	**Index**	**Parameter**	**Description**
1	0x2000	A:A	
2	0x2001	A:B	
3	0x2002	D:A	
4	0x2003	D:B	
5	0x2010	V0:A	
6	0x2011	V0:B	
7	0x2020	PT1	
8	0x2021	CTRL	
9	0x2040	F_OFFSET	
10	0x2041	RA:UP	
11	0x2042	RA:DOWN	
12	0x2050	C1:P	
13	0x2051	C1:I	
14	0x2052	C1:D	
15	0x2053	C1:D_T1	
16	0x2054	C1:I_ACT	
17	0x2070	MIN:A	
18	0x2071	MIN:B	
19	0x2074	TRIGGER	
20	0x2075	OFFSET	

8 Notes